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The Effects of Integrative Leadership on the Enterprise Synergy Innovation Performance in a Supply Chain Cooperative Network

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Abstract: Collaborative innovation in a supply chain cooperative network can improve the performance of the enterprise. However, how to achieve the sustainable and stable improvement of the enterprise synergy innovation in a supply chain cooperative network is a common topic of research. Based on a survey of 236 enterprises in 53 supply chain cooperative networks, this study found: (1) Integrative leadership has a positive impact on the enterprise synergy innovation performance in a supply chain cooperative network; (2) Knowledge integration and network relationship embeddedness play partial mediating roles between integrative leadership and the enterprise synergy innovation performance, respectively; (3) Knowledge integration and network relationship embeddedness play a sequenced mediating role between integrative leadership and the enterprise synergy innovation performance; (4) The partial mediation role of knowledge integration and network relationship embeddedness are of no significant difference; however, their single mediating roles are greater than that of the sequenced mediating role of knowledge integration and network relationship embeddedness. This paper further emphasizes the key role of the core organization leadership in a cooperative network and discusses its functional route, which is of great importance in developing the theory system of leadership and providing guidance for the cooperation of the supply chain.

Keywords: sustainable innovation; integrative leadership; synergy innovation performance; knowledge integration; network relationship embeddedness

1. Introduction

Constant innovation has become a critical factor for achieving competitive advantages [1,2]. In the past, most enterprises have relied on internal resources to complete their innovation activities. However, due to the changing environment, enterprises gradually broaden their organizational boundaries by participating in a cooperative network [3]. Scholars believe that the cooperative network can help enterprises spread risk and uncertainty [4], reduce the innovation cost [2], speed up the innovation process [3], and increase revenue [4]. Many enterprises have tried to integrate their resources in a supply chain cooperative network [5,6]. From the strategic perspective of supply chain management, the competition between enterprises has transformed into the competition between supply chains [7,8]. Thus, how to achieve sustainable and stable improvement of the enterprise synergy innovation performance in the supply chain cooperative network has led to many discussions in academia and industry [4,9,10]. Knowledge management scholars have found that a wide variety of heterogeneous external sources can enhance corporate innovation efforts [11,12]. According to the resource-based view, it is essential to obtain new expertise, technology, and resources for enterprise innovation. Therefore, knowledge sharing, absorption, integration, and utilization among enterprises are conducive to improving the collaborative innovation performance in a supply chain cooperative network. Moreover, scholars increasingly emphasize the importance of strategic partnerships. Certain scholars have explored the influence of relationships among different enterprises in the synergy innovation performance in a supply chain cooperative network. Davis & Eisenhardt (2012) suggest that synergy innovation is a complicated, cross-organizational and multidisciplinary activity based on the interactions between multiple supply chain members [13]. Thus, many elements/resources, including the trust among collaborators [2], the formulation of strategic planning [9], and the willingness to share information [14], are required in the process of relationship establishment and maintenance. Through the above analysis, we determine that there are two research limitations in previous studies. First, although previous scholars have explored the impact of resource acquisition and relationship building on collaborative innovation performance [15], there are few discussions on the collective effect of resource acquisition and relationship building. Furthermore, there is no direct administrative affiliation among the supply chain enterprise; opportunistic behavior is likely to occur between participating subjects. In addition, enterprises make decisions independently and attempt to maximize their own benefits. It is likely that one will find a target conflict between a single enterprise and supply chain cooperative network. Crosby & Bryson (2010) and Morse (2010) suggested that the leadership of the core organization has a positive effect on maintaining the cross-sectoral cooperation [16,17] as it has a positive impact on information sharing, joint decisions, relationship establishment and maintenance in the cooperative network. The leadership of the core organization is integrative leadership, which is a new paradigm of leadership, which applies to a cooperative network that has no obvious direct administrative affiliation among enterprises. Few studies have discussed the key role of the core enterprise in the supply chain.

In this paper, we use network relationship embeddedness to describe relationships among partners. Based on the theory of partnership, the resource-based view as well as core organization leadership, this study explores the joint effect of knowledge integration and network relationship embeddedness on the enterprise synergy innovation performance in a supply chain cooperative network. This study contributes to the existing literature by two means: first, although network scholars have discussed leadership as a key factor for collaborative success [18,19], the current work has only focused on the response stage [20]. Additionally, previous research has largely overlooked the specific leadership styles that such diverse members employ in networked structures [21]. This study attempts to fill this gap in the literature. This study is one of the first studies to chart the leadership styles that network members exhibit in a collaborative network. Second, this study adds to the limited empirical research on thriving by numerous means. While establishing the mediating role of knowledge integration and network relationship embeddedness in predicting the influence of leadership on enterprise synergy innovation performance, the current study extends the findings of previous studies [22,23]. This study highlights the joint role of knowledge integration and relationship embedding in leadership and collaborative innovation performance.

2. Theory and Hypotheses

2.1. The Supply Chain Collaboration Network and Enterprise Synergy Innovation Performance

In order to prove that companies in the supply chain cooperation network can obtain higher profits than individual companies, we have performed the following formula derivation. To simplify the problem, first, this study utilizes a three-level supply chain as the research object in the supply cooperative network. The supply chain network contains a supplier, a manufacturer, and a vendor. This study assumes that the manufacturer's product only requires one component from the supplier. The vendor obtains new information on market demand from the customers, then provides the information to the supplier and the manufacturer for parts innovation and product innovation. The price of the parts supplied by the supplier to the manufacturer is w_1; the production cost of each part is c_1. The cost savings from innovation is x for the supplier; the amount of innovation investment is $I_1 = \frac{1}{2}\alpha x^2(\alpha > 0,\ x < c_1)$ [24]. The cost of the material purchased by the manufacturer from the supplier is w_1, and the manufacturer's cost of providing the product is c_2. The cost savings from innovation is y for the manufacturer; the amount of innovation investment is $I_2 = \frac{1}{2}\beta y^2$ $(\beta > 0,\ y < c_2)$ [24]. The price of the product offered by the manufacturer for the vendor is w_2. The quantity of product ordered by the vendor from the manufacturer is q; the price of the product sold by the seller to the customer is p, and the cost of sales is c_3.

It should be emphasized that the formula deduction is based on the following three assumptions. First, the supplier, the manufacturer, and the vendor make decisions based on complete and perfectly rational information. Second, these entities' risk preferences are similar. Third, the product produced by this supply chain network is a *market* monopoly product. Market demand is inversely proportional to product prices, and the market demand and order quantity are equal. This study assumes that the inverse function of the product is $p = a - bq$; parameters $a > 0$, $b > 0$, and $a > c_1 + c_2 + c_3$.

Therefore, the profit of the supplier is:

$$\pi_1 = (w_1 - c_1 + x)q - \frac{1}{2}\alpha x^2.$$

The profit of the manufacturer is:

$$\pi_2 = (w_2 - w_1 - c_2 + y)q - \frac{1}{2}\beta y^2.$$

The profit of the vendor is:

$$\pi_3 = (p - w_2 - c_3)q.$$

The total profit on the supply chain network is:

$$\pi = \pi_1 + \pi_2 + \pi_3 = (p - c_1 + x - c_2 + y - c_3)q - \frac{1}{2}\alpha x^2 - \frac{1}{2}\beta y^2$$

To obtain the total profit on the supply chain network, the command is $\frac{\partial\pi}{\partial x} = 0,\ \frac{\partial\pi}{\partial y} = 0,\ \frac{\partial\pi}{\partial q} = 0,$ and $2b\alpha\beta - \alpha - \beta > 0$. We obtain the total profit:

$$\pi = \frac{\alpha\beta\ (a - c_1 - c_2 - c_3)^2}{2(2b\alpha\beta - \alpha - \beta)}$$

Next, this study assumes that the supplier, the manufacturer, and the seller are innovative alone; they do not share information and communicate with each other. This study finds the maximum of their individual profit.

The maximum profit of the supplier is:

$$\pi_{11} = \frac{\alpha\beta(a - c_3 - c_2 - c_1)^2}{2[2\alpha(4b\beta - 1) - \beta]}.$$

The maximum profit of the manufacturer is:

$$\pi_{21} = \frac{\alpha^2\beta(a - c_3 - c_2 - c_1)^2(4b\beta - 1)}{2[2\alpha(4b\beta - 1) - \beta]^2}.$$

The maximum profit of the vendor is:

$$\pi_{31} = \frac{b\alpha^2\beta^2(a - c_3 - c_2 - c_1)^2}{[2\alpha(4b\beta - 1) - \beta]^2}$$

The sum of the supplier, manufacturer, vendor profits are:

$$\pi' = \pi_{11} + \pi_{21} + \pi_{31} = \frac{\alpha\beta a - c_3 - c_2 - c_1{}^2(14b\beta - 3\alpha - \beta)}{2[2\alpha(4b\beta - 1) - \beta]^2}$$

After calculation, this study found that $\pi > \pi'$, the total profit of the supply chain collaboration network is greater than the alone innovation supplier, manufacturer and seller, and the supply chain cooperation network can enhance the synergy innovation among enterprises.

2.2. Integrative Leadership and Enterprise Synergy Innovation Performance

Although certain scholars have realized that the core enterprise in the supply chain network plays an important role in enhancing the entire supply chain competitiveness by maintaining the relationship with upstream and downstream enterprises, few scholars have explored this problem from the perspective of the core enterprise leadership role in the supply chain network. The main reasons are as follows. First, the research limitations in the field of leadership leads to this problem. The supply chain network is a nearly equal transaction network, which has no obvious direct administrative affiliation among enterprises [17]. Therefore, the research requires a new, particular leadership paradigm to address the situation above. Second, the complexity of the supply chain network requires networked leadership. Enterprises in one supply chain cooperative network are not only components of a supply chain but also as components of a network structure. This interaction makes an enterprise operate at multiple structures or different levels in a supply chain cooperative network [25,26]. Therefore, the situation above calls for the leadership of a core enterprise to coordinate the strategic objective into the overall strategic objective of the supply chain cooperative network to achieve its competitive advantage. Third, the dynamic nature of the supply chain cooperative network requires dynamic leadership. Specifically, the purpose of the supply chain cooperative network is to achieve innovation and development and access to a sustainable competitive advantage; this requires enterprises to absorb and integrate innovation resources of its external supply chain continuously. Since the search, absorption, and integration of external resources are based on the exploration, establishment, and maintenance of relationships, the supply chain cooperative network is in a dynamic environment. In conclusion, it is absolutely necessary to study the networked leadership from a dynamic perspective in a supply chain cooperative network.

Bryson and Crosby constructed a research framework of integrative leadership on the basis of cross-sector collaboration networks [16,27]. In order to form a unified concept and core elements of integrative leadership, this study analyzed published research cases through grounded theories [16,20,28–30]. This study defined the integrative leadership as one sort of dynamic and networking driving ability, which utilizes the integration of leadership elements and strategic decision-making among enterprises as its foundation and the integration of relationships as its core by establishing operating and safeguard mechanisms to achieve common interests. The integrative leadership is divided into five integration dimensions: leadership elements, strategic decision-making, relationship, operational mechanism, and security mechanism integrations. Leadership elements integration means that the core enterprise in the cooperative network can guide, encourage, and coordinate enterprises to actively participate in cooperation, then establish a beautiful vision and mission in the cooperative network. Strategic decision-making integration mainly refers to the integration of enterprises' objectives and intentions, as core enterprise can encourage other enterprises to develop strategies and make decisions together. Relationship integration mainly refers to the identification of stakeholders, relationship establishment, and relationship maintenance among enterprises in a cooperative network. Operational mechanism integration mainly refers to the establishment of communication, trust and sharing mechanisms in a cooperative network. Additionally, security mechanism integration mainly refers to a fair performance evaluation, the development of common rules and the response to a crisis situation.

The impact of integrative leadership on the cooperative innovation performance in the supply chain cooperative network mainly includes the following three aspects. First, according to the mechanism of the cooperative network, enterprises in the cooperative networks can break their enterprise boundaries to achieve the integration of core knowledge as well as to increase their opportunities to learn from each other [31]. Knowledge integration will provide innovative resources for the cooperative network and ultimately enhance enterprise synergy innovation performance in a supply chain cooperative network. Leadership elements integration can encourage leaders from different enterprises to actively participate in collaboration innovation activities in a supply chain cooperative network; this is conducive to cross-border activities such as the dissemination and exchange of knowledge among enterprises to achieve products or service innovation [3,11]. Second, from the perspective of joint strategy-making, some scholars have discussed that the cooperation strategy in the supply chain cooperative network can provide a competitive advantage for the enterprise and its partners [4]. The strategic decision-making integration of integrative leadership can ensure enterprises in a supply chain cooperative network have a common strategic goal to achieve collaborative innovation and development. Finally, from the perspective of relationship integration, since the collaborative innovation performance among enterprises in a supply chain collaboration network cannot be separated from the innovation resource support, integrative leadership can guide and encourage stakeholders to participate in the collaborative network. Through relationship integration, resources are introduced to provide the material and technical guarantee for the improvement of enterprise synergy innovation performance in the supply chain collaboration network [32].

Based on the above analysis, this study explores the relationship between integrative leadership and enterprise synergy innovation performance in supply chain cooperative network and proffers the following hypothesis:

Hypothesis 1 (H1). *Integrative leadership has a significantly positive influence on enterprise synergy innovation performance in a supply chain cooperative network.*

2.3. Knowledge Integration, Integrative Leadership, Enterprise Synergy Innovation Performance

Knowledge integration refers to the dynamic process of knowledge acquisition, deconstruction, fusion, and reconstruction. Knowledge is considered to be the source of innovation. Enterprises are all attempting to innovate their products by updating their existing knowledge bases [33]. Companies to search and use external knowledge by crossing organizational boundaries for knowledge integration [34]. In a supply chain cooperative network, companies all attempt to gain competitive advantages through external innovation by using knowledge acquisition, deconstruction, fusion, and reconstruction as needed [35,36]. In addition, studies have suggested that suppliers and customers are important sources of knowledge in the supply chain [37]. The exchange of knowledge that comes from suppliers and customers can promote the development of new products among enterprises in a supply chain cooperative network [38]. Resource-based view notes that knowledge integration can provide necessary knowledge for the innovation and development, this will definitely have a positive impact on enterprise synergy innovation performance in the supply chain cooperative network.

Integrative leadership is one type of leadership that applies to a cooperative network, it can promote and maintain cross-sector cooperation [16]. Therefore, this study attempts to explore integrative leadership's role with respect to knowledge integration based on the following two aspects. First, integrative leadership has the property of crossing organizational boundaries; this can provide opportunities for interdisciplinary learning and promote the spread and diffusion of new ideas and perspectives among organizations [39]. Knowledge integration occurs when the external knowledge matches with the knowledge that is required by an organization's internal innovation activity. Second, integrative leadership has the characteristics of relationship integration, which has two components. One is the search, establishment, and maintenance of external relations; when the enterprise establishes a number of external relations, it can contact and access more external resources and information. As suggested by Zahra, Ireland, & Hitt (2000), the more the external relationships an enterprise has, the more likely it is to achieve knowledge integration [40]. It is conducive to achieve a full range of knowledge integration. The other is the stable cooperation environment for the supply chain cooperation network that is provided by the maintenance of the relationship. When the enterprise is in a stable cooperative network, it is more likely to promote knowledge integration [41].

Based on the above analysis, this study explores the relationship among integrative leadership, knowledge integration, and enterprise synergy innovation performance in a supply chain cooperative network and proffers the following hypotheses:

Hypothesis 2 (H2). *Integrative leadership has a significantly positive influence on knowledge integration in a supply chain cooperative network.*

Hypothesis 3 (H3). *Knowledge integration has a significantly positive influence on enterprise synergy innovation performance in a supply chain cooperative network.*

Hypothesis 4 (H4). *Knowledge integration has a mediating effect between integrative leadership and enterprise synergy innovation performance in a supply chain cooperative network.*

2.4. Network Relationship Embeddedness, Integrative Leadership, Enterprise Synergy Innovation Performance

The concept of network relationship embeddedness is derived from Granovetter's research on embedding degree. He considered that the embedding degree of a network relationship referred to the trust and degree of closeness of the inter-network [42]. On the basis of Granovetter, Uzzi (1997) divided relationship embeddedness into three dimensions: trust, information sharing, and common problem solving [43]. We discuss the relationship between network relationship embeddedness and enterprise synergy innovation performance in a supply chain cooperative network from the following three aspects. First, we can see from the perspective of trust. Trust is conducive to establishing commitment among enterprises. Trust is the basis of inter-firm cooperation; if there is no trust, a cooperative alliance is not possible or sustainable [2,44]. Lack of trust leads to uncertainty, which will cause barriers to form and inhibit the sustainability of long-term relationships [45,46]. Thus, the higher the level of trust among enterprises is, the more stable the relationship among them. Morgan and Hunt (1994) argued that trust exists when one party has confidence in its exchange partner's reliability and credibility [47]. Zhao and Cavusgil (2006) found that trust was important for relationship continuity and enhancement [48]. In the scenario of a supply chain cooperative network, a stable cooperative network environment will further help to improve the enterprise synergy innovation performance [38]. Furthermore, Zhang and Huo (2013) suggested that trust with customers/suppliers significantly influences supply chain integration [49]. Second, we can observe from the information sharing perspective. Information sharing can promote relationship integration between suppliers and manufacturers in the supply chain network to realize the flow of resources, experience, and information [14,50,51]. In addition, information sharing can help to realize the sharing of business goals, strategies, product flow, capital flow and collaborative information flow, thus avoiding harmful information distortion; it also makes the firms conducive to constant collaborative innovation development among enterprises [52,53]. Finally, we can observe from the solving problems together perspective. Solving problems together can help to improve the engagement among enterprises in a supply chain cooperative network. When enterprises are involved in solving one common problem together in a supply chain cooperative network, they will cherish the stable environment more as it is established alone. Furthermore, solving problems together can achieve deep learning among enterprises, which means that enterprises can learn from each other regarding their thought processes and methodologies in problem solving; this is also a suitable means of resource gaining.

The impact of the integrative leadership on network relationship embeddedness in the supply chain cooperative network mainly includes the following aspects. First, integrative leadership can strengthen the level of trust among supply chain partners through establishing trust mechanisms and creating fair performance appraisal methods, basic rules, and regulations for safeguarding cooperation. Second, the integrative leadership can enhance the information sharing between enterprises by establishing communication mechanisms and sharing platforms. Third, integrative leadership can integrate the strategic objectives of each enterprise into one overall goal in a supply chain cooperative network. When the problem is ultimately based on the vital interests of the participating enterprises, their willingness to participate in problem solving will be higher.

Based on the above analysis, this study explores the relationship between integrative leadership, network relational embeddedness, and enterprise synergy innovation performance in a supply chain cooperative network and proffers the following hypotheses:

Hypothesis 5 (H5). *Integrative leadership has a significantly positive influence on network relational embeddedness in a supply chain cooperative network.*

Hypothesis 6 (H6). *The Network relational embeddedness has a significantly positive influence on enterprise synergy innovation performance in a supply chain cooperative network.*

Hypothesis 7 (H7). *The Network relational embeddedness has a mediating effect between integrative leadership and enterprise synergy innovation performance in a supply chain cooperative network.*

2.5. Integrative Leadership, Network Relationship Embeddedness, Knowledge Integration, and Cooperative Innovation Performance among Enterprises

In a supply chain cooperative network, the impact of network relationship embeddedness on the knowledge integration is mainly reflected in the following aspects. First, trust is the foundation of knowledge integration among enterprises. The goodwill, trust and reciprocal expectation among firms can reduce the sense of distrust and provide a stable environment for enterprises to participate in knowledge acquisition and integration [54]. Trust among enterprises can reduce the cost of supervising opportunistic behavior and allow them to put more effort into knowledge integration. Second, information sharing can promote the sharing of knowledge and resources among enterprises. A high degree of information sharing among enterprises can broaden their understanding of other enterprises' resources. When certain enterprises need corresponding innovation resources, they can achieve knowledge integration timely and effectively. Third, problem solving together can achieve deep learning among enterprises. Enterprises can learn from each other regarding thought processes and methodologies to solve problem. Additionally, the enterprises can acquire, deconstruct, integrate, and reconstruct the resources and knowledge of other companies in the supply chain network, which is conducive to realizing knowledge integration.

Based on the above analysis, this study explores the relationship among integrative leadership, network relational embeddedness, knowledge integration, and enterprise synergy innovation performance in a supply chain cooperative network and proffers the following hypotheses:

Hypothesis 8 (H8). *The Network relational embeddedness has a significantly positive influence on knowledge integration in a supply chain cooperative network.*

Hypothesis 9 (H9). *The Network relational embeddedness and knowledge integration have a sequenced mediating effect between integrative leadership and enterprise synergy innovation performance in a supply chain cooperative network.*

Based on the above analysis, the research model of this paper is provided (see Figure 1).

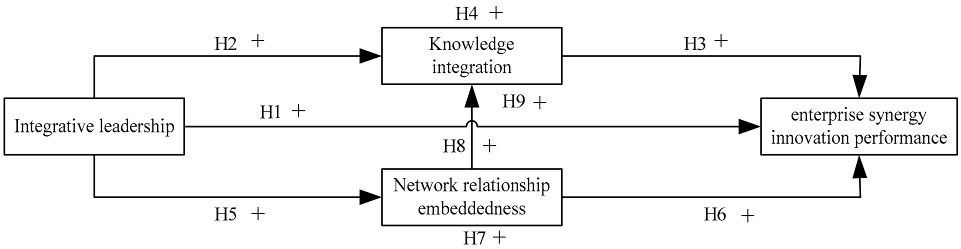

Figure 1. Theoretical Model.

3. Research Method

3.1. Data Collection

The research adopts the questionnaire survey method to collect sample data and test the stated hypotheses. Sample firms include production, processing, and manufacturing firms with obvious supply chain industry characteristics. The data were collected in China's north, south and northeast. The target population is the leaders of the enterprises in a supply chain cooperative network. Data from the questionnaire were collected by MBA students through private relationships and local government members. In this process, 385 questionnaires were distributed, while 305 questionnaires were recovered; of these, 69 questionnaires were invalid, and 236 questionnaires were sufficiently completed. Only 53 supply chain cooperative networks were included in 236 questionnaires, and there was an average of 4.94 companies in each supply chain cooperative network. Specific sample statistics are as follows (see Table 1).

Table 1. Descriptive statistics of the survey sample.

Variable	Category	Frequency	Accounting
Enterprise size	0–100 persons	67	28.88%
	101–499 persons	83	35.78%
	500 persons and above	86	35.34%
Industries	Machinery manufacturing industry	97	41.81%
	Electronics manufacturing industry	87	35.78%
	Clothing industry	44	18.97%
	Other industry	8	3.45%
Enterprise areas	Northern China	57	22.84%
	Southern China	78	33.62%
	Northeastern China	101	43.53%
Enterprise nature	State-owned enterprises	72	31.03%
	Private enterprise	91	39.22%
	Foreign companies	50	19.83%
	Other companies	23	9.91%

3.2. Variables Measurement

Questionnaire items regarding knowledge integration, network relationship embeddedness, and enterprise synergy innovation performance were translated into Chinese based on translation and back-translation methods; this was administered by two linguistics professionals. In addition, a whole set of the questionnaire was refined by a panel of several experts who majored in management and had extensive work experience; they ensured the content validity of the measurements. Table 2 shows the items of this scale, which covers the three variables in addition to integrative leadership: knowledge integration, network relationship embeddedness, and enterprise synergy innovation performance. As there is no mature scale for integrative leadership, we will develop a scale of integrative leadership later in this study.

Table 2. Construct measurement summary: confirmatory factor analysis and scale reliability.

Item Description	Standardized Loading	Cronbach's α
Enterprise Synergy Innovation Performance		
Product innovation		
1. Number of new products/services introduced since joining the supply chain network	0.89	0.926
2. Pioneer disposition to introduce new products/services since joining the supply chain network	0.87	
3. Efforts to develop new products/services in terms of hours/person, teams and training involved since joining the supply chain network	0.76	
Process innovation		
1. Number of changes in process introduced since joining the supply chain network	0.82	0.952
2. Pioneer disposition to introduce new process since joining the supply chain network	0.87	
3. Clever response to new processes introduced by other companies in the same sector since joining the supply chain network	0.77	
Administrative innovation		
1. Novelty of administrative systems since joining the supply chain network	0.69	0.893
2. Search for new administrative systems by managers since joining the supply chain network	0.83	
3. Pioneer disposition to introduce new administrative systems since joining the supply chain network	0.79	
Knowledge integration		
Knowledge acquisition		
1. Have a shared vision with partners in the supply chain network	0.81	0.876
2. Trust partners in a supply chain network	0.82	
3. Partners are willing to share knowledge with us in the supply chain network	0.76	
Knowledge deconstruction		
1. We are familiar with the knowledge gained from the outside in the supply chain network	0.83	0.916
2. We have experts who are familiar with the external knowledge in our company	0.85	
3. The extent to which external knowledge is understood by everyone	0.81	
Knowledge fusion		
1. External knowledge can be widely disseminated within the enterprise	0.76	0.887
2. We can quickly grasp the external knowledge in the supply chain network	0.81	
3. We can apply external knowledge in practice	0.79	
4. We can combine knowledge in different areas	0.77	
Knowledge reconstruction		
1. We can draw inferences from external knowledge	0.73	0.907
2. We can replace old knowledge with new knowledge	0.78	

Table 2. *Cont.*

Item Description	Standardized Loading	Cronbach's α
3. We can use the acquired knowledge to build a complete knowledge system	0.84	
4. The acquired knowledge can stimulate the original knowledge to play a role	0.81	
Network relationship embeddedness		
Joint problem solving		
1. Our main (customer/supplier/manufacturer) works with us to overcome difficulties	0.73	0.901
2. We are jointly responsible with our main (customer/supplier/manufacturer) for getting things done	0.69	
3. We work with our main (customer/supplier/manufacturer) to help solve each other's problems	0.71	
Information sharing		
1. Our main (customer/supplier/manufacturer) warns us of events that may create problems for us	0.81	0.837
2. Our main (customer/supplier/manufacturer) shares its plans for the future with us	0.83	
3. Our main (customer/supplier/manufacturer) shares proprietary and sensitive information with us	0.85	
Interorganizational trust		
1. Our main (customer/supplier/manufacturer) negotiates fairly with us	0.78	0.912
2. Our main (customer/supplier/manufacturer) does not mislead us	0.76	
3. Our main (customer/supplier/manufacturer) keeps its word	0.93	

(1) Control variabl es

The measurement items of control variables are based on previous academic journal papers and theses. We set the enterprise size, enterprise industry, the enterprise region, and the enterprise nature as control variables.

(2) Enterprise synergy innovation performance

The previous literature defended the use of a range of performance measures, not only a single one and not only financial indicators [55,56]. In accordance with the literature, the questionnaire used in this study asked the firms about the evolution of their performance during the previous three years using items proposed by Quinn and Rohrbaugh, Jiménez-Jiménez, and Sanz-Valle [55,57]. To highlight the context of the "supply chain cooperative network", the words "since joining the supply chain network" were added to each measurement item.

(3) Knowledge integration

Mainly using a number of previous research results, knowledge integration is divided into four dimensions in this study. The four dimensions of knowledge integration refer to knowledge acquisition [58,59], deconstruction [60], fusion [61,62], reconstruction [63], and include a total of 14 items. To highlight the context of the "supply chain cooperative network", the words "in a supply chain network" were added to certain measurement items.

(4) Network relationship embeddedness

The joint problem-solving construct of this paper was measured using a three-item instrument that I based on the scale developed and validated by Heide and Miner [64]. The instrument captures the degree to which exchange partners share the responsibility for resolving problems as they arise [54]. Information sharing captures the degree to which parties actively exchange information beyond the letter of the contract-information that can facilitate the other party's activities. We used a modified version of the instrument developed and validated by Heide and Miner for measuring information sharing [62]. We operationalized interorganizational trust in a lead customer or supplier with a three-item scale reflecting the degree to which the exchange partner is fair in its dealing and does not attempt to take advantage of the focal firm [54]. Interorganizational trust describes the extent to which the members of a focal firm have a collectively held trust orientation toward a customer or supplier firm [65]. Our trust measurement instrument is based on a shortened version of the scale developed and validated by Cummings and Bromiley [66].

(5) Integrative leadership

The measurement of this variable contains the following steps. First, on the basis of the literature [16,20,28], this paper extracts the elements of integrative leadership by means of the literature analysis. A total of 24 elements were extracted, including organizational boundary crossing, goal coherence, and stakeholder participation. The main process is as follows. Through the method of grounded theory, the research team members labeled the materials obtained from the cases and ultimately obtained 125 labels. Then, these labels are conceptualized and classified, and 24 concepts and 8 categories are obtained. Second, based on the research by Strauss and Corbin [67], the labels are axial coded for 8 categories. The 5 elements of the 3 categories are "causal" "background" and "outcome"; the other 19 elements are integrated into the research scale of integrative leadership. Third, the 19 elements were transformed into questionnaire items, and the initial scale of integrative leadership was obtained. Then, the questionnaire was completed by middle and senior leaders who participated in project cooperation. A total of 462 questionnaires are distributed, and 339 questionnaires were recovered, of which 45 questionnaires are invalid, and 294 questionnaires are sufficiently completed. The questionnaire is randomly divided into two parts. Each part includes 147 questionnaires. One part is used for exploratory factor analysis, and the other is used for verification factor analysis. Exploratory factor analysis explored a total of five factors, and cumulative variance explained 66.87%. Then, each factor is named according to the factor feature (see Table 3). Finally, the confirmatory factor test used Amos19.0 software. The results are shown in Table 4. Each inspection index is within the acceptable limits.

Table 3. Exploratory factor analysis results regarding integrative leadership (N = 147).

Factor Name	Elements	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Leadership element integration	Inspiration and encouragement	0.827				
	Coordination and guidance	0.833				
	Vision and mission	0.812				
	Techniques and skills	0.734				
Strategic decision-making integration	Goal congruence		0.817			
	Joint decision making and planning		0.784			
	Common strategy formulation		0.723			
Relationship integration	Establish core group			0.711		
	Stakeholder participation			0.783		
	Partnership establishment			0.862		
	Partnership maintenance			0.818		
Operational mechanism integration	Organizational legitimacy				0.793	
	Communication mechanism				0.802	
	Trust mechanism				0.826	
	Sharing mechanism				0.789	
	Leadership roles and styles				0.702	
	Performance evaluation				0.633	
Security mechanism integration	Policy rules					0.710
	Emergency response					0.689
characteristic value		3.311	2.524	3.103	3.972	1.432
cumulative variance explained (%)		13.513	25.671	39.103	58. 241	66.874

Table 4. Verification factor analysis results regarding integrative leadership (N = 147).

Index	χ^2/df	GFI	NFI	IFI	CFI	RMSEA
First-order model	2.11	0.91	0.92	0.90	0.91	0.032
Two order model	1.38	0.93	0.92	0.91	0.92	0.027
Empirical value	<3	>0.9	>0.9	>0.9	>0.9	<0.1

The average variance extracted (AVE) values of each dimension were calculated as 0.614, 0.592, 0.585, 0.627, and 0.611, respectively. In terms of convergent validity, the AVE value of each dimension is greater than 0.5, and the standardized factor loading coefficients of all items are greater than 0.707, indicating that the convergent validity of the scale was suitable. In terms of discriminant validity, the correlation coefficient of any two dimensions is between 0.34 and 0.47. The square of the correlation coefficient between each dimension is obtained, and the maximum value is $0.47 \times 0.47 = 0.221 < 0.585$. Therefore, the discriminant validity of the scale was good. In sum, the scale has passed the test.

3.3. Reliability Analysis, Validity Analysis, Common Method Variance

In this paper, the reliability and validity of the data were tested using SPSS20.0 and AMOS19.0. First, this paper uses SPSS20.0 to test the impact of the different survey methodologies on the results of the study. We used the T test and the one-way ANOVA to find that there was no significant difference in the data collected from the two routes. This result shows that the two groups of samples are from the same female; the path differences of data collection will not have an impact on the results of this study. Second, we tested the reliability of the research data using SPSS20.0. Finally, we tested the validity of the research data using AMOS19.0. The specific test results of the reliability and validity are shown in Table 5. From the data analysis results, the fitting index of each variable is within the empirical value. The reliability coefficient is greater than 0.7. These results show that the reliability and validity of the scale were good.

Table 5. Reliability and validity results of scale (N = 236).

Variable	Mean	SD	χ^2/df	GFI	CFI	RMSEA	Composite Reliability
Integrative leadership	3.23	1.12	1.46	0.92	0.91	0.02	0.94
Knowledge integration	3.64	1.07	2.71	0.91	0.91	0.01	0.91
Network relationship embeddedness	3.21	1.03	2.33	0.93	0.93	0.03	0.91
Synergy innovation performance	3.56	1.12	2.49	0.91	0.92	0.06	0.90

In this paper, the Harman single factor test method is used to test whether the data of this paper has homologous variance. However, the variance extracted by the common methods factor was only 20.31%, which is below the 50% cutoff that has been suggested as indicating the presence of a latent factor representing the manifest indicators.

4. Hypothetical Test

4.1. Correlation Analysis and Main Effect Test

(1) Correlation analysis

Table 6 provides an overview of the means and standard deviations of the constructs and the correlations between the variables. From the data in the table, we can observe that there is a clear correlation among the core variables, and the hypothesis of this paper has also been verified.

Table 6. Means, Standard Deviations, and Correlations among the core Variables.

Variable	Mean	SD	1	2	3	4	5	6	7	8
Enterprise size	2.08	1.017	1							
Enterprise Industry	1.81	1.324	0.122	1						
Enterprise area	2.19	1.225	0.119 **	0.332	1					
Enterprise nature	2.10	1.167	0.213	0.421 *	0.312	1				
Integrative leadership	3.23	1.122	0.038 *	0.207	0.329 **	0.212	1			
Knowledge integration	3.64	1.073	0.005	0.087 *	0.313	0.237 *	0.023 **	1		
Network relationship embeddedness	3.21	1.031	0.107 *	0.213	0.239*	0.154	0.212 **	0.356 *	1	
Synergy innovation performance	3.56	1.121	0.214	0.136 *	0.211	0.313 ***	0.145*	0.236 **	0.162 **	1

* $p < 0.05$ level (2-tailed); ** $p < 0.01$ level (2-tailed); *** $p < 0.001$ level (2-tailed).

(2) Main effect test

In the first step of our analysis, we tested the main effect using MPLUS9.0. Through the structural equation model shown in Figure 2, integrative leadership has a positive impact on enterprise synergy innovation performance (β = 0.41, $p = 0.003 < 0.01$). Additionally, this model produced a good fit to the data, indicating that the main effect of the model is established, confirming H1.

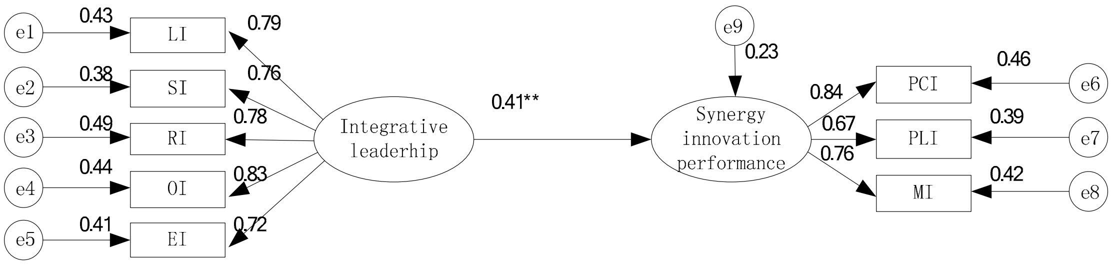

Figure 2. Main effect model. Note: ** $p < 0.01$; Model fit: $\chi^2/\text{df} = 2.206$, GFI = 0.91, CFI = 0.93, RMSEA = 0.032.

4.2. Structural Model Test

For the rigor of data analysis, we have worked through four steps to test the structural model; the final model is shown in Figure 3. In the first step, the demographic variables are put into the model as control variables. Then, all control variables are transformed into dummy variables in the model. The enterprise size variable is divided into three groups: the low group (under the people of 100), the medium group (101 to 499 people), and the high group (above 500 people). The industries variable is divided into four groups: machinery manufacturing, electronics manufacturing, clothing and other. The enterprise areas' variable is divided into three groups: northern China, southern China, and northeastern China. The enterprise nature variable is divided into three groups: private enterprise, foreign companies, other companies. In the fitting model, the control variables, only including enterprise size, influence the enterprise synergy innovation in the supply chain cooperative network. Enterprise size positively influences the knowledge integration (β = 0.132, $p = 0.014 < 0.05$) and network relationship embeddedness (β = 0.253, $p = 0.021 < 0.05$). At the same time, enterprise size positively influences enterprise synergy innovation (β = 0.097, $p = 0.008 < 0.01$).

In the second step, we incorporated integrative leadership, knowledge integration and network relationship embeddedness into the model and test the effect of integrative leadership on knowledge integration and network relationship embeddedness. The purpose of this step is to examine the possibility of two mediating variables between the integrative leadership and enterprise synergy innovation performance. From the results of the test (digital display in parentheses), integrative leadership has a positive impact on knowledge integration and network relationship embeddedness (β = 0.258, $p = 0.026 < 0.05$; β = 0.413, $p = 0.007 < 0.01$). Thus, we judged initially that there may be two mediation variables between integrative leadership and enterprise synergy innovation performance.

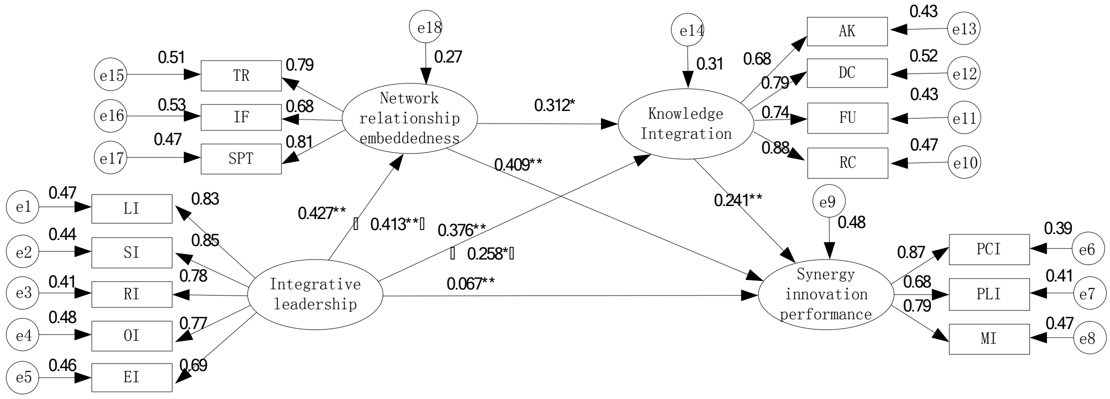

Figure 3. Structural model with standardized regression coefficients. Note: ** $p < 0.01$; * $p < 0.05$; Model fit: $\chi^2/\text{df} = 1.26$, CFI = 0.956, TFI = 0.937, RSMEA = 0.027.

In the third step, we incorporated integrative leadership, knowledge integration, network relationship embeddedness, and enterprise synergy innovation performance into a new model to examine the multiple effects of the mediating variables. From the results of the test, integrative leadership has a positive impact on enterprise synergy innovation performance. Integrative leadership has a positive impact on knowledge integration and network relationship embeddedness, respectively ($\beta = 0.376$, $p = 0.003 < 0.01$; $\beta = 0.427$, $p = 0.008 < 0.01$). Therefore, H2 and H5 are confirmed. Knowledge integration and network relationship embeddedness have a positive impact on enterprise synergy innovation performance ($\beta = 0.241$, $p = 0.006 < 0.01$; $\beta = 0.409$, $p = 0.007 < 0.01$). Therefore, H3 and H6 are confirmed. It can be concluded that knowledge integration and network relationship embeddedness play a mediation role between integrative leadership and enterprise synergy innovation performance. Therefore, H4 and H7 are confirmed. In addition, network relationship embeddedness has a positive impact on knowledge integration ($\beta = 0.312$, $p = 0.037 < 0.05$), thus confirming H8. This result shows that knowledge integration and network relationship embeddedness play a sequenced mediation role between integrative leadership and enterprise synergy innovation performance, thus confirming H9. Additionally, the fitting index of the above model is $\chi^2/\text{df} = 1.26$, CFI = 0.956, TFI = 0.937, RSMEA = 0.027, which are within acceptable limits. To further determine whether knowledge integration and network relationship embeddedness play a partial mediating role or a complete mediating role, we removed the path between integrative leadership and enterprise synergy innovation performance, then tested the mediation effect again. The results show that knowledge integration and network relationship embeddedness continue to have a mediation role between integrative leadership and enterprise synergy innovation performance. However, the fitting index of this model is $\chi^2/\text{df} = 5.18$, CFI = 0.893, TFI = 0.901, RSMEA = 0.089. Compared with the previous model, the fitting index is obviously worse. Therefore, this study accepts the partial mediation model, which is more accurate.

In the final step, we set the bootstrap sampling to 3000 then test the program of mediation effect using MPLUS7.0. The specific results are shown in Table 7. In this operation, the mediation effects of the different paths and the intensity differences of mediation variables were examined. We set the path coefficient between integrative leadership and network relationship embeddedness to a1 and the path coefficient between network relationship embeddedness and enterprise synergy innovation performance to b1. Additionally, we set the path coefficient between integrative leadership and knowledge integration to a2 and the path coefficient between knowledge integration and enterprise synergy innovation performance to b2. We set the path coefficient between network relationship embeddedness and knowledge integration to c1. Therefore, the level of different mediation effects is M1 = a1b1, M2 = a2b2, and M3 = a1c1b2. The total mediation effect is M = M1 + M2 + M3. The comparison between different mediation effects was DM1 = M3 − M1, DM2 = M3 − M2, and DM3 = M1 − M2. From the data analysis, it can be observed that, in the mediation effect of network relationship embeddedness and knowledge integration, the sequenced mediation effect of both are verified. From the perspective of a mediation effects comparison, in the partial mediation role of knowledge integration and network relationship embeddedness, there is no significant difference between the integrative leadership and the enterprise synergy innovation performance; however, their single mediating roles are greater than the sequenced mediating role of knowledge integration and network relationship embeddedness.

Table 7. Mediating effect strength test.

Mediation Model	PE	Upper Limit	Lower Limit	Judging Standard	Conclusion
M1: IL-NRE-SIP	0.17	0.078	0.214	The corresponding interval of point estimates whether it contains 0. Including 0 is not significant, not including 0 is significant	The mediating effect holds, confirming H7
M2: IL-KI-SIP	0.09	0.172	0.308		The mediating effect holds, confirming H4
M3: IL-NRE-KI-SIP	0.03	0.321	0.513		The mediating effect holds, confirming H9
DM1 = M3 − M1	−0.14	−0.109	−0.007		Significantly, the M1 effect is greater than M3
DM2 = M3 − M2	−0.06	−0.321	−0.061		Significantly, the M2 effect is greater than M3
DM3 = M1 − M2	0.08	−0.098	0.238		Not significant, M1, M2 effect quite

Note: IL represents integrative leadership, NRE represents network relationship embeddedness, SIP represents synergy innovation performance, and KI represents knowledge integration. PE represents point estimation.

5. Discussion and Revelation

5.1. Discussion of the Results and Theoretical Contribution

We conducted an empirical analysis on the relationships among integrative leadership, knowledge integration, network relationship embeddedness, and enterprise synergy innovation performance. This study seeks to draw the attention of managers in a supply chain cooperative network toward the role of integrative leadership, knowledge integration and network relationship embeddedness so as to promote enterprise synergy innovation performance. The study also demonstrates that the relationship among members in cooperative networks exerts significant influence on knowledge integration [14,50,51] and enterprise synergy innovation performance [52,53]. The theoretical contributions of this study are as follows:

First, integrative leadership is conducive to the improvement of the synergy innovation performance among enterprises in a supply chain cooperative network. This conclusion verifies the conjecture of the relationship between the core enterprise leadership and enterprise synergy innovation performance in a supply chain cooperative network [18–20]. In previous studies, scholars have demonstrated the positive effects of cross-border cooperation and consistency of strategic goals on cooperation innovation among organizations in cooperative networks [4,32]. However, these studies did not emphasize the role of leadership among organizations in cooperative networks. The core elements of integrative leadership, such as relationship integration and strategic decision integration, have positive impacts on the cross-border cooperation and the consistency of strategic goals among organizations. The conclusions of the study not only further confirm the views of previous scholars [4,31], but also enrich the theory of inter-organizational leadership and the research perspectives of the enterprise synergy innovation performance in a supply chain collaboration network. At the same time, this study analyzes the connotation of integrative leadership and developed its scale, which will further enrich theoretical and practical research on integrative leadership [16,17].

Second, knowledge integration plays a partial mediating role between integrative leadership and enterprise synergy innovation performance. Scholars have confirmed that integrative leadership can ensure cross-border cooperation among organizations in cooperative networks [18,20,53]. The positive effect of cross-border cooperation on knowledge integration has been confirmed by scholars [34], and it is also true in a supply chain cooperation network [38]. Knowledge integration can bring new knowledge and resources to the enterprise, and it is conducive to carrying out innovation activities among partners, thereby enhancing collaborative innovation performance [39]. The conclusions of this study confirm that integrative leadership is the key influencing factor of knowledge integration among enterprises in a supply chain cooperative network. On the other hand, knowledge integration plays an important role in bridging integrative leadership and collaborative innovation performance among enterprises in a supply chain cooperative network.

Third, network relationship embeddedness plays a partial mediating role between integrative leadership and enterprise synergy innovation performance. The good communication mechanism and information sharing mechanism established by integrative leadership can achieve trust among enterprises in a supply chain cooperation network. The positive impact of trust on network relationship embeddedness has been confirmed by scholars [47,48]. Therefore, the study concluded that integrative leadership not only can affect knowledge integration, but also can influence the establishment and maintenance of relationships among enterprises in a supply chain cooperative network. In addition, the positive effect of network relationship embeddedness on knowledge integration has been confirmed and the positive effect of network relationship embeddedness on collaborative innovation performance among enterprises in a supply chain cooperative network has also been confirmed. The research conclusions also emphasize the joint effects of integrative leadership, network relationship embeddedness, and knowledge integration on collaborative innovation performance among enterprises in a supply chain cooperative network. That is, integrative leadership influences knowledge integration through network relationship embeddedness, and knowledge integration then influences collaborative innovation performance among enterprises in a supply chain cooperative network.

Finally, this study finds that the partial mediating role of knowledge integration and network relationship embeddedness has no significant difference between integrative leadership and the enterprise synergy innovation performance; however, their single mediating roles are greater than their sequenced mediating roles. Therefore, we further confirmed the important roles of knowledge and relationships for enterprise synergy innovation performance [22,23]. Furthermore, this study clarifies the role of the relationship between enterprises. Specifically, the relationship between enterprises has a positive effect on knowledge integration, thus improving the enterprise synergy innovation performance in the supply chain cooperative network.

5.2. Management Inspiration

According to this paper's conclusion, three points of management inspiration are proposed; we hope that these recommendations will be helpful for companies that participate in the supply chain network to gain a competitive advantage.

First, the core enterprise should adopt an integrative leadership style and play a leading role in a supply chain cooperative network. Ideally, the enterprise in a cooperation network should be 'all for one and one for all'. However, due to divergent interests, there will be information asymmetry and opportunistic behavior in a cooperative network. This observation requires the core enterprise to exert its influence and guidance, such as encouraging enterprises in a cooperative network to participate in decision and plan making to reduce the incidence of opportunistic behavior. In addition, before project cooperation, the core business should guide other enterprises to develop a fair performance allocation mechanism as well as a contingency plan that will ensure the completion of cooperation projects; it should also develop a scheme to increase the communication frequency among enterprises.

Second, the core enterprise in a supply chain cooperative network should pay attention to the key effect of knowledge integration on the enterprise synergy innovation performance in a supply chain cooperative network. Knowledge acquisition, deconstruction, fusion, and reconstruction are crucial to the improvement of collaborative innovation performance. Therefore, on one hand, the integrative leader must ensure the smooth flow of knowledge and resources within the cooperation network. On the other hand, they must also establish the cooperation relationship with the organizations outside the cooperation network to integrate the key resources and knowledge into their cooperation network.

Third, integrative leaders should pay attention to the positive effects of network relationship embeddedness on the enterprise synergy innovation performance. The result of data analysis has shown that knowledge integration and networking relationship embeddedness have equal status between integrative leadership and enterprise synergy innovation performance. Therefore, the core business not only needs to be concerned with the exchange of resources and technologies among enterprises but also to care about the emotional communication between them. On one hand, the core business needs to integrate and maintain relationships among enterprises, improving enterprise openness and knowledge absorption capabilities as well as promoting knowledge integration. On the other hand, the core business needs to fully step into its leading role, such as by encouraging emotional communication among enterprises, improving mutual trust, promoting information sharing, and confronting problems together. The integrative leader needs to provide a stable cooperation environment for the supply chain cooperation network through the establishment and maintenance of relationships among enterprises. When the enterprise is in a stable cooperative network, it is more likely to promote knowledge integration and improve synergy innovation performance among enterprises in a supply chain cooperative network.

5.3. Research Limitations

This study has certain limitations. First, most of the variables used in this paper are multidimensional variables; however, in the hypothesis test, we did not conduct a data analysis for each dimension of these variables. Therefore, the ensuing research needs to be conducted on multiple dimensions to fully understand the multidimensional connotation of variables. Second, although this paper analyzed the control variables such as the size of enterprises and the nature of enterprises, their sample size is limited. Therefore, in the ensuing research, it is necessary to further expand the sample size to delve deeper. Finally, in the ensuing studies, other scenario variables should be considered, such as organizational openness and organizational willingness to cooperate, as they may also may result in the biased conclusions of this study.

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