Research on the connectivity of port infrastructure along the 21st Century Maritime Silk Road

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Abstract. The connectivity construction of the Maritime Silk Road in the 21st century has created more opportunities for trade and further promoted maritime trade among countries along the route. As an important hub of the maritime connectivity network, the construction of port infrastructure connectivity is of great significance. Taking the port infrastructure of 30 countries along the 21st-century Maritime Silk Road as an example, this paper analyzes the current state of port connectivity construction in China. It identifies that the port infrastructure connectivity between China and Southeast Asia is the most developed and establishes an indicator system for evaluating the potential for port infrastructure connectivity. Based on the principal component analysis (PCA), it is found that Germany, Singapore, the United Kingdom, the Netherlands, and other countries have relatively high port infrastructure connectivity potential. Finally, suggestions are put forward: China should strengthen the connectivity construction of port infrastructure with Europe and prioritize policy exchanges with Germany to align port development strategies and enhance bilateral maritime trade by establishing complementary trade chains.

1. Introduce

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*"[1]. The aim was to build a comprehensive, multi-tiered, and intricate connectivity network across Asia, Europe, and Africa, promoting trade exchanges between countries along the route to expand the complementary advantages of trade and foster common development and prosperity for all nations. In the process of promoting the construction of a connectivity network among countries, infrastructure connectivity is a top priority. Ports, as crucial nodes connecting countries' maritime transportation channels, establish a port infrastructure connectivity network. This network is essential for facilitating the flow of resources in countries along the 21st Century Maritime Silk Road and ensuring smooth maritime transportation channels among nations. Therefore, this paper analyzes the potential of port infrastructure connectivity on the 21st Century Maritime Silk Road. This analysis is of great significance for China to make informed decisions regarding port infrastructure connectivity and to further promote 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's focus 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 facilities connectivity and regional integration levels. The results indicate that, compared with other modes of transportation, port facilities' connectivity has the most significant impact on trade and regional integration levels. It is evident that enhancing port infrastructure connectivity to facilitate maritime channels is crucial for promoting the construction of the 21st Century Maritime Silk Road. However, the level of port infrastructure connectivity between China and the countries along the 21st Century Maritime Silk Road is much lower than the level of other infrastructure connectivity. Yu Junjie et al[3] measured the level of interconnection of various types of transportation infrastructure. The results show that the level of port infrastructure interconnection is lagging behind the level of aviation infrastructure interconnection. China still needs to continue increasing efforts to promote the construction of port infrastructure connectivity.

From the established literature, the current research related to port infrastructure connectivity has also included qualitative descriptions and quantitative analyses of the research results. The studies mostly focus on exploring the impact of port infrastructure connectivity on the economy and trade[4-6], port node siting issues related to port infrastructure connectivity [7, 8], and qualitative analysis of the impact factors of connectivity[9]. However, there are relatively few

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quantitative studies focusing on the impact factors of port infrastructure connectivity itself. This paper will focus on the construction of port infrastructure interconnection based on existing research results. It will narrow the scope of research to focus on port infrastructure interconnection as the main subject. The research will be designed based on hypotheses regarding the factors influencing port infrastructure interconnection. By analyzing the current situation of port connectivity network construction between China and countries along the Maritime Silk Road, this paper will concentrate on port cooperation and trade exchanges. It will construct an evaluation index system for assessing the potential of port infrastructure connectivity and study each country's potential to achieve port infrastructure connectivity. Through a comparison of the current status and potential, the paper will analyze the shortcomings in China's port infrastructure connectivity construction and provide recommendations for development. The Port Infrastructure Connectivity in China. The text also analyzes the deficiencies in the construction of port infrastructure connectivity by comparing the current situation with its potential. It then provides suggestions for the development of port infrastructure connectivity in China. The research in this paper can provide a scientific basis for the construction of China's port infrastructure interconnection.

2. Analysis of the current situation of port infrastructure connectivity between China and countries along the sea silk road

Over the years, China has actively engaged in exchanges and cooperation with countries along the Maritime Silk Road to enhance political mutual trust. In this section, we will focus on some of the major port countries and study China's port infrastructure connectivity with port countries along the Maritime Silk Road in terms of port cooperation and trade facilitation.

2.1 Analysis of port co-construction projects

As a large port country, China has an advantageous position in port construction technology, as well as port operation and management. Through its involvement in overseas port infrastructure construction and operation, China offers terminal construction technology and terminal construction financial support to ports with inadequate infrastructure in countries along the Maritime Silk Road. Additionally, China shares its successful experience in port operation and management with ports facing challenges in operation and management. This initiative aims to enhance the development of ports in countries along the Maritime Silk Road.

Table 1 presents China's involvement in overseas port construction projects and overseas port operation projects from 2002 to 2019. It can be seen that China has more port cooperation projects with the Southeast Asian region, with larger investment amounts, all based on the investment and construction cooperation mode. Among the three countries in the South Asian region, all are engaged in port cooperation construction projects, with the collaboration with Sri Lanka being the most extensive. In West Asia, our country only has port cooperation projects with Turkey. In European countries, China, Greece, Israel, and many other countries are undertaking port projects, but the scale of these projects is relatively small.

On the whole, China's cooperation with Southeast Asia and South Asia countries in port construction is relatively close. This reflects that political mutual trust between China and countries in Southeast Asia and South Asia along the HaiShi line is stronger.

Table 1. Overseas port construction and operation projects

Nation	Port	Total investment (US $ billion)	ways of cooperation
Malaysia	Port Royal Melaka	97.27	Investments
	Kuala Lumpur International Port	28.4	Investment
	Kuantan Deepwater Port Terminal	4.13	construction
Singapore	Port of Pampanga, Brazil	25.82	Investment
Sri Lanka	Colombo Port	14	Investment
	Port of Hambantota	13.16	support construction
	Port of Colombo	5	Investment
Myanmar	Kyaukphyu Special Economic Zone Deepwater Port	13	Investment
	Dilawar Port	0.14	Undertake construction
	Madhe Island Deep Water Port	-	Investment in construction
Israel	Ashdod South Port	10	Undertake construction
Turkey	Istanbul Kumport Terminal	9.4	Acquisition
Philippines	Manila Port	0.1	Acquisition
	Davao City Seaport	7.8	Investment
Indonesia	Tanjung Priok Port, Indonesia	5.9	Investment
France	Marseille Terminal Link	4.46	Acquisition
Greece	Port of Piraeus	4.11	Acquisition
Pakistan	Port Qasim	1.6	Construction
Malaysia	Gwadar Deepwater Port	2.48	aid and assistance

2.2 Analysis of the bilateral trade situation

With the advancement of the Belt and Road Initiative and the establishment of a network of sea lanes, maritime trade between China and the countries along the Maritime Silk Road has continued to flow smoothly. This development not only boosts maritime trade between China and the countries along the Maritime Silk Road but also impacts global maritime trade. From the perspective of bilateral trade volume and trade share between China and the countries along the Maritime Silk Road (as shown in Figure 1), the countries with which China has the highest bilateral trade volume are Singapore, Malaysia, Indonesia, Thailand, Vietnam, and Germany. Among them, China's bilateral trade volume with Germany is the largest. From the perspective of bilateral trade proportion between China and different countries, China only represents 6.45% of Germany's total trade volume. Overall, the Southeast Asian region and South Asia are more reliant on our import and export trade, while Europe is less dependent on our import and export trade.

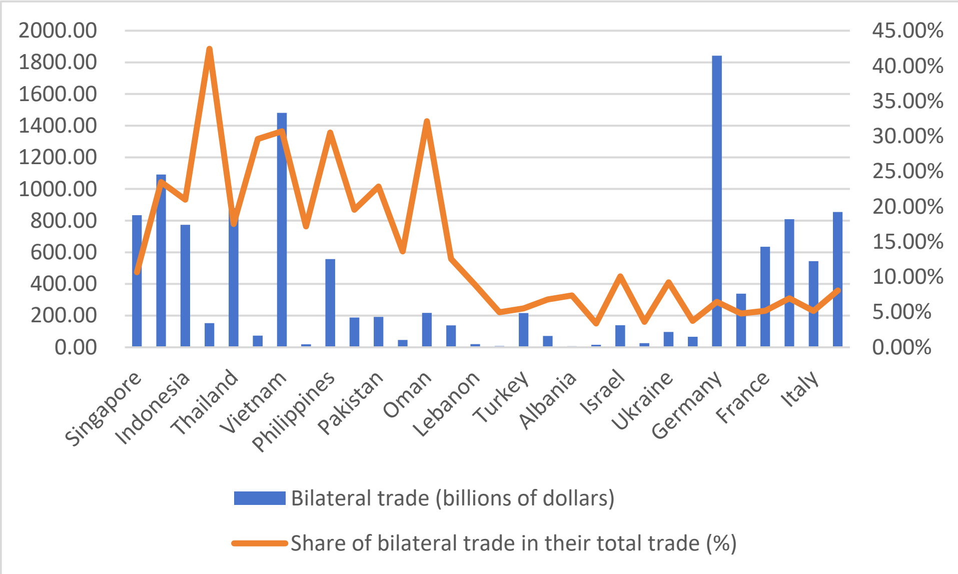

Fig. 1 China's bilateral trade volume with countries along the Maritime Silk Road and its percentage share

3. Indicator identification and methodology

3.1 Analysis of influencing factors

In the construction of "The Belt and the Road", connectivity is the key, and infrastructure is the cornerstone of connectivity. As a crucial hub of maritime trade, enhancing port infrastructure connectivity is essential for the development of the "Belt and Road" initiative. Due to the complex and dynamic nature of port infrastructure interconnection construction and the involvement of numerous stakeholders, there are many influencing factors that affect the construction of port infrastructure interconnection.

The concept of the "The Belt and Road" initiative aims to enhance the connection between China's economy and the world. It seeks to foster cooperation among countries along the route and stimulate global economic development by improving infrastructure and connectivity across various sectors. In the construction of port infrastructure connectivity, the condition of the port's own infrastructure is an important cornerstone that affects connectivity. The main purpose of port infrastructure connectivity is to promote the smooth flow of maritime trade. Therefore, the bilateral trade connectivity environment plays a crucial role in influencing the construction of port infrastructure connectivity. In addition, the level of economic development of the port hinterland, which reflects the domestic demand power of trade, is also an important factor influencing the construction of connectivity. In maritime trade, transportation time and trade costs are important factors that influence traders' decisions on whether to engage in import and export trade. Therefore, the level of trade facilitation is also a key factor that affects port infrastructure connectivity.

Therefore, this paper mainly focuses on the port's infrastructure conditions, the economic status of the port hinterland, the bilateral trade connectivity environment, and the trade facilitation level of the country where the port is situated.

3.2 Construction of the indicator system

As there are many influencing factors affecting port infrastructure connectivity, an evaluation indicator system was developed. It includes 4 secondary indicators and 20 tertiary indicators, covering aspects such as the conditions of the port itself, the connectivity in the country where the port is situated, the level of import and export trade, and the trade facilitation level. This system was constructed based on the reasonableness of the indicators and the availability of data, as illustrated in Table 2.

The data for the indicators were mainly obtained from the World Bank database, the Global Competitiveness Report, the Belt and Road official website, and the EPS database.

3.3 Methodology

By analyzing the commonly used evaluation methods, it is found that the weights in the hierarchical analysis method and fuzzy mathematics comprehensive evaluation are all determined by individuals with strong subjectivity, which can impact the objective evaluation of the object being evaluated. At the same time, port infrastructure connectivity is influenced by various factors, and there is a correlation between different indicators. The principal component analysis method reduces the redundant information between indicators by reducing dimensionality. This method is suitable for evaluating indicator systems with strong correlations. Therefore, this study prioritizes the use of the principal component analysis method to analyze and evaluate port infrastructure connectivity. The weight of the principal component analysis method is determined based on data analysis, which is more objective and avoids the hierarchical analysis method and fuzzy mathematics comprehensive evaluation. The weight determination in principal component analysis is based on data analysis, which is more objective and avoids the subjective influence introduced by hierarchical analysis and fuzzy mathematics comprehensive evaluation methods.

The indicators underwent KMO and Bartlett tests, and the results indicated that principal component analysis could be conducted if KMO > 0.6 and Bartlett < 0.1. The score of each principal component was calculated according to Eq.1 and Eq.2.

$$\theta_{ij} = \frac{b_{ij}}{\sqrt{\lambda_i}} \quad (1)$$

$$H_i = \sum \theta_{ij} ZA_j \quad (2)$$

Where, j denotes the j[th] indicator; i denotes the i[th] principal component; b_{ij} denotes the loading coefficient of the j[th] variable on the i[th] principal component; λ_i denotes the eigenvalue corresponding to the i[th] principal component; θ_{ij} denotes the eigenvectors of the standardized orthogonalization of the j[th] indicator for the i component; H_i denotes the scores of the five principal components; and ZA_j denotes the standardized data for each indicator for each country.

The corresponding contribution rate of each principal component is determined by the weight of each principal component, and normalization is conducted to obtain the weight value of each principal component. Composite scores were calculated using Eq. 3.

$$F = \sum \omega_i H_i \quad (3)$$

Where, F indicates the comprehensive score; ω_i indicates the weight of each principal component.

Table 2 Indicator system

Tier 1 Indicators	Secondary indicators	Tertiary Indicators	Indicator Description
Potential for port infrastructure connectivity in countries along the Sea Silk Route	Port's own conditions	Port Infrastructure Quality Index	Level of port hardware facilities Interconnection basis
		Annual port throughput	Throughput capacity and international status of the port (interconnection)
		Liner Shipping Connectivity Index	Integration level of liner transportation network (interconnection)
	Conditions of connectivity in the country where the port is located	GDP per capita	People's living standard
		GDP growth rate	Overall economic growth rate and growth trend of the country
		GDP of the country	Overall economic strength and market size of the country
		Global Competitiveness	Ability of sustained economic growth
		ADB Participation	Participation in the "Belt and Road" financing platform
		Foreign Investment	Ability to attract foreign business
	Level of import and export trade	Total Import and Export Trade	Demand for trade (this group is an interoperability effect)
		Import and export trade growth rate	Growth trend of import and export trade
		Foreign Trade Dependency	Dependence on foreign trade
	Trade facilitation level	Efficiency of customs clearance procedures	Speed, simplicity and predictability of procedures when clearing customs
		Quality of trade and transportation-related infrastructure	Comprehensive evaluation of infrastructure
		Logistics Performance Index	Capacity and quality of logistics services Interoperability
		Burden of customs procedures	Efficiency of customs procedures in each country
		Import turnaround time, median (days)	Supply chain management and transportation efficiency
		Export turnaround time, median (days)	ditto
		Documentary compliance import costs	Costs involved in customs document auditing
		Documentary compliance export cost	ditto

4. Port infrastructure connectivity potential measurement and empirical analysis

4.1 Data and sources

The route of the 21st Century Maritime Silk Road is mainly divided into three: one is the newest route, connecting Russia and Northern Europe through the Arctic Ocean; one through Southeast Asia, South Asia and then through the Indian Ocean branch northward into Europe and along the western edge of the Indian Ocean southward to connect with the African countries; and one extends to the South Pacific Ocean [10]. This paper selects the route from China to the south through Southeast Asia, South Asia and then through the Indian Ocean to the north into Europe.

In this paper, according to the port size, geographic location and national economic strength of each country along the route and other related conditions of consideration, selected China and the route on the 30 major port countries along the route to analyze the research, along the route of the 30 countries are Malaysia, Indonesia, Singapore, Myanmar, Thailand, Cambodia, Vietnam, Brunei, the Philippines in Southeast Asia, South Asia's Bangladesh, Pakistan, Sri Lanka, Oman, Lebanon, Cyprus, and Turkey in West Asia, Egypt in Africa, and Greece, Albania, Croatia, Israel, Bulgaria, Ukraine, Romania, Germany, Spain, France, Britain, Italy, and the Netherlands in Europe.

Thirty countries from Asia, Africa, and Europe along the 21st Century Maritime Silk Road were selected for empirical analysis, and the source of indicator data is shown in Table 3

Table 3 Main variables

Name of variable	1-7	Code name	Source of data
Port Infrastructure Quality Index	TEU	A1	World Bank database
Annual port throughput	2004 = 100	A2	World Bank Database
Liner Shipping Connectivity Index	USD	A3	World Bank Database
GDP per capita	%	A4	World Bank Database
GDP growth rate	(Billions of dollars)	A5	World Bank Database
GDP of the country	1-100	A6	World Bank Database
Global Competitiveness	1,0	A7	Global Competitiveness Report 2018
ADB Participation	USD	A8	Belt and Road Official Website
Foreign Investment	USD	A9	World Bank Database
Total Import and Export Trade	%	A10	EPS Database
Import and export trade growth rate	%	A11	EPS Database
Foreign Trade Dependency	1-5	A12	EPS Database
Efficiency of customs clearance procedures	1-5	A13	World Bank Database
Quality of trade and transportation-related infrastructure	1-7	A14	World Bank Database
Logistics Performance Index	1-5	A15	World Bank Database
Customs Procedure Burden	1-5	A16	World Bank Database
Import turnaround time	Days	A17	World Bank Database
Export turnaround time	Day	A18	World Bank Database
Decumentary compliance Import cost	Dollar	A19	World Bank Database
Decumentary compliance Export cost	US Dollar	A20	World Bank Database

4.2 Empirical analysis

This paper primarily utilizes SPSS software to analyze the indicator data. After processing the indicators, a KMO and Bartlett test were conducted on the three-level indicators. The results indicated that KMO=0.698 (>0.6) and Bartlett=0 (<0.1), suggesting a strong correlation among the variables, which can be further analyzed as principal components.

The principal component analysis was used to analyze the intrinsic correlation between the indicators. Several indicators were selected to represent their basic data structure. According to the test results, five principal components were chosen, and the eigenvalues and contribution rates of each principal component are reflected in Table 4.

Table 4 Total explained variance

subassemblies	Initial eigenvalue		
	total	Percentage of variance	Accumulation %
1	8.642	43.212	43.212
2	3.485	17.427	60.639
3	1.795	8.976	69.615
4	1.440	7.200	76.816
5	1.162	5.810	82.625

The loadings of each component are shown in Table 5, and the correlation coefficients between each indicator and each principal component can be found. The larger loadings on the first principal component are A14, A13, A15, A7, A16, A4, A1, A3, and A19. This indicates that the first principal component mainly reflects information from nine indicators such as the quality of trade- and transportation-related infrastructures, the efficiency of the customs clearance process, the logistics performance index, global competitiveness, the burden of customs procedures, per capita GDP, port infrastructure quality index, liner shipping connectivity index, and the cost of compliance documents at the time of importation. The burden, GDP per capita, port infrastructure quality index, liner shipping connectivity index, and cost of compliant documents at the time of import, etc. The second principal components with large loadings are A2, A6, A10, and A5, indicating that the second principal component mainly reflects information related to four indicators such as the annual throughput of ports, the country's GDP, the total import and export trade, and the growth rate of GDP, etc. The third principal component with large loadings are A18 and A17, indicating that the third principal component mainly reflects the comprehensive information of the two indicators of import turnaround time and export turnaround time. The fourth principal component with larger loadings are A8 and A20, indicating that the fourth principal component mainly reflects the comprehensive information of the two indicators of the participation of the ADB and the cost of compliance of the documents at. At the time of export, the fifth principal component with larger loadings includes A11 and A12. This suggests that the fifth principal component predominantly captures the comprehensive information of the four indicators related to import and export trade growth rate and foreign trade dependence.

Table 5 component matrix

	subassemblies				
	1	2	3	4	5
Zscore(A14)	0.966	-0.011	-0.010	-0.026	-0.076
Zscore(A13)	0.960	-0.108	0.001	-0.059	-0.023
Zscore(A15)	0.956	-0.050	-0.019	0.006	-0.014
Zscore(A7)	0.953	-0.118	-0.050	0.044	0.017
Zscore(A16)	0.893	-0.162	-0.091	-0.249	0.136
Zscore(A4)	0.852	-0.358	0.009	-0.101	-0.054
Zscore(A1)	0.844	-0.197	-0.121	-0.370	0.096
Zscore(A3)	0.817	0.373	0.046	-0.130	0.014
Zscore(A19)	0.594	-0.257	-0.484	0.227	0.052
Zscore(A2)	0.399	0.821	0.074	0.124	0.209
Zscore(A6)	0.501	0.818	0.043	0.183	0.014
Zscore(A10)	0.663	0.691	0.036	0.114	0.022
Zscore(A9)	0.219	0.667	0.072	0.276	0.025
Zscore(A5)	-0.456	0.497	0.156	-0.326	0.246
Zscore(A18)	0.355	-0.185	0.805	0.323	-0.107
Zscore(A17)	0.327	-0.468	0.683	0.313	-0.176
Zscore(A8)	0.289	0.222	0.319	-0.612	-0.440
Zscore(A20)	0.409	-0.200	-0.407	0.544	-0.119
Zscore(A11)	0.015	-0.208	0.316	0.079	0.747
Zscore(A12)	0.342	-0.401	0.118	-0.180	0.455

The results of the calculated port infrastructure connectivity potential are shown in Table 6. According to the evaluation results of the potential of port infrastructure connectivity among countries, it can be seen that Singapore, Germany, and the Netherlands score higher on the first principal component. This indicates that Singapore has the best port infrastructure quality and trade facilitation conditions. On the second principal component, China scores the highest, reflecting its high trade potential attributed to significant trade demand and rapid economic growth. Finally, on the third principal component, Egypt scores the highest. Egypt scores the highest. As an important node of the 21st Century Maritime Silk Road, Egypt's port turnaround efficiency is very prominent. Lebanon scores the highest on the fourth principal component, indicating that the country has better policies and lower costs in terms of clearance expenses. On the fifth principal component, Singapore still scores the highest, reflecting the strategic position of the port of Singapore as the largest transshipment port in the Asia-Pacific region.

From the comprehensive score, China has the best conditions for port infrastructure interconnection. China's large volume of foreign trade, ports, and port infrastructure are perfect, with very good conditions for interconnection. Following China is Germany, one of the more developed countries in Europe, with a high level of national economy, developed port infrastructure, and huge trade potential. Singapore is ranked third, highlighting its international status as an Asian shipping hub and international shipping transit center. Singapore ranks third, highlighting its international status as an Asian shipping hub and international shipping transit center. It is followed by the United Kingdom, the Netherlands, France, Spain, and Italy, all of which are developed European countries with more advanced facilities. These countries have excellent conditions for achieving the interconnection of port infrastructures.

Table 6 Potential for port infrastructure connectivity across countries

	H1	rank	H2	rank	H3	rank	H4	rank	H5	rank	Total H score	rank
China	4.29	4	8.47	1	0.61	10	1.27	7	0.98	7	4.27	1
Germany	5.38	2	0.90	4	0.11	16	0.30	13	-0.68	21	2.99	2
Singapore	5.78	1	-1.52	28	0.42	14	-1.75	28	1.85	1	2.72	3
Britain	4.27	5	-0.17	18	-0.49	22	-0.19	19	-1.09	25	2.05	4
Netherlands	4.96	3	-2.90	31	-0.27	20	-1.94	30	0.13	14	1.79	5
France	3.51	6	-0.01	14	-0.48	21	0.29	14	-1.07	24	1.73	6
Spain	3.08	7	-0.10	17	-0.58	25	-0.08	16	-1.20	28	1.44	7
Italy	2.32	8	-0.02	15	-0.96	27	0.45	10	-1.12	26	1.07	8
Malaysia	1.26	10	-0.57	20	-0.02	17	0.36	12	1.62	2	0.68	9
Israel	1.36	9	-1.02	24	0.86	7	-0.10	18	-0.49	19	0.55	10
Cyprus	0.39	11	-1.64	29	0.82	8	0.04	15	-0.44	17	-0.08	11
Oman	0.11	12	-0.66	21	0.50	13	-0.42	21	-1.30	29	-0.16	12
Greece	-0.16	13	-1.22	25	-0.52	23	1.34	5	1.44	5	-0.18	13
Thailand	-0.37	16	-0.05	16	-1.05	29	0.38	11	0.79	10	-0.23	14

Vietnam	-1.04	20	0.41	11	1.59	3	-0.98	25	0.99	6	-0.30	15
Turkey	-0.34	15	0.22	12	-0.58	24	-0.09	17	-1.97	31	-0.34	16
Croatia	-0.30	14	-1.38	27	-0.63	26	1.31	6	0.78	11	-0.35	17
Indonesia	-1.15	21	0.72	8	0.97	4	-0.44	22	-0.02	15	-0.38	18
Romania	-0.89	17	-1.00	23	-0.21	19	1.76	3	0.89	8	-0.48	19
Brunei	-1.03	18	-1.86	30	1.70	2	0.98	8	0.82	9	-0.60	20
Bulgaria	-1.03	19	-1.37	26	-0.05	18	1.46	4	0.73	12	-0.66	21
Egypt	-2.28	25	0.80	5	2.16	1	-2.73	31	1.46	4	-0.93	22
Philippines	-2.28	24	0.01	13	0.53	11	1.82	2	-0.11	16	-0.98	23
Lebanon	-2.09	23	-0.79	22	0.51	12	1.96	1	-1.50	30	-1.14	24
Sri Lanka	-1.94	22	0.46	9	-1.26	30	-1.32	27	-1.12	27	-1.25	25
Ukraine	-3.08	26	-0.28	19	0.93	5	0.96	9	0.60	13	-1.44	26
Cambodia	-3.54	29	0.44	10	0.32	15	-0.62	23	-0.44	18	-1.81	27
Pakistan	-3.48	28	1.23	3	-1.01	28	-1.14	26	-0.85	23	-1.83	28
Bangladesh	-4.03	30	1.39	2	0.88	6	-1.81	29	-0.50	20	-1.91	29
Albania	-3.18	27	0.74	7	-5.58	31	-0.88	24	1.52	3	-2.09	30
Burma	-4.49	31	0.79	6	0.79	9	-0.21	20	-0.70	22	-2.16	31

4.3 Discussion

According to the potential of port infrastructure connectivity of countries along the 21st Century Maritime Silk Road and the current status of port infrastructure connectivity between China and other countries, it can be found that China and Southeast Asia have stronger port infrastructure connectivity. However, in terms of the potential of each country to realize port infrastructure connectivity, Southeast Asia's Singapore and Malaysia, as well as Europe's Germany, the United Kingdom, France, Italy, the Netherlands, Spain, and other countries, have a higher capacity to achieve port infrastructure connectivity. However, in terms of the potential of each country, Singapore and Malaysia in Southeast Asia, and Germany, the United Kingdom, France, Italy, the Netherlands, Spain, and other countries in Europe have a higher capacity to achieve port infrastructure interconnection. Our country should enhance policy exchanges with major European countries to expedite the interconnection of port infrastructure between China and Europe.

5 Conclusion

This paper analyzes the port infrastructure connectivity in the context of the 21st-century Maritime Silk Road and the potential of each country to achieve port infrastructure connectivity. It also provides development suggestions for enhancing port infrastructure connectivity in China. The research conclusions of this paper are as follows:

1) China is actively involved in enhancing port infrastructure connectivity with countries along the 21st-century Maritime Silk Road. The progress in establishing port infrastructure connectivity with the Southeast Asian region is most advanced, particularly with Singapore and Malaysia. However, efforts to improve port infrastructure connectivity with South and West Asia are still in the early stages, and further development is needed. Similarly, the goal of strengthening port infrastructure connectivity with Europe has not yet been fully realized.

2) The results of measuring the potential of port infrastructure connectivity in various countries indicate that China, Germany, Singapore, Britain, the Netherlands, France, Spain, Italy, Malaysia, Israel, and other countries have a higher potential for port infrastructure connectivity.

3) China should increase the construction of port infrastructure connectivity with countries along the European route. Priority should be given to strengthening the construction of port infrastructure connectivity with European countries such as Germany, the United Kingdom, the Netherlands, France, Spain, and Italy.

The indicator data on port infrastructure connectivity in this paper mainly focuses on the data of the countries where the ports are located. The next step is to study the specific ports of the countries along the Maritime Silk Road to conduct further research on port infrastructure connectivity.

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