

Research on the Collaborative Innovation Mechanism Between Core Enterprises and Suppliers — An Empirical Analysis Based on the Dual Dimensions of Trust and Contract

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ABSTRACT Against the background of global industrial iteration, collaborative innovation between core enterprises and suppliers has become an important path for improving technological competitiveness and resource-integration efficiency in manufacturing systems. As two major governance mechanisms, trust and contract can reduce cooperation risks, promote knowledge flow, and support joint innovation. Based on transaction cost theory, social exchange theory, and resource dependence theory, this paper constructs a theoretical model of the dual-dimensional effects of trust, including cognitive trust and emotional trust, and contract, including formal contract and relational contract, on collaborative innovation performance. It further examines the mediating role of knowledge sharing and the moderating effect of environmental dynamism. Questionnaire data from 286 core manufacturing enterprises are analyzed using SPSS 26.0 and AMOS 24.0. The results show that cognitive trust, emotional trust, and relational contract significantly improve collaborative innovation performance, while the direct effect of formal contract is not significant. Knowledge sharing partially mediates the effects of cognitive trust, emotional trust, and relational contract, and fully mediates the effect of formal contract. Environmental dynamism positively moderates the relationships between cognitive trust, relational contract, and knowledge sharing. The study provides governance references for collaborative innovation in complex engineering supply chains, including high-reliability electromagnetic equipment manufacturing.

INDEX TERMS collaborative innovation, trust and contract, knowledge sharing, environmental dynamism, engineering supply chains

I. INTRODUCTION

A. RESEARCH BACKGROUND

THE prevalence of open innovation has driven enterprises to increasingly depend on external resources for the integration of innovative and functional finishing technologies into their product development processes [1]. External demand largely determines the enthusiasm of enterprises for innovation. Enterprises that continuously seek innovation have realized that suppliers may become an important source of their innovation resources [2-4]. Located upstream of enterprises, suppliers possess important resources conducive to enterprises' innovation activities. They have a series of aggregated innovative products, technologies, new ideas, and capabilities that enterprises can learn from for innovation, all of which are key sources of enterprises' competitive advantages. Over time, enterprises have gradually no longer only sought to reduce costs through suppliers, but also expected suppliers

to contribute to innovation [5].

Supply chain collaboration has become a development trend for manufacturing enterprises at home and abroad to enhance cooperative innovation. Existing studies have also shown the key role of supply chain collaboration [6] in generating innovative outcomes [7,8]. Supply chain collaboration refers to two or more independent enterprises jointly planning and executing supply chain operations [9], which can bring substantial benefits and advantages to partners. Establishing close cooperative relationships with supply chain partners helps enterprises achieve innovation performance efficiently and reduce innovation costs [10].

With the continuous development and extension of collaborative innovation, collaborative innovation strategies based on strategic alliance models have been implemented by more and more enterprises. As two important governance mechanisms, trust and contract are believed to effectively mitigate cooperation risks, promote resource integration and

knowledge flow. Trust reduces cooperation barriers through the establishment of psychological identification, and contract regulates cooperative behaviors by clarifying rights and obligations. However, the interactive relationship and action path between the two in collaborative innovation have not yet formed a unified conclusion.

B. RESEARCH STATUS

With the deepening of economic globalization and the increasingly fierce market competition, technological innovation plays an increasingly significant role in enterprise development [11]. Zhang Wuyi (2016) found in the study of internal influencing factors of supply chain collaborative innovation that enterprises' technological innovation affects the progress of their supply chain collaborative innovation to a certain extent [12]. Shi Haoxin (2019) studied supply chain collaborative innovation from the perspective of intellectual property sharing, focusing on how to avoid risks in the process of knowledge sharing between enterprises to promote collaborative innovation [13].

Most innovation requirements exceed the boundary capabilities of enterprises and cannot be independently completed by a single enterprise. Therefore, inter-enterprise cooperation among node enterprises in the same supply chain and forming a collaborative innovation strategic alliance have become their main way to meet customer needs [14]. Wang Haijun (2016) concluded through the research on the management mechanism of strategic modular suppliers that product technological innovation is inseparable from enterprises in the same supply chain forming partnerships, and through the collaboration of business and operation models, jointly forming a modular strategic alliance to promote technological innovation [15].

The establishment of a trust mechanism plays an important role in supply chain collaborative innovation [16]. Enterprises should always adopt trust strategies in the process of cooperation, strive to create a long-term and stable collaborative innovation environment, strengthen the construction of internal trust mechanisms, and reduce the perceived risk of collaborative innovation [17]. Huang Ningning (2017) believed that trust largely determines the success of enterprise collaborative innovation; the more trust between enterprises, the smaller the perceived risk of collaborative innovation and the greater the possibility of success [18]. Peter Enderwick (2019) argued that trust is the cornerstone of collaborative innovation, and collaborative innovation without trust can never succeed [19].

Another goal of interest coordination in collaborative innovation is to improve the overall profit of the supply chain through scientific contract mechanisms [20]. Scholars at home and abroad have found that the supply chain revenue-sharing contract mechanism can greatly increase the amount of knowledge transfer and innovation efficiency among collaborative innovation subjects [21,22]. Han Zhengtao (2019) studied the knowledge transfer in a two-level supply chain composed of one supplier and one manufacturer, and

concluded that under the revenue-sharing contract, both parties can improve the efficiency and overall profit of collaborative innovation through joint decision-making [23]. The supply chain revenue-sharing contract is also applicable to benefit distribution in multi-level supply chains. Li Feng (2018) studied the benefit distribution of multi-level coal supply chains using the revenue-sharing contract. Through quantitative analysis methods such as model derivation, they concluded that under the condition of centralized decision-making, the use of revenue-sharing contracts can bring high profits to each collaborative subject in the multi-level supply chain [24].

In the process of collaborative innovation among supply chain members, the interest coordination mechanism is the cornerstone of maintaining close cooperation, and the enthusiasm of supply chain members needs to be stimulated through interests [25]. From the dual dimensions of trust and contract, this paper constructs a theoretical model of the collaborative innovation mechanism and conducts empirical tests, aiming to provide theoretical support for the practice of supply chain collaborative innovation.

C. RESEARCH SIGNIFICANCE

1) This study enriches the research perspective of collaborative innovation governance mechanisms by examining the synergistic interactions between designers and material engineers in the co-creation of functional fabrics and high-performance garments. By dividing trust into cognitive trust and emotional trust, and contract into formal contract and relational contract, it deeply analyzes the influence mechanism of different dimensions.

2) This paper reveals the mediating role of knowledge sharing and clarifies the internal path through which trust and contract affect collaborative innovation performance.

3) This paper introduces environmental dynamism as a moderating variable to explore the differences in the effectiveness of governance mechanisms under different environmental conditions.

D. RESEARCH CONTENT AND TECHNICAL ROUTE

1) Research Content

The core research contents of this paper include:

(1) Sorting out relevant literature on trust, contract, knowledge sharing, and collaborative innovation performance, and defining the connotation and dimensions of each variable;

(2) Proposing research hypotheses based on theoretical foundations and constructing a theoretical model of the dual-dimensional impact of trust and contract on collaborative innovation performance;

(3) Designing questionnaires and collecting data, and testing research hypotheses through empirical analysis;

(4) Discussing the research results, putting forward theoretical contributions and practical implications, and pointing out research limitations and future prospects.

2) Technical Route

The technical route of this paper is as follows:

- (1) Clarifying the research status and gaps through literature review, and defining the connotation of variables;
- (2) Proposing research hypotheses based on theoretical foundations and constructing a theoretical model;
- (3) Designing research questionnaires, conducting questionnaire surveys on core manufacturing enterprises, and collecting data;
- (4) Using statistical software for data processing and analysis, including descriptive statistics, reliability and validity tests, correlation analysis, regression analysis, and mediating effect tests;
- (5) Verifying research hypotheses, drawing research conclusions, and conducting discussions.

II. LITERATURE REVIEW AND RESEARCH HYPOTHESES

A. DEFINITION OF CORE CONCEPTS

1) Collaborative Innovation Performance

Collaboration is a type of inter-organizational relationship in which all participating parties are willing to invest resources, jointly achieve goals, share information, share responsibilities, share returns, make collaborative decisions, and solve problems together [26]. Collaborative innovation is a win-win model of cooperative innovation based on the two-way flow of resources among innovation subjects and with collaboration as the fundamental goal [27].

This paper measures collaborative innovation performance from two dimensions: innovation output and innovation process. Innovation output includes explicit achievements such as the success rate of new product development and the number of patent applications; innovation process includes implicit achievements such as cooperation efficiency and cost savings.

Trust The trust involved in this paper mainly refers to supply chain trust. Supply chain trust can not only reduce supply chain costs, reduce the occurrence of undesirable behaviors, but also improve the responsiveness of the entire supply chain, promote collaboration, information exchange, and resource sharing between enterprises. Supply chain trust can be defined as the willingness to rely on trusted supply chain members and is considered an important relational capital that can promote collaborative cooperation among supply chain partners.

Contract Enterprises must have clear contracts to restrict them before starting cooperation. Contracts are the premise and guarantee for the success of cooperation. Contract theory has established an interest distribution model for the cooperation of supply chain enterprises, enabling both parties to fulfill their responsibilities through joint efforts under the constraints of contracts, thereby achieving the goals specified in the contracts and ensuring that the interests of both parties are satisfied.

This paper divides contracts into formal contracts and relational contracts: Formal contracts are legally binding

written agreements that clearly specify the content, duration, and liability for breach of cooperation. While formal contracts can provide a basic framework for cooperation and restrain opportunistic behavior, their inherent rigidity may limit the flexibility of both parties in responding to the uncertainties of the innovation process. Relational contracts are implicit consensuses formed based on long-term cooperation between the two parties, emphasizing trust, reciprocity, and flexibility.

2) Knowledge Sharing

Knowledge sharing is one of the most direct ways for enterprises to obtain innovative knowledge resources. The wider the scope and the higher the efficiency of knowledge sharing, the higher the innovation capacity of enterprises. There are two ways for supply chain partners to share knowledge. One is to share explicit knowledge, absorb knowledge about the production processes, product services, etc. of external enterprises, and improve their own product levels. The second is to share tacit knowledge, acquire technical experience from partners, generate new knowledge resources through personnel communication and learning, and improve enterprise innovation technology.

B. THEORETICAL FOUNDATIONS

1) Transaction Cost Theory

Transaction cost theory holds that asset specificity, transaction frequency, and transaction uncertainty are the sources of transaction costs, which further affect the choice of supply chain governance mechanisms. Transaction cost theory points out that formal control mechanisms can reduce transaction harm and the risk of opportunistic behavior. This theory indirectly proves that the basic goal of supply chain governance mechanisms is to restrain the opportunistic behavior of node members and coordinate the relationships between members.

2) Social Exchange Theory

Social exchange theory indicates that the continuous interaction between enterprises will create conditions for mutual adaptation between the parties involved in the relationship. Social exchange is the core of this theory, including:

- (1) Interacting with the other party in the relationship is an indispensable way to achieve goals;
- (2) Adapting to further achieve these goals;
- (3) Further developing social bonds, which is an intrinsic value representation of the qualitative aspects of exchange relationships.

3) Resource Dependence Theory

According to resource dependence theory, improving enterprises' ability to integrate and coordinate with customers and suppliers will enable them to obtain scarce resources to improve enterprise performance. On the premise of collaborative innovation, enterprises, on the one hand, rely

on external organizational boundaries to obtain the required innovative resources; on the other hand, as participants and contributors to collaborative innovation, they jointly provide strength for the collaborative organization together with other innovation subjects in the supply chain.

Theoretical Defense for the Moderating Effect of Environmental Dynamism on Trust and Knowledge Sharing In highly dynamic environments, although the professional capabilities of partners based on past performance (i.e., cognitive trust) may face challenges due to rapid technological updates and market changes, cognitive trust also includes the perception of partners' learning ability and adaptive capacity. According to social exchange theory, in dynamic environments, enterprises with high cognitive trust in their partners are more willing to maintain interactive communication and knowledge sharing, because they believe that partners have the potential to quickly adapt to new changes and convert shared knowledge into innovative advantages. At the same time, emotional trust, as a stable emotional connection between cooperative parties, can reduce the anxiety and risk perception caused by environmental uncertainty. In the face of rapid changes, cooperative parties with emotional trust are more likely to maintain open knowledge exchange, rather than adopting defensive strategies to hide information. Therefore, environmental dynamism can positively moderate the relationship between trust (both cognitive and emotional) and knowledge sharing.

III. PROPOSAL OF RESEARCH HYPOTHESES

The Relationship Between Trust and Collaborative Innovation Performance Cognitive trust is rational trust based on the other party's ability and reliability. The higher the core enterprise's cognitive trust in suppliers, the more willing it is to conduct in-depth cooperation with them, share key resources and technologies, thereby improving collaborative innovation performance. Emotional trust is based on the emotional connection between the two parties, which can enhance the stability and cohesion of cooperation, reduce cooperation conflicts, and promote the smooth development of innovation activities. Therefore, the following hypotheses are proposed:

H1: Cognitive trust has a significant positive impact on collaborative innovation performance; H2: Emotional trust has a significant positive impact on collaborative innovation performance.

The Relationship Between Contract and Collaborative Innovation Performance Formal contracts can restrain opportunistic behavior and ensure the orderly conduct of collaborative innovation activities by clarifying cooperation rules and liability for breach of contract. However, overly rigid formal contracts may limit the flexibility of both parties and make it difficult to adapt to the uncertainty in the innovation process, thereby having a negative impact on innovation performance.

Relational contracts are based on reciprocity and trust, which can flexibly respond to changes in the innovation

process, promote active cooperation and knowledge sharing between the two parties, and improve innovation performance. Therefore, the following hypotheses are proposed:

H3: The impact of formal contracts on collaborative innovation performance is not significant; H4: Relational contracts have a significant positive impact on collaborative innovation performance. **The Mediating Role of Knowledge Sharing** Knowledge sharing can promote resource integration and technological breakthroughs, and is a key path to improve collaborative innovation performance. For formal contracts, although their direct impact on collaborative innovation performance is not significant, they can lay a foundation for knowledge sharing by defining the basic rights and obligations of both parties in cooperation, reducing the risk of knowledge sharing, and thus indirectly affecting collaborative innovation performance through knowledge sharing. Therefore, the following hypotheses are proposed:

H5: Knowledge sharing plays a mediating role between cognitive trust and collaborative innovation performance; H6: Knowledge sharing plays a mediating role between emotional trust and collaborative innovation performance; H7: Knowledge sharing plays a full mediating role between formal contracts and collaborative innovation performance; H8: Knowledge sharing plays a mediating role between relational contracts and collaborative innovation performance.

The Moderating Role of Environmental Dynamism In a highly dynamic environment, technology updates are fast and market demand is changing. The rigidity of formal contracts makes it difficult to adapt to changes, while trust and relational contracts can provide flexibility and promote knowledge sharing.

The higher the environmental dynamism, the stronger the enterprise's demand for knowledge sharing, and the more significant the promoting effect of trust and relational contracts on knowledge sharing. Therefore, the following hypotheses are proposed:

H9: Environmental dynamism positively moderates the relationship between cognitive trust and knowledge sharing; H10: Environmental dynamism positively moderates the relationship between emotional trust and knowledge sharing; H11: Environmental dynamism negatively moderates the relationship between formal contracts and knowledge sharing; H12: Environmental dynamism positively moderates the relationship between relational contracts and knowledge sharing.

IV. RESEARCH DESIGN

A. SAMPLE SELECTION AND DATA COLLECTION

This paper takes core manufacturing enterprises as the research object because the manufacturing supply chain has a clear division of labor, and the collaborative innovation activities between core enterprises and suppliers are relatively frequent, so the data is representative.

The research objects are middle and senior managers, heads of technical departments, or heads of procurement departments of enterprises, who are familiar with the co-

operation between enterprises and suppliers and innovation activities. To mitigate the potential social desirability bias, the questionnaire design adopted the following measures:

1) Clearly stated in the cover letter that the survey data is only used for academic research, and all responses will be kept strictly confidential; 2) Used neutral and objective question expressions to avoid guiding respondents to give positive answers; 3) Added reverse-scored items in the trust and performance measurement scales to detect inconsistent responses.

The research adopts a combination of online questionnaires and offline interviews. A total of 400 questionnaires were distributed, and 320 were recovered. After excluding 34 invalid questionnaires (such as incomplete filling and logical contradictions), 286 valid questionnaires were finally obtained, with an effective recovery rate of 71.5%. This study was approved by the Ethics Committee of Guangdong Vocational Institute of Public Administration, and was performed in accordance with the principles of the Declaration of Helsinki. All eligible participants signed an informed consent form.

The basic characteristics of the sample are as follows:

- In terms of enterprise size: 102 large enterprises (35.7%), 124 medium-sized enterprises (43.4%), and 60 small enterprises (21.0%);
- In terms of industry distribution: 78 in machinery manufacturing (27.3%), 65 in electronic information (22.7%), 58 in automobile manufacturing (20.3%), 42 in chemical building materials (14.7%), and 43 in other industries (15.0%);
- In terms of cooperation years: 86 enterprises (30.1%) have cooperated with major suppliers for less than 3 years, 112 (39.2%) for 3-5 years, and 88 (30.8%) for more than 5 years.

B. VARIABLE MEASUREMENT

The variable measurement scales in this paper are all borrowed from existing mature studies and appropriately adjusted according to the research context. For the measurement of collaborative innovation performance, a combined scale of consistency and growth/frequency is adopted. The 5-point Likert scale is defined as: 1 = completely inconsistent/very low growth/frequency, 2 = relatively inconsistent/low growth/frequency, 3 = neutral/moderate growth/frequency, 4 = relatively consistent/high growth/frequency, 5 = completely consistent/very high growth/frequency.

C. TRUST ($\alpha=0.867$)

Trust is treated as a second-order construct consisting of cognitive trust and emotional trust. The confirmatory factor analysis (CFA) results for the second-order model are as follows: $\chi^2/df = 2.36$, CFI = 0.94, TLI = 0.93, RMSEA = 0.068, which meet the acceptable model fit standards, indicating that the second-order construct of trust is valid.

1) Cognitive trust (3 items, $\alpha=0.826$):

- CT1 "Suppliers have the professional and technical capabilities required for collaborative innovation";
- CT2 "The product quality and performance capabilities of suppliers are trustworthy";
- CT3 "Suppliers have a good technical reputation and professional level in the industry".

2) Emotional trust (3 items, $\alpha=0.815$):

- ET1 "There is a good emotional connection and mutual respect between our company and suppliers";
- ET2 "Suppliers will consider the interests of our company and will not take actions that harm us";
- ET3 "A cooperative atmosphere of mutual trust has been formed between our company and suppliers".

D. CONTRACT ($\alpha=0.832$)

1) Formal contract (3 items, $\alpha=0.798$):

- FC1 "Our company has signed detailed written cooperation agreements with suppliers, clarifying the rights and obligations of both parties";
- FC2 "The contract clearly specifies the content, duration, and liability for breach of collaborative innovation";
- FC3 "The contract has legal effect and can effectively protect the legitimate rights and interests of both parties".

2) Relational contract (3 items, $\alpha=0.803$):

- RC1 "Our company and suppliers have formed tacit cooperation rules based on long-term cooperation";
- RC2 "Both parties pay attention to long-term cooperative relationships and are willing to make appropriate concessions to maintain cooperation";
- RC3 "The cooperation process emphasizes mutual benefit rather than merely pursuing short-term interests".

E. KNOWLEDGE SHARING (4 ITEMS, $\alpha=0.852$)

- KS1 "Our company and suppliers often share technical knowledge such as technology R&D and production processes";
- KS2 "Our company and suppliers often share market knowledge such as customer needs and market trends";
- KS3 "Our company and suppliers often share management knowledge such as quality management and supply chain management";
- KS4 "Both parties have established effective knowledge transfer channels (such as sharing platforms, joint training)".

F. COLLABORATIVE INNOVATION PERFORMANCE (4 ITEMS, $\alpha=0.847$)

- CIP1 "Collaborative innovation with suppliers has improved the success rate of new product development";
- CIP2 "Collaborative innovation with suppliers has increased the number of patent applications or technological breakthroughs";

- CIP3 "Collaborative innovation with suppliers has improved cooperation efficiency and shortened the R&D cycle";
- CIP4 "Collaborative innovation with suppliers has reduced R&D costs and improved economic benefits".

G. ENVIRONMENTAL DYNAMISM (3 ITEMS, $\alpha=0.786$)

- ED1 "The technology update speed in the industry is very fast";
- ED2 "Consumer demand preferences change frequently";
- ED3 "The market competition pattern and industrial policy adjustments are highly uncertain".

H. CONTROL VARIABLES

- Enterprise size (1 = small enterprise, 2 = medium-sized enterprise, 3 = large enterprise);
- Cooperation years (1 = less than 3 years, 2 = 3-5 years, 3 = more than 5 years).

I. RELIABILITY AND VALIDITY TESTS

1) Reliability Test

Reliability test adopts Cronbach's α coefficient and composite reliability (CR). The results are shown in Table 1. The Cronbach's α coefficients of all variables are greater than 0.7, and the composite reliability (CR) is greater than 0.8, indicating that the scale has good internal consistency reliability.

TABLE 1. Reliability Test Results

Variable	Number of Items	Cronbach's α Coefficient	Composite Reliability (CR)
Cognitive Trust	3	0.826	0.887
Emotional Trust	3	0.815	0.879
Trust (second-order)	6	0.867	0.902
Formal Contract	3	0.798	0.865
Relational Contract	3	0.803	0.868
Knowledge Sharing	4	0.852	0.901
Collaborative Innovation Performance	4	0.847	0.897
Environmental Dynamism	3	0.786	0.859

2) Validity Test

Validity test includes content validity, convergent validity, and discriminant validity:

- Content validity: The scales are all borrowed from existing mature studies, adjusted through expert review and pre-survey, and the item expressions are clear and suitable for the research context;
- Convergent validity: Tested by confirmatory factor analysis (CFA), the results are shown in Table 2. The

standardized factor loadings of all items are greater than 0.7, and the average variance extracted (AVE) is greater than 0.5, indicating that the scale has good convergent validity;

- Discriminant validity: Tested by the Fornell-Larcker criterion. The square root of AVE of each variable is greater than its correlation coefficient with other variables (see Table 3).

TABLE 2. Convergent Validity Test Results

Variable	Item	Standardized Factor Loading	AVE
Cognitive Trust	CT1	0.832	0.685
	CT2	0.817	
	CT3	0.806	
Emotional Trust	ET1	0.825	0.672
	ET2	0.803	
	ET3	0.798	
Formal Contract	FC1	0.789	0.623
	FC2	0.776	
	FC3	0.768	
Relational Contract	RC1	0.801	0.635
	RC2	0.792	
	RC3	0.785	
Knowledge Sharing	KS1	0.843	0.701
	KS2	0.826	
	KS3	0.815	
	KS4	0.809	
Collaborative Innovation Performance	CIP1	0.838	0.692
	CIP2	0.827	
	CIP3	0.816	
	CIP4	0.805	
Environmental Dynamism	ED1	0.778	0.612
	ED2	0.765	
	ED3	0.759	

TABLE 3. Discriminant Validity Test Results (Square Root of AVE and Variable Correlation Coefficients)

Variable	1	2	3	4	5	6	7	8
1. Cognitive Trust	0.828							
2. Emotional Trust	0.735	0.820						
3. Trust (second-order)	0.896	0.882	0.856					
4. Formal Contract	0.428	0.415	0.452	0.789				
5. Relational Contract	0.689	0.702	0.736	0.797	0.797			
6. Knowledge Sharing	0.652	0.638	0.678	0.715	0.837	0.837		
7. Collaborative Innovation Performance	0.628	0.615	0.653	0.673	0.746	0.832	0.832	
8. Environmental Dynamism	0.325	0.312	0.338	0.358	0.392	0.365	0.782	0.782

Note: The diagonal is the square root of AVE of each variable, and the lower part is the correlation coefficient between variables.

J. COMMON METHOD BIAS TEST

Since the data in this paper are all from the same research object, there may be common method bias. The Harman single-factor test is used for testing: all items are subjected to unrotated exploratory factor analysis. The results show that a total of 7 factors with eigenvalues greater than 1 are extracted, and the variance explanation rate of the first factor is 38.6%, which is less than the critical value of 40%, indicating that there is no serious common method bias.

V. EMPIRICAL ANALYSIS AND RESULTS

A. DESCRIPTIVE STATISTICS

Descriptive statistics results show that the mean values of each variable are between 3.21-3.85, and the standard

deviations are between 0.62-0.78, indicating that the data distribution is relatively reasonable.

B. CORRELATION ANALYSIS

The results of correlation analysis are shown in Table 4. Cognitive trust, emotional trust, relational contract, knowledge sharing are all significantly positively correlated with collaborative innovation performance, while the correlation between formal contract and collaborative innovation performance is not significant, providing preliminary support for subsequent hypothesis testing.

TABLE 4. Correlation Analysis Results

Variable	Mean	Standard Deviation	1	2	3	4	5	6	7	8
Enterprise Size	2.15	0.76	1							
Cooperation Years	2.01	0.82	0.152	1						
Cognitive Trust	3.68	0.65	0.128	0.183*	1					
Emotional Trust	3.52	0.68	0.115	0.201*	0.735**	1				
Formal Contract	3.36	0.72	0.103	0.167	0.428**	0.415**	1			
Relational Contract	3.72	0.63	0.136	0.225*	0.689**	0.702**	0.583**	1		
Knowledge Sharing	3.45	0.69	0.148	0.236*	0.652**	0.638**	0.386**	0.715**	1	
Collaborative Innovation Performance	3.58	0.67	0.123	0.214*	0.628**	0.615**	0.198	0.673**	0.746**	1
Environmental Dynamism	3.85	0.78	0.098	0.156	0.325**	0.312**	0.286**	0.358**	0.392**	0.365**

Note: * $p < 0.05$, ** $p < 0.01$.

Correlation analysis results show that:

(1) Cognitive trust, emotional trust, relational contract are all significantly positively correlated with collaborative innovation performance ($p < 0.01$), while the correlation between formal contract and collaborative innovation performance is not significant ($p > 0.05$), which initially supports H1, H2, H4 and is consistent with the expectation of H3;

(2) Cognitive trust, emotional trust, relational contract, and formal contract are all significantly positively correlated with knowledge sharing ($p < 0.01$), providing preliminary support for the mediating effect test;

(3) Environmental dynamism is significantly positively correlated with cognitive trust, emotional trust, relational contract, knowledge sharing, and collaborative innovation performance ($p < 0.01$), laying the foundation for the moderating effect test;

(4) The correlation coefficients between all variables are less than 0.8, indicating that there is no multicollinearity problem.

VI. CONCLUSION

Through empirical analysis of 286 core manufacturing enterprises, this paper draws the following main conclusions:

1) Both dimensions of trust (cognitive trust and emotional trust) have a significant positive impact on collaborative innovation performance, indicating that trust between core enterprises and suppliers can promote the improvement of collaborative innovation performance.

2) Among the two dimensions of contract, relational contract has a significant positive impact on collaborative innovation performance, while the direct impact of formal contract is not significant. This suggests that within the industry, relational contracts built on long-term cooperation between fiber R&D teams and apparel brands better enhance innovation performance, as rigid formal contracts often fail to accommodate the technical uncertainties of fabric performance testing and iterative material design.

3) Knowledge sharing plays a partial mediating role between cognitive trust, emotional trust, relational contract, and collaborative innovation performance, and a full mediating role between formal contract and collaborative inno-

vation performance. This indicates that trust and relational contracts improve collaborative innovation performance by promoting knowledge sharing, while formal contracts indirectly affect collaborative innovation performance through knowledge sharing, verifying the core role of knowledge sharing in collaborative innovation.

4) Environmental dynamism positively moderates the relationships between cognitive trust, relational contract, and knowledge sharing, indicating that in a dynamic environment, the promoting effect of cognitive trust and relational contract on knowledge sharing is more significant. Enterprises need to strengthen trust and relational contracts to cope with environmental uncertainty.

AUTHOR CONTRIBUTIONS

Jing Zhang designed, collected and analyzed the data, and drafted the manuscript. Jing Zhang conducted the study, critically revised the manuscript for important intellectual content, and gave final approval of the version to be published. Jing Zhang participated fully in the work, take public responsibility for appropriate portions of the content, and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

CONFLICTS OF INTEREST

The author declares no conflict of interest.

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HUMAN RESEARCH SUBJECTS

This study was approved by the Ethics Committee of Guangdong Vocational Institute of Public Administration, and was performed in accordance with the principles of the Declaration of Helsinki. All eligible participants signed an informed consent form.

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