Impact Path Analysis of Port Infrastructure Interconnection Potential on the 21st Century Maritime Silk Road

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Abstract. As an important fulcrum for building the economic belt of the 21st Century Maritime Silk Road, clarifying the influence paths among the influencing factors of the construction of port infrastructure connectivity is crucial for promoting the smooth flow of maritime transportation channels. By combing the existing research results, it is found that the political environment, trade facilitation level, and port hinterland economy have influence on port infrastructure connectivity potential and sort out the relationship between the influencing factors, put forward six reasonable hypotheses, and validate the hypothesized relationship based on the structural equation modeling and the actual data of 69 countries along the route, and get the conclusion, which is found that the trade facilitation level and port hinterland economy have a strong influence on the port infrastructure connectivity potential. It is found that trade facilitation level and port hinterland economy have a strong positive influence on port infrastructure connectivity potential, and the influence of political environment on port infrastructure connectivity potential is not significant.

Keywords: ports; infrastructure; connectivity; structural equation modeling

1 Introduction

In 2013, during his visit to Central Asia and Southeast Asia, General Secretary Xi Jinping successively proposed the construction of the "Silk Road Economic Belt" and the "21st Century Maritime Silk Road"15[1] , aiming to build an all-around, multi-layered and composite network of connectivity in Asia, Europe and Africa. The aim is to build an all-round, multi-layered and complex connectivity network in Asia, Europe and Africa, to promote trade exchanges among countries along the route, to expand the complementary advantages of trade among countries, and to promote common development and prosperity of all countries. In the process of promoting the construction of connectivity network among countries, the construction of infrastructure connectivity is a priority area, and ports, as an important node connecting countries' maritime transportation channels, create port infrastructure connectivity network, which is crucial for promoting the circulation of resources in the countries along the 21st Century Maritime Silk Road, and unimpeded the maritime transportation channel among countries. Therefore, this paper's analysis of the potential of port infrastructure connectivity on the 21st Century Maritime Silk Road is of great significance to China's scientific

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decision-making on port infrastructure connectivity and further promoting the construction of port infrastructure connectivity between China and the countries along the Maritime Silk Road.

Since the "Belt and Road" national strategic policy was put forward, China has focused on the construction of connectivity has achieved remarkable results, a large number of scholars at home and abroad around the 21st Century Maritime Silk Road connectivity research.

He Min et al.[2] conducted an empirical analysis of the relationship between facility connectivity and the level of regional integration, and the results show that compared with other modes of transportation, port facility connectivity has the most obvious effect on the promotion of trade and the level of regional integration, so it can be seen that strengthening the construction of port infrastructure connectivity to smooth out the sea transportation channel is of great significance in promoting the construction of the 21st century Sea Silk Road. However, the level of port infrastructure interconnection between China and the countries along the Maritime Silk Road is much lower than the level of other infrastructure interconnection. Yu Junjie et al.[3] measure the level of interconnection of various transportation infrastructures, and the results show that the development of port infrastructure interconnection is lagging behind the level of aviation infrastructure interconnection. China still needs to continue to make more efforts to promote the construction of port infrastructure connectivity.

From the viewpoint of existing literature, there are some research results of qualitative description and quantitative analysis in port infrastructure connectivity, mostly focusing on the exploration of the impact of port infrastructure connectivity on economy and trade[4][5][6] , the siting of port nodes for port infrastructure connectivity[7][8] , and qualitative analysis of the impact factors of connectivity[9] , etc. There are relatively few studies focusing on quantitative analysis of the impact factors of port infrastructure connectivity itself, Therefore, this paper intends to use quantitative analysis to analyze the impact path of port infrastructure connectivity. Due to the large number of factors influencing the potential of port infrastructure connectivity and the complex relationship between the influencing factors, structural equation modeling (SEM) is considered to be an effective analytical method to analyze the impact paths of a complex system with non-intuitively observable variables and multiple dependent variables, which can deal with multiple variables at the same time and take into account the effect of measurement error, and estimate the relationship between the variables more accurately through the combination of measurement modeling and structural modeling. The relationship between variables can be more accurately estimated by combining measurement models with structural models.This paper will focus on the quantitative factors affecting port infrastructure connectivity based on the existing research results. Based on the existing research results, this paper will focus on the construction of port infrastructure interconnection, narrow the research scope, take port infrastructure interconnection as the main body of research, design the research hypothesis of port infrastructure interconnection influencing factors, conduct empirical analysis based on the actual data of more than 69 countries along the 21st Century Maritime Silk Road, and construct a structural model of the influence paths of the potential of port infrastructure interconnection. Equation modeling, exploring port infrastructure connectivity influencing factors and role mechanisms, and putting forward suggestions for further development of port infrastructure connectivity construction along the 21st Century Maritime Silk Road. The research of this paper can provide a reference basis for

China to further promote the construction of port infrastructure connectivity on the 21st Century Maritime Silk Road.

2 Research Design

2.1 Theoretical Foundations

In the context of the State's proposal to build the Belt and Road to realize interconnection, interconnection mainly consists of five aspects, including policy, trade, capital, facilities and people's hearts, from which interconnection will be realized. The significance of connectivity is to serve the circulation of factors of production such as capital, technology and labor. The connectivity of port infrastructure studied in this paper mainly refers to the connectivity of routes between ports, the smooth flow of trade, and the connection and coordination of port collection and transportation.

The core idea of system theory is to regard the research object as a system, explore the intricate relationship among system, elements and environment, and optimize the system viewpoint to see the problem[10] . From the viewpoint of system theory, port infrastructure connectivity is a complex system problem, port infrastructure connectivity construction will be affected by the level of port infrastructure construction, the economic and trade environment of the port hinterland, international relations, the bilateral trade environment, the degree of trade facilitation, logistics efficiency and so on, with many influencing factors and the intricate relationship between the influencing factors. This paper focuses on the political environment, port hinterland economy and trade facilitation level to explore its impact on port infrastructure connectivity construction path.

2.2 Research Hypothesis

2.2.1 Political Environment and Potential for Port Infrastructure Connectivity

Whether or not the political situation in the connected countries is stable will affect the joint construction and operation of maritime infrastructure, thereby affecting their connectivity. The connectivity between China and the "Belt and Road" countries is mainly affected by their domestic influence and their relationship with neighboring countries, which mainly involves various factors such as the stability of the political regime, the status of religious and ethnic groups, the situation of infrastructure and the positioning of the future development of the country, etc. For example, in February 2016, one month after the acquisition of the Piraeus port by COSCO Shipping, the Piraeus port was struck by a strike again, and container stacking and cargo handling operations were disrupted. strikes, container stacking and cargo handling operations were disrupted, and both customs clearance and container-free period procedures were affected. In addition, political stability is an important foundation for economic development. Political instability affects business investment, levels of social equity and welfare, resource allocation, and international relations. The level of trade facilitation in a country also requires the support and leadership of government policies. Therefore, the hypothesis is formulated:

H1: The political environment positively affects the potential for port infrastructure connectivity;

H2: The political environment positively affects the economic situation in the port hinterland;

H3: The political environment contributes positively to a country's level of trade facilitation;

2.2.2 Potential for Port Hinterland Economy and Port Infrastructure Connectivity

Ports are the central hub of regional foreign trade, providing commodities, raw materials and other transportation services for the development of the hinterland, promoting market integration and service clustering, having a radiation effect on the economic and industrial development of the hinterland, and being an important driving force for the economic growth of the coastal region, while the economy of the hinterland provides ports with sufficient capital and goods security, is an important carrier for the development of ports, and is the basis of the survival and development of ports. [11]The port hinterland economy has a certain supporting and driving role in the construction of port infrastructure connectivity. Gong Chun et al.[12] take Chinese ports along the Maritime Silk Road as the main research body and empirically analyze the relationship between ports and the hinterland economy, and the research results show that China's five major ports have shown the synergistic effect of port and hinterland, and the development of the hinterland economy has a significant role in promoting the development of ports. Jiang Huiyuan[13] explored the relationship between port competitiveness and port hinterland economy based on entropy weight-TOPSIS model and gray correlation model, and empirically proved that the port competitiveness has a strong correlation effect with the port hinterland economic environment, which affects the port competitiveness through the total economic volume, economic structure, and economic quality. Wu Zhenming[14] analyzed the influence path between port economy and hinterland economy and got the conclusion that hinterland economy can drive the development of port economy. To summarize, the hypothesis is proposed:

H4: The port hinterland economy has a positive impact on port infrastructure connectivity development.

2.2.3 Trade Facilitation Level and Port Infrastructure Connectivity Potential, Port Hinterland Economy

With economic development, the promotion of trade facilitation and the reduction of trade costs have received extensive attention from various countries, and the term trade facilitation has frequently appeared in various academic studies, with scholars studying various aspects of trade facilitation, such as policies, impacts and levels. However, there is no uniform definition of the meaning of trade facilitation so far. WTO (1998) and UNCTAD (2001) believe that trade facilitation refers to the simplification and harmonization of international trade procedures. OCED (2001) defines trade facilitation as the simplification and standardization of the procedures and the flow of related information required for the flow of international goods from the seller to the buyer and the payment of the other party. UN/ECE considers trade facilitation as the simplification and standardization of the procedures and the flow of related information required for the flow of international trade from the seller to the buyer and the payment of the other party. ECE considers trade facilitation as a comprehensive and integrated approach to reducing the complexity and costs of trade transaction processes, ensuring that all economic and trade activities are carried out in an efficient, transparent and predictable manner on the basis of internationally acceptable norms, guidelines and best practices. APEC

(2002) defines trade facilitation, which generally refers to the use of new technologies and other measures to simplify and harmonize trade-related procedures and administrative barriers, reduce costs, and promote better flow of goods and services. Although the definitions of trade facilitation vary among organizations, they all encourage the simplification of customs clearance procedures, increased transparency of information, lowering of customs clearance costs, and increased efficiency of customs clearance as a means of facilitating the smooth flow of trade.

According to scholars' related research on trade facilitation it can also be seen that the level of trade facilitation has a certain impact on connectivity. Samia et al.[15] took Morocco's bilateral maritime connectivity as the main body of the study, and identified the influencing factors affecting maritime connectivity through statistical analysis, and utilized regression analysis combined with gravitational modeling to analyze the influencing factors statistically, and got the conclusions that: economic growth, logistics level, direct maritime connectivity and maritime trade components all have a strong positive impact on bilateral connectivity.

Port infrastructure connectivity requires not only route network connectivity and policy docking, but also trade facilitation. With the development of the global economy and the advancement of science and technology, it is necessary to modernize the seaports, maritime transport systems, and import and export procedures of countries along the Maritime Silk Road, improve the level of trade facilitation, and reduce trade costs, so as to stimulate route connectivity and trade exchanges, and to drive smaller countries with weaker economies to enter the global market, thus further facilitating the interconnection of port infrastructures.

In addition, a large number of studies have shown that the improvement of trade facilitation level has a positive role in promoting international trade. Wang Min et al.[16] build a trade facilitation evaluation index system to measure the trade facilitation level of countries along the Maritime Silk Road, and analyze the impact of trade facilitation level on China's bilateral trade in agricultural products with countries along the Maritime Silk Road based on the trade gravity model, and conclude that improving the level of trade facilitation in the countries along Maritime Silk Road has a positive and positive impact on China's bilateral trade in agricultural products with these countries. Dr. Liu et al.[17] used SYS-GMM to empirically analyze the impact of trade facilitation level on China's exports of electromechanical products, and came to the conclusion that compared with the GDP, population size, bilateral distance and other factors of the trade partner countries, the impact of trade facilitation level on China's exports of electromechanical products is the most significant. Zhang Yuan[18] Measured the impact of trade facilitation level on China's export trade by using principal component analysis and gravity model, and got the conclusion that for every 1% increase in logistics efficiency, China's export trade volume increases by 0.98%. Jordan[19] conducted an empirical study on the economic effects brought about by trade facilitation on the 21st Century Maritime Silk Road, and the results show that whether it is China or ASEAN, South Africa, or East Africa, the increase in the level of trade facilitation will bring about a positive impact on the country's economy, welfare, and trade. Li Wei[20] also empirically analyzes the economic growth of countries along the "Belt and Road" by the level of trade facilitation, and gets the conclusion that the level of trade facilitation has the most obvious effect on the economic promotion of middle and high economic countries. In summary, the following hypotheses are proposed:

H5: The level of trade facilitation positively affects the port hinterland economy.

H6: The level of trade facilitation has a positive impact on port infrastructure connectivity development.

2.3 Conceptual Model

The purpose of this paper is to explore the influencing factors of port infrastructure connectivity and the mechanism of the role between the influencing factors. While most of the existing related studies focus on theoretical analysis or single analysis of the relationship between two types of variables using correlation model and gravity model, and most of the research content focuses on exploring the impact of connectivity on the economy and trade, but port infrastructure connectivity itself is a complex system that will be affected by multiple factors, and the structural equation modeling is a well-established method to deal with the complex relationship between multiple variables. Therefore, a conceptual model of the influencing factors of port infrastructure connectivity potential as shown in **Fig. 1** is constructed based on the literature combing and research hypotheses above, and a structural equation model is constructed on the basis of this model for hypotheses testing to reveal the degree of influence of the above influencing factors on the port infrastructure connectivity potential as well as the paths of the influence.

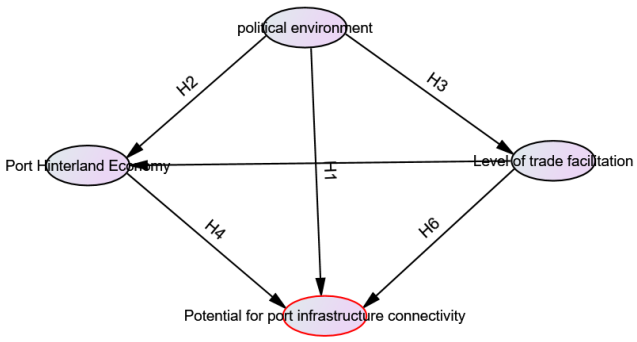

Fig. 1. Conceptual model of factors influencing the potential for port infrastructure connectivity.

2.4 Measurement of Variables

2.4.1 Political Environment

"The concept of the Belt and Road Initiative is to strengthen the ties between countries through connectivity, promote cooperation among countries along the route and drive the development of the world economy. However, since the Belt and Road Initiative involves a wide range of interests and a complex connectivity environment, the promotion of port infrastructure connectivity requires stable political relations and a stable political environment.

Summarizing the above analysis, this paper selects the indicators of political stability, government effectiveness, regulatory quality, rule of law and anti-corruption control to

measure the political security environment. Political stability reflects the country's political instability and the absence of terrorism; government effectiveness, regulatory quality, and anti-corruption control reflect the government's management of the country; and the rule of law reflects the legal protection provided by the country for the construction of connectivity.

2.4.2 Port Hinterland Economy

The economic development of a country cannot be separated from the development of ports, and the development of ports is also closely dependent on the economic development and policy orientation of the country. Yang Ren et al.[21] analyzed and evaluated the competitiveness of ports along the Maritime Silk Road, and pointed out that the hinterland economy of a port can be reflected by the GDP of the country to which the port belongs. Meng Feirong et al.[22] pointed out that the hinterland economic system includes three parts: hinterland economic aggregate, hinterland economic structure, and hinterland economic quality. The total hinterland economy mainly refers to the gross domestic product, foreign direct investment, etc., the structure of the hinterland economy mainly refers to the industrial structure, foreign trade dependence, etc., and the quality of the hinterland economy mainly refers to the GDP per capita and labor productivity, etc.

Considering that the role of port infrastructure connectivity is to promote foreign trade, this paper selects the total value of GDP, the total value of imported goods and services, and the total value of exported goods and services to measure the economic situation of port hinterlands in the countries along the Maritime Silk Road.The total value of GDP reflects the overall economic level of port hinterlands, while the total value of imported and exported goods and services reflects the demand for foreign trade in port hinterlands.

2.4.3 Level Of Trade Facilitation

Transportation time and trade costs are important factors influencing traders' choice of whether to engage in import and export trade. Trade facilitation is to simplify customs clearance procedures, improve customs clearance efficiency, save transportation time, and reduce trade costs, which is crucial for promoting smooth maritime trade. Li Baomin[23] and Diao Li[24] et al. point out that trade facilitation measurement takes into account the port efficiency and customs environment, in which the port efficiency not only refers to the efficiency of the port itself, but also includes the operational efficiency of the infrastructure of aviation, railroads, ports, roads and so on.

In summary, this paper selects the quality of trade and transportation-related infrastructure, the efficiency of customs clearance, and logistics performance to measure the logistics performance of the countries along the Maritime Silk Road. The quality of trade and transportation-related infrastructure is a comprehensive evaluation of various trade and transportation-related infrastructures such as ports, railroads, highways, and information technology. The efficiency of customs clearance procedures reflects the speed, simplicity and predictability of procedures for the clearance of imported goods, exported goods and transshipment goods. The Logistics Performance Index reflects the capacity and quality of a country's logistics services.

2.4.4 Potential for Port Infrastructure Connectivity

As ports are the gateway to world trade, strengthening the construction of port infrastructure connectivity is crucial to unimpeded maritime transportation channels to promote international circulation. A large number of scholars have explored the aspect of ports and connectivity. Liang Kedi[25] investigates the impact of port connectivity infrastructure construction on the economy of RCEP member countries, and uses the liner shipping connectivity index to measure the level of liner shipping connectivity of each country. Gao Cong et al.[26] measure the level of connectivity of various transportation infrastructures, in which two indicators, container terminal throughput and the number of bilateral cooperation documents on port infrastructure, are selected for measuring the level of port infrastructure connectivity. In addition, port infrastructure connectivity construction also needs to consider the quality level of port infrastructure, and port infrastructure itself meets the demand for connectivity construction is the premise of port infrastructure connectivity construction. Sun Shuai[27] pointed out in his study of container port connectivity that the conditions of port infrastructure itself must be considered in connectivity, and the more superior the conditions of port infrastructure, the higher the attractiveness of the port, and the level of connectivity can be improved.

To summarize, liner connectivity index, port throughput and port infrastructure quality are selected to measure the potential of port infrastructure connectivity in the countries along the Maritime Silk Road. Port infrastructure quality index reflects the level of port hardware facilities, reflecting the comprehensive production and service capacity of ports in various aspects such as loading and unloading, storage, processing, transportation, etc. The stronger the capacity and the higher the efficiency, the stronger the ability to attract ships to call. Annual port throughput is an important quantitative indicator reflecting the port's throughput capacity and international status. The better the hardware conditions of the port, the stronger the attraction of the port, the more ships call at the port, the higher the annual throughput of the port. Liner Shipping Connectivity Index shows the integration level of a country with the global liner shipping network, which consists of the number of ship calls, the number of liner shipping, the number of liner companies served, the number of direct routes, etc. It can reflect the closeness of a country's ports to the world's ports and routes, and the status of a country's ports in the world's shipping network, as well as the competitiveness of a country's ports and its foreign trade capacity. The higher the liner transportation connectivity index, the better the liner transportation connectivity index is. The higher the liner shipping connectivity index is, the closer the port is connected with other ports in the world and the better the port connectivity is.

2.5 Initial Structural Equation Modeling

Based on the above analysis of factors influencing port infrastructure connectivity, analysis of research hypotheses and analysis of variables, a total of 4 latent variables such as political environment, port hinterland economy, trade facilitation level, port infrastructure connectivity and 4 explicit variables such as liner connectivity index, port throughput, port infrastructure quality index, political stability, government effectiveness, regulatory quality, rule of law environment, anti-corruption control, import trade volume, export trade volume, total GDP, quality of trade and transportation-related infrastructure, customs clearance efficiency, logistics performance, and 14 explicit variables, of which port infrastructure connectivity is an

endogenous latent variable, to construct the initial model of structural equations shown in **Fig. 2**. The matrix indicates the explicit variable indicators, the ellipse indicates the latent variable indicators, the circle indicates the measurement error, and the arrow indicates the influence path.

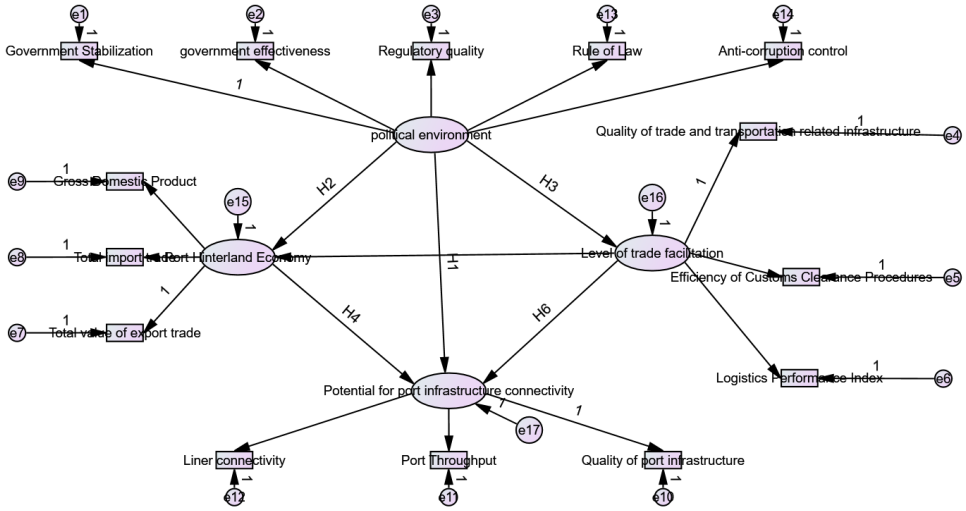

Fig. 2. Initial structural equation model for port infrastructure connectivity potential analysis.

3 Data Analysis and Results

3.1 Data Collection

According to the completeness and availability of data, this paper selects the explicit variable indicator data of 69 countries along the Maritime Silk Road for three years from 2018-2021 as a measure of the ability of each country to realize port infrastructure connectivity, and after excluding some unavailable missing values, the number of samples is 207, which is in line with the requirement that the number of samples is greater than 10 times the number of explicit variable indicators as required by the structural equation model. Specific data sources for each indicator are shown in **Table 1**.

Table 1. Data sources for indicators of significant variables.

Explicit variable indicators	nicknames	unit (of measure)	Data sources
port throughput	A1	TEU	UNCTAD databases
liner connectivity	A2	Maximum 2004 = 100	World Bank database
Quality of port infrastructure	A3	1-7	World Bank database

Quality of trade and transport-related infrastructure	A4	1-5	World Bank database
Efficiency of customs clearance procedures	A5	1-5	World Bank database
Logistics Performance Index	A6	1-5	World Bank database
gross domestic product (GDP)	A7	dollar	World Bank database
Total value of import trade	A8	dollar	World Bank database
Total value of export trade	A9	dollar	World Bank database
political stability	A10	1-5	Global Governance Database
government effectiveness	A11	1-5	Global Governance Database
Regulatory quality	A12	1-5	Global Governance Database
rule of law	A13	1-5	Global Governance Database
Anti-Corruption Control	A14	1-5	Global Governance Database

3.2 Data Analysis

3.2.1 Descriptive Analysis of Data

Descriptive statistical analysis of the data for 2018-2021 for 12 indicators for 69 countries along the Maritime Silk Road after removing missing values is shown in **Table 2**.The gap between the maximum and minimum values of the indicators is large, and the variance is also generally large, with a large degree of data dispersion, mainly due to the disparity in port sizes and the complexity of the economic and trade environments of the countries along the Belt and Road, and port infrastructure The improvement of the level of interconnection and intercommunication can help to reduce the economic gap between countries.

Table 2. Descriptive Statistical Analysis of Indicators for Each Apparent Variable.

	N	minimum value	maximum values	average value	standard deviation	variance (statistics)
A1	207	5.84E+04	3.75E+07	5.69E+06	7.78E+06	6.06E+13
A2	207	4.20	113.77	38.93	28.77	827.46
A3	207	1.16	6.80	4.28	1.01	1.01
A4	207	1.70	4.60	2.89	0.66	0.44
A5	207	1.57	4.20	2.79	0.57	0.33
A6	207	1.90	4.40	2.96	0.59	0.35
A7	207	3.04E+09	5.12E+12	5.27E+11	9.72E+11	9.44E+23
A8	207	0.00E+00	1.79E+12	1.69E+11	2.89E+11	8.37E+22
A9	207	0.00E+00	2.02E+12	1.80E+11	3.14E+11	9.88E+22
A10	207	0.94	98.11	41.70	25.52	651.34
A11	207	0.48	100.00	51.04	25.65	657.88
A12	207	0.48	100.00	50.96	25.94	673.04
A13	207	0.48	99.05	48.26	25.60	655.57

A14	207	0.95	100.00	46.74	25.95	673.50

3.2.2 Correlation Analysis Between Variables

The sample data are normalized to eliminate the influence of different index outlines, and the Pearson correlation analysis is performed for each index, and the analysis results are shown in **Table 3**, most of the correlations between the indexes are above 0.5, which is good and significant, and it is suitable for doing the analysis of structural equation modeling.

Table 3. Indicator relevance.

	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14
A1	1	0.860**	0.592**	0.684**	0.657**	0.674**	0.528**	0.639**	0.646**	0.306**	0.579**	0.483**	0.495**	0.451**
A2	0.860**	1	0.707**	0.764**	0.721**	0.742**	0.563**	0.690**	0.69**	0.316**	0.610**	0.544**	0.566**	0.509**
A3	0.592**	0.707**	1	0.761**	0.760**	0.750**	0.353**	0.485**	.0500**	0.551**	0.763**	0.719**	0.718**	0.682**
A4	0.684**	0.764**	0.761**	1	0.944**	0.947**	0.600**	0.713**	0.717**	0.448**	0.748**	0.725**	0.716**	0.692**
A5	0.657**	0.721**	0.760**	0.944**	1	0.930**	0.572**	0.693**	0.694**	0.493**	0.781**	0.765**	0.748**	0.725**
A6	0.674**	0.742**	0.750**	0.947**	0.930**	1	0.596**	0.709**	0.710**	0.434**	0.752**	0.733**	0.706**	0.688**
A7	0.528**	0.563**	0.353**	0.600**	0.572**	0.596**	1	0.898**	0.866**	0.161*	0.402**	0.344**	0.339**	0.339**
A8	0.639**	0.690**	0.485**	0.713**	0.693**	0.709**	0.898**	1	0.993**	0.258**	0.500**	0.453**	0.447**	0.449**
A9	0.646**	0.690**	0.500**	0.717**	0.694**	0.710**	0.866**	0.993**	1	0.277**	0.509**	0.465**	0.458**	0.464**
A10	0.306**	0.316**	0.551**	0.448**	0.493**	0.434**	0.161*	0.258**	0.277**	1	0.711**	0.741**	0.778**	0.796**
A11	0.579**	0.610**	0.763**	0.748**	0.781**	0.752**	0.402**	0.500**	0.509**	0.711**	1	0.925**	0.913**	0.897**
A12	0.483**	0.544**	0.719**	0.725**	0.765**	0.733**	0.344**	0.453**	0.465**	0.741**	0.925**	1	0.921**	0.904**
A13	0.495**	0.566**	0.718**	0.716**	0.748**	0.706**	0.339**	0.447**	0.458**	0.778**	0.913**	0.921**	1	0.957**
A14	0.451**	0.509**	0.682**	0.692**	0.725**	0.688**	0.339**	0.449**	0.464**	0.796**	0.897**	0.904**	0.957**	1

A14	0.451**	0.509**	0.682**	0.692**	0.725**	0.688**	0.339**	0.449**	0.464**	0.796**	0.897**	0.904**	0.957**	1

Note: ** Significant at the 0.01 level (two-tailed); * Significant at the 0.05 level (two-tailed).

3.3 Reliability and Validity Tests

Reliability reflects the reliability of the sample data, and a high reliability indicates that the results of the test are consistent, stable and reliable. Cronbach's Alpha test for the measurement index, the closer the value is to 1, the better the reliability. Validity reflects the extent to which the results reflect the content of the measurement, the higher the validity, the stronger the validity of the measurement data, so this paper carries out KMO and Bartlett test on the indicator data. The results of the reliability and validity tests are shown in **Table 4**. The Cronbach's Alpha value is 0.959, which exceeds the reliability standard of 0.6, indicating that the reliability of the indicator data is high, and the KMO value is 0.896, which exceeds the validity standard of 0.7, indicating that the indicator validity is high.

Table 4. Results of Reliability and Validity Tests.

dimension (math.)	sports event	Cronbach's Alpha	KMO test	Bartlett's test	
political climate	5	0.967	0.896	Approximate cardinality/degrees of freedom	significance
Port Hinterland Economy	3	0.966		4892.161/96	0
Trade facilitation	3	0.979			
Potential for port infrastructure connectivity	3	0.879			
summary table	14	0.959			

3.4 Analysis of Initial Model Results

The sample data were brought into the constructed initial model of structural equations and estimated by maximum likelihood estimation, and after 16 iterations, the model fitting results and parameter estimation results were obtained as shown in **Table 5** and **Table 6**. Most of the model fit indicators are within the standard range, indicating that the model fit is good and the estimation results can be analyzed. According to the estimation results, it can be found that the hypothesis H3, H4, H5, H6 path coefficient is less than 0.95 and the significance degree $P<0.001$, the hypothesis is established, H1 assumed path coefficient 0.038 but the significance degree is low, rejected the original hypothesis, and the path coefficient of H2 is negative, rejected the original hypothesis.

Table 5. Model Fit Results.

fitness indicator	CMIN/DF	CFI	NFI	RFI	IFI	TFI	RMSEA
(an official) standard	<5	>0.9	>0.9	>0.9	>0.9	>0.9	<0.1
fitted value	4.635	0.948	0.935	0.916	0.948	0.933	0.133

Table 6. Parameter estimates for each variable.

	Estimate	S.E.	C.R.	P
Political environment ----->level of trade facilitation	0.936	0.078	11.997	***
Trade facilitation levels ----->Port Hinterland Economy	0.873	0.082	10.627	***
Political environment ----->Port Hinterland Economy	-0.283	0.096	-2.953	0.003
Level of trade facilitation ----->Port Infrastructure Connectivity Potential	0.627	0.087	7.187	***
Port Hinterland Economy ----->Port Infrastructure Connectivity Potential	0.23	0.057	4.027	***
Political environment ----->Port Infrastructure Connectivity Potential	0.038	0.086	0.436	0.663

3.5 Structural Equation Modeling Corrections

Since the assumption that the path coefficient of H3 is negative is inconsistent with the theoretical study, the assumption is deleted, and the revised model fitting indicators as well as parameter estimates are shown in **Table 7** and **Table 8**. The path coefficient of the political environment on the trade facilitation level is 0.932, with a large degree of influence, and the path coefficient of the trade facilitation level on the economy of the port hinterland is 0.692, and both the trade facilitation level and the economy of the port hinterland have a direct influence on the potential of port infrastructure connectivity, with a significant effect, and the effect of the political environment's direct influence on the potential of port infrastructure connectivity is not The direct effect of political environment on the potential of port infrastructure connectivity is not significant.

Table 7. Modified Structural Equation Model Fit Indicators.

fitness indicator	CMIN/DF	CFI	NFI	RFI	IFI	TFI	RMSEA
(an official) standard	<5	>0.9	>0.9	>0.9	>0.9	>0.9	<0.1
fitted value	4.694	0.946	0.933	0.915	0.946	0.932	0.134

Table 8. Estimated parameters of the modified structural equation model.

	Estimate	S.E.	C.R.	P
Political environment ----->level of trade facilitation	0.932	0.078	11.935	***
Trade facilitation levels ----->Port Hinterland Economy	0.692	0.054	12.728	***

Level of trade facilitation ----->Port Infrastructure Connectivity Potential	0.612	0.086	7.089	***
Port Hinterland Economy ----->Port Infrastructure Connectivity Potential	0.236	0.057	4.149	***
Political environment ----->Port Infrastructure Connectivity Potential	0.055	0.086	0.638	0.523

4 Conclusions, Insights and Limitations

4.1 Conclusion

The "Belt and Road" initiative has been put forward for more than 10 years, and the connectivity results are remarkable, 163 countries along the route have responded to the Belt and Road cooperation initiative, and the trade volume of the Belt and Road has continued to climb, but most of the studies on the impact paths affecting the potential of port infrastructure connectivity have been focused on the theoretical level, and there is a lack of practical demonstration based on data. This paper puts forward six reasonable hypotheses and constructs the initial structural model based on the existing theoretical research foundation, collects 207 sample data, carries out the reliability and validity test on the variables, proves the reliability and validity of the indicator variables, runs the structural equation model by using AMOS 26 and corrects the initial structural equations, and the corrected structural equation model has a better fit, and through the analysis of the path coefficients Through the analysis of path coefficients and path significance, it is found that the trade facilitation level of the countries along the route has a positive influence on the potential of port infrastructure connectivity, the economic level of the port hinterland also has a positive effect on the potential of port infrastructure connectivity, but the degree of influence is lower than that of the trade facilitation level, and the influence of the political environment on the potential of port infrastructure connectivity is insignificant, but the political environment will affect the trade facilitation level, thus affecting the potential of port infrastructure connectivity. The political environment does not have a significant impact on port infrastructure connectivity potential, but the political environment affects trade facilitation, which indirectly affects port infrastructure connectivity potential, and trade facilitation has a positive impact on port hinterland economy.

4.2 Management Insights

In selecting countries for port infrastructure connectivity construction, priority can be given to countries with a high level of trade facilitation, good political relations with China, simplified customs clearance procedures and a high level of quality of transportation infrastructure. In the construction of port infrastructure connectivity, priority can be given to the signing of relevant free trade agreements, for example, the signing of the RCEP regional free trade agreement, through the signing of the agreement to promote regional cooperation, simplify customs clearance procedures, improve the level of bilateral trade facilitation, and drive bilateral trade exchanges and improve the level of economic development of the two countries. Political stability is a necessary but not the only condition to be considered when building connectivity.

4.3 Research Contributions and Limitations

Based on the actual data, this paper clarifies the path relationship between the political environment, trade facilitation level, port hinterland economy and port infrastructure connectivity potential to provide theoretical support for the decision-making of China's Belt and Road connectivity construction. However, due to the requirements of structural equation modeling on the amount of indicator data as well as the sample size, the variable indicators in this paper are relatively small, and there is still a lot of research space after increasing the number of indicators.

References

[1] National Development and Reform Commission, Ministry of Foreign Affairs, Ministry of Commerce.: Vision and Action to Promote the Construction of Silk Road Economic Belt and 21st Century Maritime Silk Road. Transportation Finance and Accounting. Pp.84-89(2015). DOI:CNKI:SUN:JTCK.0.2015-04-027.

[2] He Min.: Facility Connectivity and Regional Integration: An Empirical Analysis Based on China's Relationship with "Belt and Road" Countries. China Circulation Economy.pp.34-42(2020).

[3] YU Junjie, ZHI Yupeng, CHEN Yufan.: Measurement and dynamic evolution of transportation infrastructure connectivity between China and countries along the Belt and Road. Statistics and Decision Making.pp.56-59(2020).DOI:10.13546/j.cnki.tjyjc.2020.19.012.

[4] Liang R , Liu Z .:Port Infrastructure Connectivity, Logistics Performance and Seaborne Trade on Economic Growth: an Empirical Analysis on "21st-Century Maritime Silk Road".Journal of Coastal Research.pp.319(2020).DOI:10.2112/SI106-074.1.

[5] Munim Z H , Schramm H J .:The impacts of port infrastructure and logistics performance on economic growth: the mediating role of seaborne trade.Journal of Shipping & Trade. Pp.1(2018). DOI:10.1186/s41072-018-0027-0.

[6] Weijun L, Xiwen B,Dong Y, Yao H.: Maritime connectivity, transportation infrastructure expansion and economic growth: a global perspective. Transportation Research Part A.pp.170(2023). DOI:https://doi.org/10.1016/j.tra.2023.103609.

[7] Zuo Shichao.: Research on the Selection of Strategic Pivot Ports of the "21st Century Maritime Silk Road". Dalian Maritime University(2019).

[8] JIA Peng, DUAN Jingming, ZHAO Xueding et al.: "Study on Investment Location Selection of Ports along the 21st Century Maritime Silk Road. China Navigation, pp.70-77(2022)

[9] Li Wei, Yang Lingxiao.: Analysis of Influencing Factors and Countermeasure Suggestions for China-ASEAN Maritime Connectivity. China Water Transportation.pp.14-15(2020). DOI:10.13646/j.cnki.42-1395/u.2020.06.005.

[10] Wang Jingmin.: How is the efficient operation of port-hinterland supply chain possible--an analysis of the influencing factors of operation efficiency under the perspective of system theory. Journal of Dalian Maritime University (Social Science Edition).pp.59-71(2022)

[11] Kuang, HB, Zhu, JY, Bai, ZZ.:Study on the Interaction between Green Competitiveness of Coastal Ports and Hinterland Economy.SUSTAINABILITY.pp.2(2023). DOI10.3390/su15021364

[12] Gong C, Yang X, Liu Y, et al.: China's Port-Hinterland Coordinated Economic Development under 'Maritime Silk Road' Initiative.Journal of Coastal Research.pp.sp1(2020). DOI:10.2112/JCR-SI112-123.1.

[13] JIANG Huiyuan, HUANG Miao, TIAN Xiaoyong. :The correlation effect between coastal port

competitiveness and hinterland economy. Water Transportation Management.pp.9-14(2022). DOI:10.13340/j.jsm.2022.10.012.
[14] Wu Zhenming.: Research on the Interactive Development of Port Economy and Hinterland Economy. Business Culture.pp.30-31(2022)
[15] Samia B, Zoubida B, Hanaa H.: Maritime Bilateral Connectivity Analysis for Sustainable Maritime Growth: Case of Morocco. Sustainability.pp.6(2023)
[16] WANG Min, WU Xiaofen, DANG Jiange.: "Measurement of trade facilitation level of the 21st Century Maritime Silk Road. Statistics and Decision Making.pp.104-108(2021). DOI:10.13546/j.cnki.tjyjc.2021.05.022.
[17] Liu Drongxuan, Xin Li.:The impact of 21st century maritime silk road trade facilitation on China's exports of electromechanical products--a dynamic analysis based on SYS-GMM. Statistics and Information Forum.pp.58-66(2019)
[18] Zhang Yuan.: The impact of trade facilitation on China's export trade. Nanjing Agricultural University (2021). DOI:10.27244/d.cnki.gnjnu.2019.001157.
[19] Jordan.: Research on Trade Liberalization and Facilitation of the 21st Century Maritime Silk Road and Its Economic Effects. Huaqiao University(2018).
[20] Li Wei.: Impact of trade facilitation on economic growth between China and countries along the "Belt and Road" - An empirical analysis based on nighttime lighting data. Journal of Lianyungang Vocational and Technical College.pp.10-19(2023). DOI:10.19858/j.cnki.1009-4318.2023.01.019.
[21] YANG Ren, MOU Naixia, PENG Peng et al.: Competitiveness evaluation of important ports along the "Maritime Silk Road". Journal of Geo-Information Science.pp.623-631(2018)
[22] MENG Feirong, GAO Xiuli.: Research on the degree of coordination of economic coupling between ports and direct hinterland and its influencing factors--Taking the port cluster around Beibu Gulf as an example. Geography and Geographic Information Science.pp.94-100(2017)
[23] LI Baomin, ZENG Chen.: The Impact of Trade Facilitation on China's Export Potential: An Empirical Analysis Based on Data from 48 Countries Along the Belt and Road. Decision and Information.pp.65-77(2023)
[24] Diao Li, Ding Yuzhu, Fan Yunru. :Research on trade facilitation between China and Central and Eastern European countries. Russian East European Central Asian Studies.pp.23-45(2023). DOI:10.20018/j.cnki.reecas.2023.04.002.
[25] LIANG Kedi, LIANG Jing, Dai Tianlun.: Study on the Economic Impact of Port Connectivity Infrastructure Construction on RCEP Member Countries. Navigation Technology.pp.68-72(2022).
[26] Gao Cong, Li Siyuan.: Research on the Evaluation of Transportation Infrastructure Connectivity Level of China-Central and Eastern European Countries Based on TOPSIS. Logistics Science and Technology.pp.81-84(2023). DOI:10.13714/j.cnki.1002-3100.2023.17.022.
[27] SUN Shuai.: Research on connectivity evaluation of major container ports along China's coast. Dalian Maritime University.(2023). DOI:10.26989/d.cnki.gdlhu.2022.000103.