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Research on the Key Path to Improve the Collaborative Innovation Performance of Port Logistics Enterprise Cluster

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Abstract: Under the new pattern of international and domestic double circulation, the scale of China's port logistics enterprise cluster is expanding, but the innovation difficulty of cluster enterprises is increasing sharply, the innovation power of core technology is insufficient, there are some problems, such as focusing on agglomeration rather than cooperation, the integration of industrial chain and innovation chain is not close, and the choice of innovation path is improper. The method and purpose of this paper are based on the theory of collaborative innovation, establish a structural equation model, empirically test the logistics clusters with ports above designated size in China, and put forward the key path for the collaborative innovation of port logistics enterprise clusters, and improve the collaboration degree and innovation performance of cluster enterprises. The empirical results show that the external environment of collaborative innovation (EECCI), the innovation learning ability of cluster enterprises (ILACE) and the cluster enterprises cooperation (CEC) can directly or indirectly affect the cluster collaborative innovation performance (CCIP), and the innovation learning ability of cluster enterprises (ILACE) plays a mediating role between the external environment of collaborative innovation (EECCI) and the cluster collaborative innovation performance (CCIP). Port logistics enterprise clusters need to develop environmental governance, knowledge governance, information governance and other mechanisms to promote collaborative innovation in the industrial chain, technology chain and value chain.

Keywords: Port Logistics, Enterprise Cluster, Collaborative Innovation

1. Introduction

The cluster of port logistics enterprises refers to the cluster formed by many port logistics enterprises with different levels and scales and other related actors in a specific port area due to the difference of division of labor. At present, China has basically formed five major port logistics clusters, including Yangtze River Delta, Pearl River Delta, Bohai Rim, Southeast Coastal and Southwest Coastal ports. The new situation of international and domestic double circulation has brought profound changes to the innovation environment of China's port logistics enterprises. The means of technological innovation of port logistics enterprises are increasingly diversified. Innovation needs to accumulate more professional and complex knowledge, which also leads to the increasing difficulty of innovation. Port logistics enterprises need to form clusters to meet this challenge through the continuous integration of knowledge and technology.

Both theory and practice show that innovation is the decisive factor for the survival of the country, industry and enterprise. Due to the increasing difficulty of innovation, the investment of port logistics enterprises in technological innovation will continue to grow, but at the same time, innovation will also face greater risks. This will promote the innovation mode of port logistics enterprises from the traditional closed innovation to open innovation [1]. The port logistics cluster enterprises carry out innovative technology research by establishing wider cooperation, actively use external resources to form a wider range of collaborative innovation network, and realize value co creation in the cluster through collaborative innovation.

Previous studies have shown that the collaborative innovation of port logistics enterprise cluster belongs to cross organizational innovation, and there are three main problems: first, the collaborative innovation of port logistics enterprise cluster tends to pursue its own value maximization, pay more

attention to short-term interests, ignore long-term R&D investment, and lack of internal motivation to pursue technological innovation [2]. Second, due to the inconsistent goals of port logistics enterprise cluster, intellectual property disputes are easy to occur in the process of collaborative innovation, and the sharing scope of technology and knowledge in the cluster is limited, which leads to the obstruction of cluster collaborative innovation [3]. Thirdly, in the process of collaborative innovation, the interest distribution of port logistics enterprise cluster often conflicts and lacks perfect interest distribution mechanism [4].

In order to clarify the key path of collaborative innovation of port logistics enterprise cluster and improve the collaborative degree and innovation performance of cluster enterprises, based on previous work and the collaborative innovation practice of China's major port logistics enterprise clusters above designated size, this paper focuses on how the port logistics enterprise cluster drives innovation performance through collaborative innovation, aiming at the lack of cooperation power in the process of cluster collaborative innovation. In order to solve the practical problems such as improper choice of innovation path, this paper uses structural equation model to conduct empirical research, and discusses the problem-solving strategies.

2. Materials and Methods

On the basis of literature review, this paper establishes research hypotheses, and focuses on building the relationship model of the external environment of collaborative innovation (EECCI), the innovation learning ability of cluster enterprises (ILACE), the cluster enterprises cooperation (CEC) and the cluster collaborative innovation performance (CCIP). Through the questionnaire survey of China's port logistics enterprise clusters above designated size, this paper uses structural equation model (SEM) for empirical research.

2.1. Literature Review

2.1.1. Cluster Collaborative Innovation Performance

The existing literature mainly discusses the key factors that affect the performance of cluster collaborative innovation. When carrying out innovation activities, cluster managers need to consider the use of dynamic capabilities to make decisions in a changing environment. These capabilities include the environmental perception ability, collaborative ability, resource integration and innovation learning ability of cluster enterprises. It is found that market environment and other macro factors have an important impact on cluster collaborative innovation performance [1]. Some studies also found that the degree of cluster synergy is related to the innovation ability, policy support, social capital and synergy mechanism of cluster enterprises, and the policy environment has the most significant impact on cluster synergy [5]. The cooperation between cluster partners not only has a positive impact on collaborative innovation performance, but also has a mediating effect [6].

2.1.2. Evaluation of Cluster Collaborative Innovation Performance

For the performance evaluation of collaborative innovation in clusters, the research has mainly established performance evaluation model through different dimensions. Some scholars evaluate innovation performance from two aspects of process and elements, and divide the indicators into five index systems [7]. There are also four dimensions of personnel, capital, material and achievements to build collaborative innovation index system [8]. Some scholars also establish an evaluation system from the perspective of collaborative innovation of production, learning and research from three aspects: dominance, invisibility and coordination of innovation performance [9]. The composition of innovation performance mainly depends on the knowledge absorption capacity of enterprises and the input of technology research and development. The power of innovation is derived from the market demand intensity and macro environmental factors [10].

2.1.3. Mode and Mechanism Selection of Collaborative Innovation

The key of collaborative innovation is to choose the appropriate innovation mode according to the innovation ability and resources of cluster enterprises [11]. When selecting collaborative innovation mode, clusters need to pay attention to regional development, and consider the key issues such as organizational mode, innovation driving force and system construction of cluster collaborative innovation [12]. Under different dynamic structures, collaborative innovation of technology-based enterprises is the key to realize industrial transformation, and technology-based enterprises can choose two collaborative innovation modes: dependent and dominant [13].

Most of the existing studies are based on the macro industry level to discuss the collaborative innovation performance of cluster. This study focuses on the key path and strategy of port logistics enterprise cluster to achieve collaborative innovation performance from the perspective of port logistics enterprise cluster.

2.2. Hypothesis

Literature studies have found that there are three main factors affecting the collaborative innovation of port logistics enterprise cluster: one is the external collaborative innovation environment such as policy, tax, market and so on. The second is collaborative innovation learning ability of cluster enterprises, including knowledge absorption, integration ability and knowledge spillover of cluster enterprises. The third is the collaborative elements among cluster enterprises, which are embodied in trust, communication, commitment and collaborative mechanism among enterprises.

2.2.1. The Impact of the EECCI on the CCIP

The external innovation environment is an important factor in the collaborative innovation of port logistics enterprise cluster. The development of cluster collaborative innovation activities is inseparable from the interaction with the external environment.

The process of cluster collaborative innovation will be restricted by the external environment, which will affect its innovation performance. The existing literature has discussed that the government actively implementing innovation related policies can effectively promote the development of enterprise innovation activities, which can improve its innovation performance to a certain extent [2]. The role of government in enterprise collaborative innovation and the problems in the process of cluster collaborative innovation will have a significant impact on innovation performance. Based on the perspective of law and policy, some scholars proposed to establish a regulatory system for collaborative innovation to improve innovation performance [3]. There are also studies based on the perspective of market structure, pointing out that strong product competitiveness can improve the performance of cluster collaborative innovation [4, 14]. For this reason, this paper puts forward the following assumptions.

H_1: the EECCI has a significant positive impact on CCIP.

2.2.2. The Impact of ILACE on the CCIP

The innovation learning ability of port logistics enterprises cluster can affect the decision-making of cluster collaborative innovation activities, and it is an important factor affecting the performance of cluster collaborative innovation. The collaborative innovation of cluster enterprises needs to experience the process of learning and interaction, which will integrate the internal and external discrete knowledge into structured knowledge. Enterprises need to undergo external innovation across organizations to form a sustainable advantage in competition, and knowledge sharing based learning mechanism should be established between organizations [15-16]. Knowledge absorption capacity has a strong impact on innovation performance [17]. As far as knowledge state itself is concerned, it is in fragmentation state before integration. Whether it is an individual or a cluster of enterprises, it is necessary to integrate the fragmented knowledge to form a structured knowledge system gradually, and finally, it can be transformed into the core competence of the organization. Therefore, the hypothesis is put forward.

H_2: The ILACE has a significant positive impact on CCIP.

2.2.3. The Impact of CEC on the ILACE and CCIP

The role of cluster enterprise collaboration on innovation performance is described in the existing literature. Many researches have studied the inter enterprise collaboration from the perspectives of social capital such as commitment, trust, cooperation relationship [18-21]. Trust relationship among organizations originates from multi-level interaction among partners and sharing of common vision. This is because each member of an organization has core resources or capabilities. The refinement of social division strengthens the dependence of resources or capabilities between organizations. In turn, this trust relationship will further accelerate the exchange of resources or capabilities between partners, expand the scope and depth of the cooperation relationship, and finally form rules and unique culture that both parties can abide by. This dependence, trust and communication strengthen the collaborative innovation performance among organizations. Social capital factors such as trust, relationship and cooperation can significantly enhance innovation performance of enterprises. In addition, the knowledge spillover effect will reduce the elasticity coefficient of independent R&D, which will affect the innovation performance of enterprises [22]. The collaborative innovation of port logistics enterprises mainly emphasizes the cooperation and cooperation among the cluster enterprises. It is required to establish sufficient trust and efficient communication between the cluster enterprises. In addition, we need to allocate the benefits reasonably and establish a risk sharing mechanism. Only in this way can we give full play to the advantages of mutual resources complementation and maximize the innovation performance of cluster synergy. In conclusion, the following assumptions are proposed:

H_3: The CEC has a significant positive impact on the CCIP.

H_4: the CEC has a significant positive impact on the ILACE.

2.2.4. The Impact of the EECCI on the ILACE

The innovation learning ability of port logistics enterprise cluster may be affected by the external collaborative innovation environment. External innovation environment has a positive impact on exploratory learning ability in organizational innovation activities [23]. Among the factors of innovation environment, R&D density has a significant impact on R&D intensity. The hypotheses are as follows.

H_5: The EECCI has a significant positive impact on the ILACE.

2.3. Model

This study focuses on the relationship and interaction among the external environment of collaborative innovation, the innovation learning ability of cluster enterprises, the collaboration among cluster enterprises, and the performance of cluster collaborative innovation. According to the previous literature review and theoretical assumptions, the conceptual model is as shown in Figure 1. On this basis, through the construction of structural equation model (SEM) for hypothesis testing, the specific path of port logistics enterprise cluster to improve collaborative innovation performance is explored.

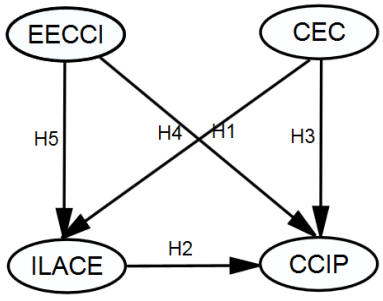

Figure 1. *Conceptual model. EECCI=External Environment of Cluster Collaborative Innovation; CEC=Cluster Enterprises Cooperation; ILACE=Innovative Learning Ability of Cluster Enterprises; CCIP=Cluster Collaborative Innovation Performance.*

2.4. Variable Measurement

2.4.1. EECCI

The EECCI mainly refers to the market competition and

the government's policy support for the cluster collaborative innovation of port logistics enterprises.

2.4.2. CEC

The CEC mainly refers to the sum of the relationship and decision-making behavior of cluster enterprises in collaboration. In order to test the impact of collaboration between cluster enterprises on innovation performance, based on the existing research, this paper measures through trust, relationship, commitment and collaboration mechanism. The trust refers to the mutual trust between port logistics cluster enterprises; Relationship refers to the state of interaction among cluster enterprises; Commitment is mainly reflected in the identification of responsibility; Collaborative mechanism refers to the mechanism of synergy among cluster enterprises through linkage and interaction, including collaborative incentive mechanism, risk control mechanism, benefit distribution mechanism, etc.

2.4.3. ILACE

The behavior choice of cluster enterprises in Collaborative Innovation (such as key innovation decisions) can reflect the strength of enterprise innovation learning ability to some extent. Based on the existing research, this paper uses the cluster enterprise knowledge absorption ability, knowledge integration ability, knowledge spillover level to measure. Among them, knowledge absorptive capacity mainly refers to the ability of cluster enterprises to increase creativity and flexibility by absorbing internal and external new knowledge; The ability of knowledge integration mainly reflects the ability of cluster enterprises to integrate decentralized knowledge and construct knowledge system; The level of knowledge spillover mainly reflects whether there is knowledge outflow and its degree.

2.4.4. CCIP

For the evaluation of cluster collaborative innovation performance, this study focuses on the European regional innovation evaluation system, and on this basis, puts forward the measurement variables to reflect the collaborative innovation performance of port logistics enterprise cluster from four aspects, including the number of patent applications and authorizations, academic achievements, new product (service) development, process (flow) optimization and improvement, etc.

2.5. Questionnaire and Data Collection

In this study, the sampling method is used to investigate the cluster of port logistics enterprises in China, and the empirical model is constructed. The variables are measured by Likert five scale. The survey went through two stages: pre survey and formal survey. Based on the revision of 47 pre survey questionnaires, 203 valid questionnaires were collected from February 2021 to March 2021. In order to solve the problem of non-positive definite data, it is necessary to ensure the normality of the sample data, which requires the absolute value of kurtosis less than 10 and the absolute value of skewness less than 3. In this paper, both of these two conditions are tested, and the normality of the sample data is good.

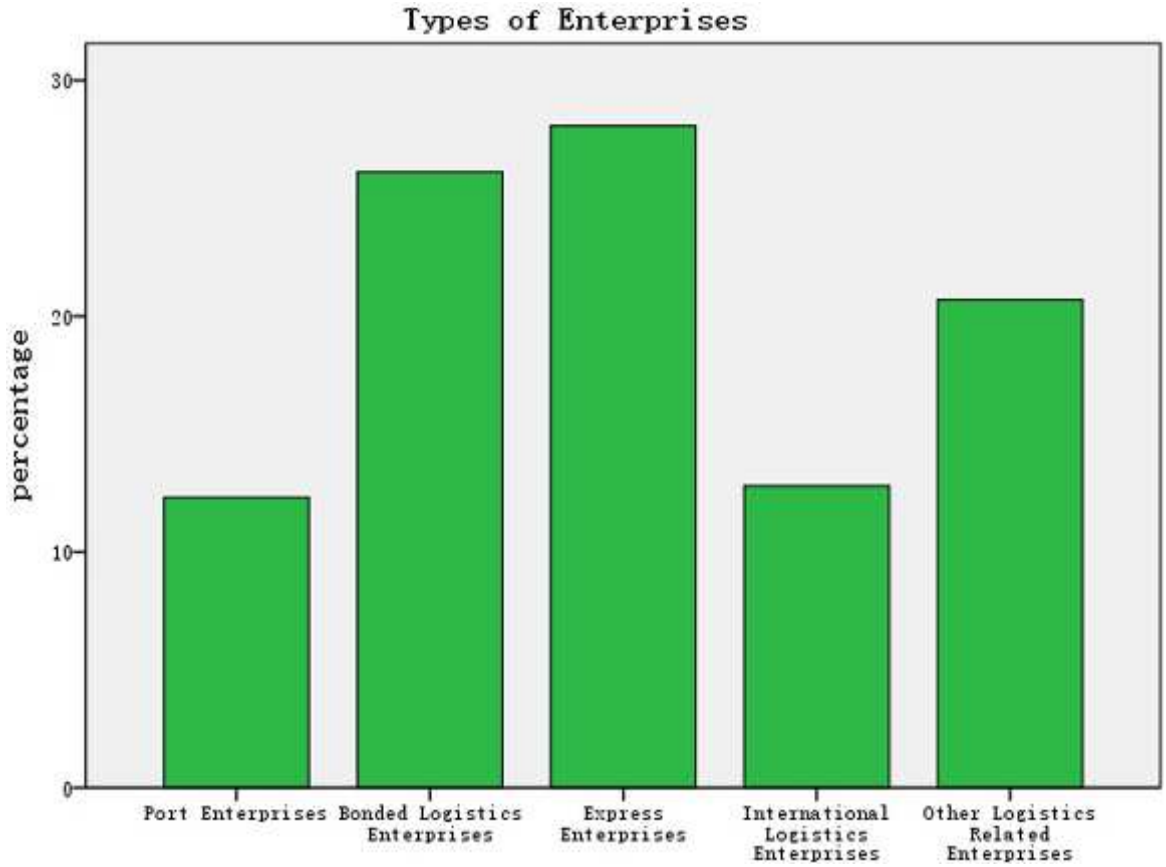

Figure 2. *Types of sample enterprises.*

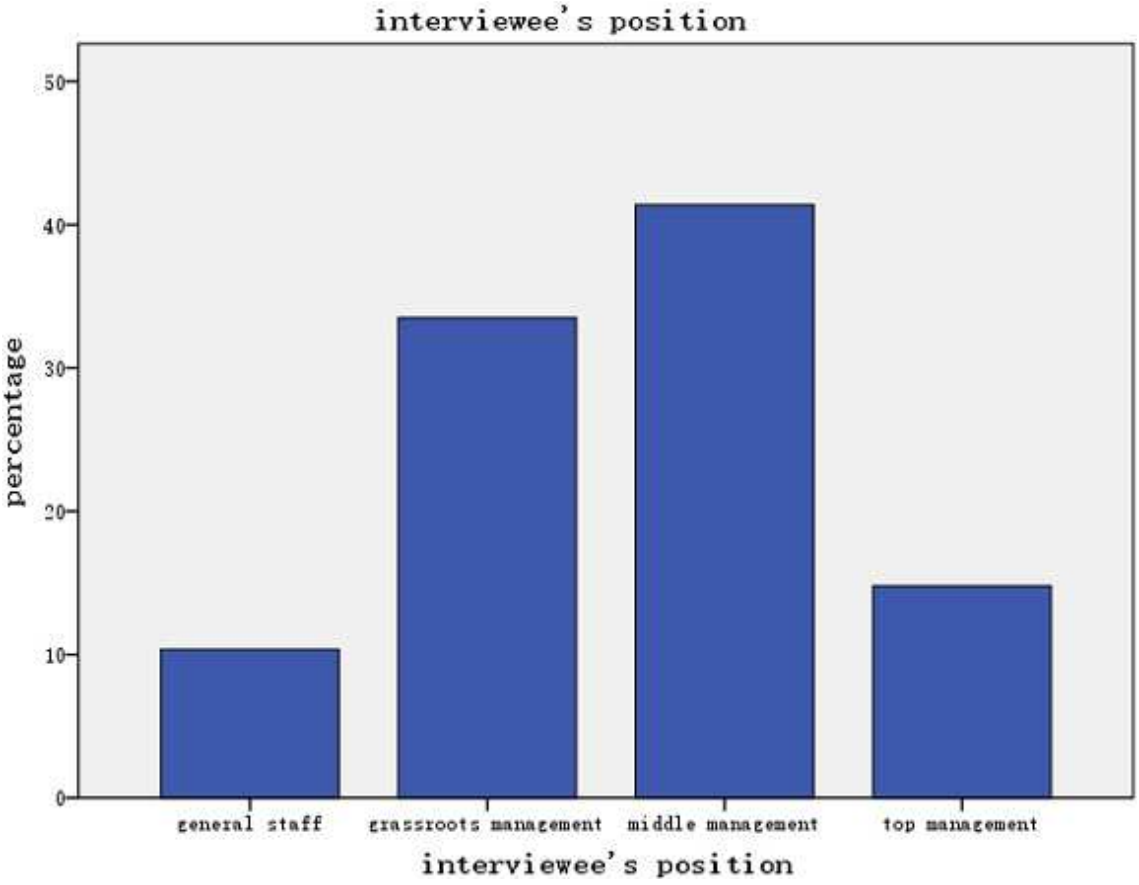

Figure 3. *Position of interviewee.*

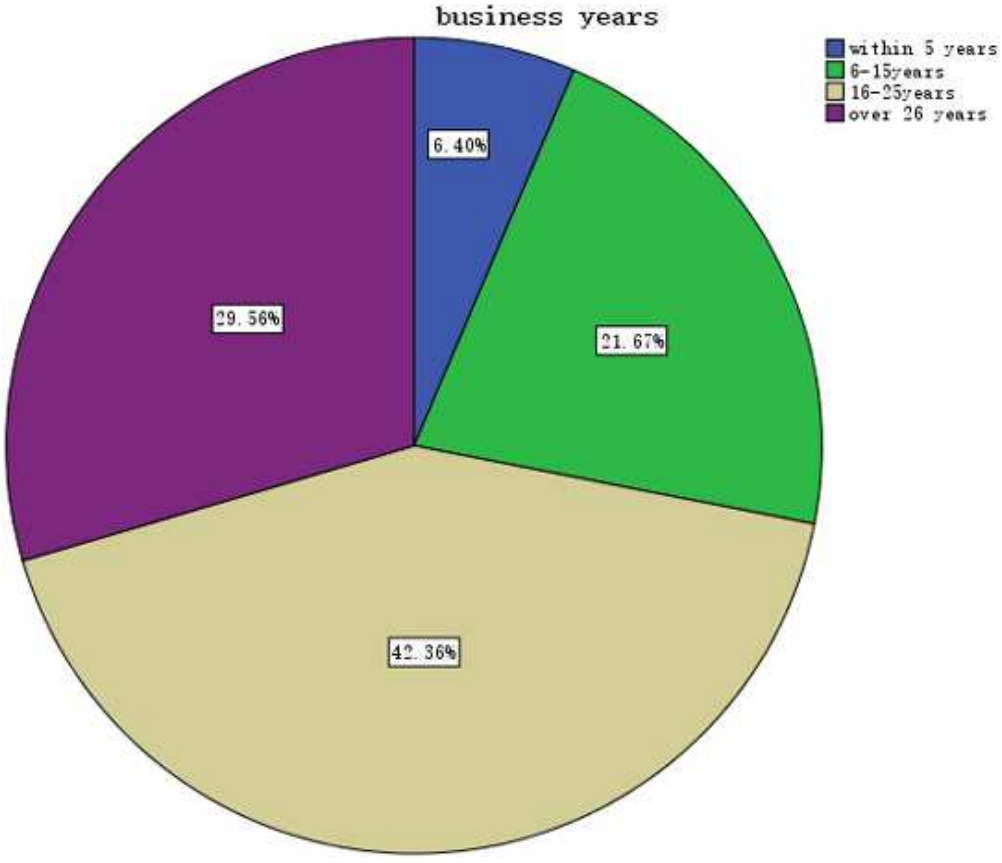

Figure 4. *Operating years of sample enterprises.*

2.6. Sample Data

Port is the core and carrier of port logistics enterprise cluster, and the competitiveness of the cluster largely depends on its own conditions. The sample of this survey is mainly the logistics enterprise cluster formed by China's large-scale ports. The cluster enterprises mainly include port enterprises, bonded logistics enterprises, express enterprises, international logistics enterprises and other enterprises providing logistics services. As shown in Figure 2, in the sample, port enterprises accounted for 12.3%, bonded logistics enterprises accounted for 26.1%, express enterprises accounted for 28.1%, international logistics enterprises accounted for 12.8%, and other types of enterprises accounted for 20.7%.

As can be seen from Figure 3, more than 50% of the respondents hold middle and senior management positions in port logistics enterprises. The respondents should be very familiar with the basic situation of enterprises and clusters, so as to ensure the correctness of the data collected by the questionnaire to the greatest extent.

Figure 4 shows the operating years of the sample enterprises. More than 63% of the enterprises have been operating for more than 15 years, indicating that the operation and management of the sample enterprises have been on the right track, the management is basically stable, and the cluster enterprises have performed stably in innovation and R&D investment, which ensures the stability of the data to a certain extent.

2.7. Correlation of Variables

In this paper, Pearson analysis was used to measure the correlation of variables. It can be seen from table 1 that the correlation coefficients between the four variables involved in this paper are all greater than 0, among which the innovation learning ability of cluster enterprise (ILACE) and cluster collaborative innovation performance (CCIP), the cluster enterprise collaboration (CEC) and cluster collaborative innovation performance (CCIP) are highly correlated (the correlation coefficients are greater than 0.8).

Table 1. *Correlation matrix of variables.*

Variable	ILACE	CEC	EECCI	CCIP
ILACE	1.000	0.695	0.791	0.809
CEC	0.695	1.000	0.683	0.871
EECCI	0.791	0.683	1.000	0.691
CCIP	0.809	0.871	0.691	1.000

EECCI=External Environment of Cluster Collaborative Innovation; CEC=Cluster Enterprises Cooperation; ILACE=Innovative Learning Ability of Cluster Enterprises; CCIP=Cluster Collaborative Innovation Performance.

2.8. Reliability Analysis

The reliability of the scale is analyzed by Cronbach α, and the measurement results show that the coefficient is more than 0.8, it indicating that the questionnaire has high reliability.

2.9. Validity Analysis

Validity is mainly used to test the accuracy and usability of the questionnaire. Exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) were used to measure the validity.

2.9.1. Exploratory Factor Analysis (EFA)

This paper mainly uses principal component analysis method to carry out exploratory factor analysis, and extracts four components, which are basically consistent with the conceptual model constructed in this paper. They are external environment of cluster collaborative innovation (EECCI), innovation learning ability of cluster enterprises (ILACE), collaboration among cluster enterprises (CEC) and cluster collaborative innovation performance (CCIP). The KMO and Bartlett test results of each subscale are shown in Table 2.

Table 2. *KMO and Bartlett test.*

Subscale	KMO	p value
EECCI	0.819	0.000
ILACE	0.807	0.000
CEC	0.776	0.000
CCIP	0.847	0.000

EECCI=External Environment of Cluster Collaborative Innovation; CEC=Cluster Enterprises Cooperation; ILACE=Innovative Learning Ability of Cluster Enterprises; CCIP=Cluster Collaborative Innovation Performance.

2.9.2. Confirmatory Factor Analysis (CFA)

Content Validity. Content validity is mainly used to test the accuracy of the concept of the questionnaire. In the process of compiling the scale, this paper makes a systematic literature review, conducts in-depth interviews with port logistics cluster enterprises, and listens to the suggestions of experts and scholars in the industry. On this basis, the scale is repeatedly demonstrated and revised to ensure that the content is scientific and reasonable.

Convergent Validity. Convergent validity, as the most important index of confirmatory factor analysis, the following conditions need to be met:

First, the factor load is greater than 0.5; The second is the Constituent Reliability (Equation (1)) is more than 0.7; Third, The Average Extraction Variance (Equation (2)) is more than 0.5. μ is the standardized factor load rate.

$$CR = \frac{(\sum \mu)^2}{[(\sum \mu)^2 + \sum(1-\mu^2)]} \quad (1)$$

$$AVE = \frac{\sum \mu^2}{[\sum \mu^2 + \sum(1-\mu^2)]} \quad (2)$$

In this study, all factor loads are greater than 0.5 and the residual term is not negative, which is statistically significant. The results of confirmatory factor analysis in Table 3 show that the convergence validity index is good.

Table 3. *CFA Analysis Results.*

Variable	Convergent Validity		Fitness Index			
	AVE	***CR***	χ^2/df	***GFI***	***AGFI***	***CFI***
ILACE	0.71	0.89	0.304	0.942	0.905	0.907
CEC	0.63	0.81	0.291	0.950	0.914	0.911
EECCI	0.79	0.86	0.196	0.909	0.972	0.926
CCIP	0.82	0.91	0.175	0.923	0.961	0.947

AVE=Average Extraction Variance; CR=Composite Reliability; χ^2/df=Chi square/degree of freedom; GFI= Goodness of Fit Index; AGFI=Adjusted goodness of fit index; CFI=Comparative Fit Index; EECCI=External Environment of Cluster Collaborative Innovation; CEC=Cluster Enterprises Cooperation; ILACE=Innovative Learning Ability of Cluster Enterprises; CCIP=Cluster Collaborative Innovation Performance.

2.10. The Fitting Results of Structural Equation Model

In this study, amos21.0 software is used to estimate the structural equation model in Figure 5, and the fitting statistics are shown in Table 4. In the initial model, p<0.05, AGFI<0.9, GFI<0.9, the fitting is low, so it needs to be corrected. According to the correction suggestions of the software, the covariance relationship between the error terms is added. Table 4 shows that the other indexes of the modified model are significant except AGFI, and the data fitting is good. The hypothesis test results are shown in Table 5, and the modified action path is shown in Figure 5.

Table 4. *Structural Equation Model Fitting.*

Model state	χ^2/df	p	***RMSEA***	***GFI***	***AGFI***	***CFI***
Initial model	1.947	0.000	0.047	0.801	0.816	0.921
Modified model	1.081	0.391	0.003	0.915	0.896	0.975

χ^2/df =Chi square/degree of freedom; RMSEA=Root-Mean-Square Error of Approximation; GFI=Goodness of Fit Index; AGFI=Adjusted Goodness of Fit Index; CFI =Comparative Fit Index.

Table 5. *Hypothesis test results.*

Hypothesis	Path	Standardization Coefficient	P-Value	Result
H_1	CCIP<-EECCI	0.216	**	pass
H_2	CCIP<-ILACE	0.692	***	pass
H_3	CCIP<-CEC	0.831	***	pass
H_4	ILACE<-EECCI	0.604	***	pass
H_5	ILACE<-CEC	0.159	*	pass

*p < 0.05, **p < 0.01, ***p < 0.001. EECCI=External Environment of Cluster Collaborative Innovation; CEC= Cluster Enterprises Cooperation; ILACE=Innovative Learning Ability of Cluster Enterprises; CCIP=Cluster Collaborative Innovation Performance.

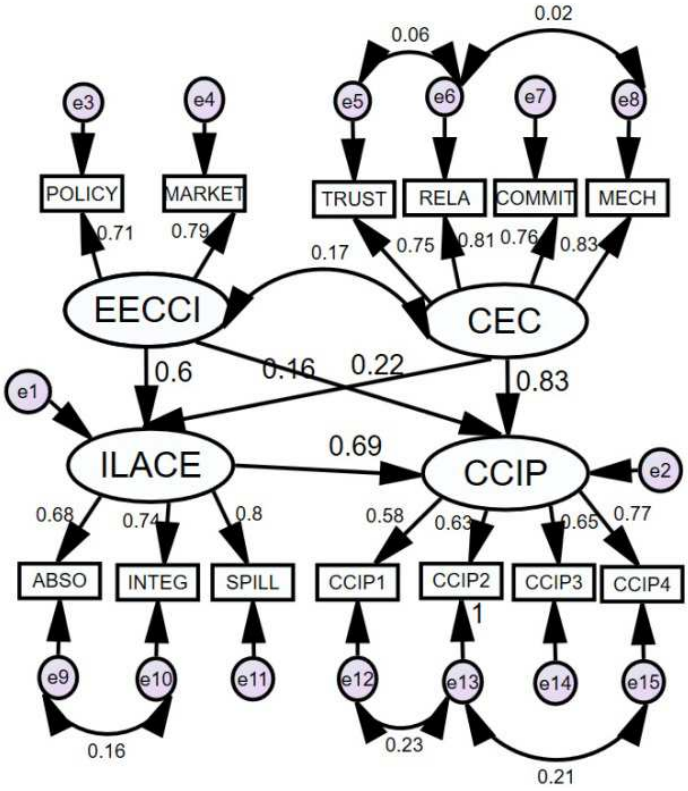

Figure 5. *Structural equation model and path coefficient. EECCI=External Environment of Cluster Collaborative Innovation; CEC=Cluster Enterprises Cooperation; ILACE=Innovative Learning Ability of Cluster Enterprises; CCIP=Cluster Collaborative Innovation Performance; RELA=Relationship; COMMIT=Commitment; MECH=Cooperation Mechanism; ABSO=Knowledge absorption; INTEG=Knowledge integration; SPILL=Knowledge Spillover.*

3. Results

3.1. The Intermediary Role of ILACE

Figure 5 shows that the path coefficient of EECCI to ILACE is 0.604, which is statistically significant. It shows that the external environment of collaborative innovation of port logistics enterprise cluster can significantly and positively affect the innovation learning of cluster enterprises. It is also found that the path coefficient of ILACE to CCIP is

0.692, which is statistically significant. This shows that port logistics enterprise cluster innovation learning ability can significantly and positively affect the cluster collaborative innovation performance.

It can also be seen from Figure 5 that the path coefficient of EECCI to CCIP is 0.216, which is significant at the statistical level of 0.01. The above test results show that, compared with the direct impact, ILACE plays a mediating role between EECCI and CCIP, and the mediating effect is 0.60 × 0.69=0.41, accounting for 65.1% [0.41%÷(0.22+0.41)=65.1%], direct action accounted for 34.9%. That is to say, the external environment of cluster collaborative innovation mainly affects the innovation performance of cluster enterprises indirectly by influencing their innovation learning ability.

Therefore, in the collaborative innovation of port logistics enterprise cluster, the enterprise knowledge absorption ability, knowledge integration ability and knowledge spillover play an intermediary role in the external innovation environment and the collaborative innovation performance of the cluster. This also shows that the government, as the policy and law maker, can effectively improve the performance of cluster collaborative innovation by supporting the innovation activities of port logistics enterprise cluster, and further shows that the external innovation environment such as policy plays an important role in cluster collaborative innovation decision-making.

3.2. The Collaboration Between Port Logistics Enterprises Cluster Has a Direct Positive Impact on CCIP

The path coefficient of CEC to ILACE is 0.159, which is statistically significant at the level of 0.05. This shows that the cooperation among enterprises can affect the innovation learning ability of cluster enterprises. In addition, the influence path coefficient of ILACE for CCIP is 0.692, and that of CEC for CCIP is 0.831, both of which are statistically significant. The above test results show that the synergy between cluster enterprises can not only directly affect the innovation performance of port logistics enterprise cluster, but also indirectly affect the innovation performance of cluster through enterprise innovation learning ability, and its indirect effect can be expressed as 0.16×0.83=0.13. In the relationship between inter firm collaboration and cluster collaborative innovation performance, the proportion of direct effect is 86.5% [0.83÷(0.13+0.83)=86.5%], and the mediating effect accounted for 13.5%. Therefore, compared with the indirect impact, the impact of inter firm collaboration on cluster innovation performance is more direct, and the mediating effect is relatively small.

4. Discussion

Collaborative innovation among port logistics enterprise clusters is a cross-organizational innovation. The existing research focuses more on maximizing the short-term benefits of cluster collaborative innovation, ignoring the driving research of the internal dynamics of collaborative innovation on innovation performance. Compared with the existing research, this paper focuses on the practical problems such as insufficient cooperation motivation and improper choice of innovation path in the process of cluster collaborative innovation. According to the results of the above data analysis, whether it is the external innovation environment of the port logistics enterprise cluster or the cooperation between the cluster enterprises, it can directly or indirectly affect the performance of the cluster collaborative innovation. The above empirical results provide the management enlightenment for the collaborative innovation of the Chinese port logistics enterprises cluster as follows:

4.1. Collaborative Innovation on Environmental Governance Mechanism

The empirical results show that the external environment of collaborative innovation of port logistics enterprises cluster will indirectly affect the collaborative innovation performance through the innovation learning of cluster enterprises. From the policy level, the government can create a good external innovation environment for the collaborative innovation of port logistics enterprises cluster, such as finance and tax policies. In addition, it can support the innovation practice of port logistics enterprise cluster through fund subsidy, but it is necessary to further implement the details of policy implementation, play the role of financial and tax support, and support those port logistics clusters and enterprises that have real willingness and conditions to carry out innovative research and development.

4.2. Collaborative Innovation Knowledge Governance Mechanism

The empirical results show that the innovation learning ability of cluster enterprises has a significant impact on collaborative innovation performance. In terms of specific innovation activities, this is mainly reflected in the process of acquiring knowledge, transferring knowledge, integrating and creating knowledge. Through the establishment of effective knowledge governance mechanism, port logistics enterprise cluster can restrain and encourage the learning among cluster enterprises at the institutional level, and balance the interest relationship among cluster enterprises to a certain extent. In the specific organizational form of cluster knowledge governance, we can establish formal or informal organizations to coordinate the learning activities of cluster enterprises, optimize and coordinate the knowledge structure of cluster enterprises, and promote the overall or partial knowledge creation of cluster enterprises. Knowledge governance can not only improve the learning efficiency of cluster enterprises, but also resist potential innovation risks, and provide necessary organizational guarantee for knowledge sharing and knowledge innovation among cluster enterprises.

4.3. Collaborative Innovation of Information Governance Mechanism

The empirical results show that the synergy between cluster enterprises mainly affects the innovation performance of cluster in a direct way. Good trust relationship and smooth communication among cluster enterprises need to solve the problem of information asymmetry among cluster enterprises first, because asymmetric information will affect the efficiency of collaborative innovation. The key to realize cluster collaborative innovation is to establish information governance model based on information sharing among port logistics cluster enterprises. The establishment of information governance mechanism can play a good role in regulating the relationship between organizations. Relying on cross-border information system can effectively solve the problem of information asymmetry. The establishment of information governance mechanism is helpful for port logistics enterprise cluster to further enhance the differences in resources or capabilities, and establish a sustainable competitive advantage.

4.4. Collaborative Innovation Incentive and Income Distribution Mechanism

Port logistics cluster enterprises should build an effective collaborative innovation incentive and income distribution mechanism. Before cluster enterprises implement collaborative innovation, it is necessary to reasonably plan and design the cost sharing and income distribution mechanism of cluster enterprises to carry out collaborative innovation, and balance the relationship between the overall goal of cluster and the individual goal of enterprises. The establishment of incentive mechanism for cluster collaborative innovation can further optimize the allocation of innovation resources, improve the enthusiasm of cluster enterprises, and ensure that cluster enterprises can obtain reasonable benefits when they participate in collaborative innovation, maximize the overall interests of cluster, and enhance the competitiveness and collaborative innovation performance of cluster.

4.5. Collaborative Innovation of Risk Management and Control Mechanism

It is necessary to build the risk management mechanism of cluster collaborative innovation in advance. In the process of collaborative innovation activities, port logistics enterprise clusters generally need to seek multilateral cooperation among enterprises to achieve complementary advantages, which will make the form of risk more complex. Especially in the cluster open collaborative innovation system, the traditional mechanism is difficult to deal with the collaborative risk in the process of cluster enterprise cooperation. It is necessary to design an effective risk management mechanism according to the characteristics of port logistics enterprise cluster collaborative innovation.

The first is to achieve synergy at the level of industrial chain. To achieve the synergy of port logistics enterprise clusters in different regions, we need to break the disadvantages of regional administrative subordination as a whole, seek the functional complementarity of each link from the industrial chain, and create conditions for the realization of collaborative innovation inside and outside the cluster.

The second is to achieve synergy in technology research and development. This is the key to the collaborative innovation of port logistics cluster, whose essence is to realize the complementary technology R&D resources among cluster enterprises. Therefore, it is necessary to integrate the technological needs, technological services and innovation incentives of cluster enterprises into the collaborative innovation system of cluster.

The third is to achieve synergy at the level of value chain. In the middle and high end of the value chain, port logistics enterprise cluster should further increase R&D investment, especially make breakthroughs in key and core technologies through collaborative innovation, promote technology upgrading, and enhance the control of the value chain. At the low end of the value chain, the cluster should strive to make a breakthrough in value transfer, carry out value transplantation in technology and other links through collaborative innovation, and transform or upgrade the original industrial chain.

5. Conclusions

This paper empirically studies the key path of collaborative innovation of logistics enterprise cluster by constructing structural equation model. Through the above evaluation and analysis, the following information can be obtained:

In order to further promote the collaborative innovation development of China's port logistics enterprise cluster, we can start from the environmental governance mechanism and adjust the collaborative innovation environment through fiscal and tax policies; Starting from the knowledge governance mechanism, we can establish formal or informal organizations to coordinate the learning activities of cluster enterprises, and promote the knowledge creation of the whole or part of cluster enterprises; Starting from the information governance mechanism, we can solve the problem of information asymmetry among cluster enterprises, enhance the diversity of cluster resources or capabilities, and establish a sustainable competitive advantage; Starting from the incentive and income distribution mechanism, we can balance the relationship between the overall goal of the cluster and the individual goal of the enterprise, and realize the maximization of the overall interests of the cluster while ensuring the reasonable income of the individual enterprise; We can also start from the risk management and control mechanism to promote the innovation collaboration of clusters at the level of industrial chain, technology chain and value chain.

Conflicts of Interest

The authors declare no conflict of interest.

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