Research on Evaluation Index System of Shipping High-Quality Development

Xiangyu Yin[1] and Minghui Qu[2(✉)]

[1] China Waterborne Transport Research Institute, Beijing 100088, China
[2] Jiaodong Company, The Fourth Construction CO., LTD of China Construction Eighth Engineering Division, Yantai 264000, Shandong, China
1370915214@qq.com

Abstract. Since the 19th National Congress of the Communist Party of China, China's economic and social development has shifted from a stage of high-speed growth to a stage of high-quality development. The new era requires all departments of the social economy to grasp the trend of high-quality development. As a fundamental production department, the shipping industry also needs to be comprehensively deployed around "high-quality development". In this context, with shipping as the research object. Firstly, the research background and significance of evaluating the high-quality development of shipping are analyzed. Through literature review and summarization of domestic and foreign research on shipping, dimensions and indicators related to shipping are collected; Secondly, elaborate on the basic principles and application steps of the correlation analysis method, and use the correlation analysis method to screen evaluation indicators; Finally, the high-quality development of shipping is divided into five aspects: infrastructure, shipping management, green and safety, open and lead, innovative and advanced. A 39 indicator evaluation index system for high-quality development of shipping has been established, which is an evaluation standard that can measure and promote the main aspects and overall high-quality development of China's shipping industry.

Keywords: Shipping · High quality development · Evaluation index system

1 Introduction

Under the background that the country actively promotes the high quality development of the whole industry, shipping as a national strategic basic industry, it is imperative to accelerate the high quality development. However, China has not yet established a systematic and comprehensive evaluation index system for high-quality shipping, due to two reasons. On the one hand, China's industry standards are not yet sound, and some standards have a relatively long time frame for formulation, which is not suitable as a reference for the formulation of high-quality standards; On the other hand, high-quality evaluation standards have dynamic characteristics. With the development and changes of the shipping industry, the concept of high-quality development in shipping will be

S. H. B. D. M. Zailani et al. (Eds.): ICMSEM 2023, 259, pp. 1470–1482, 2024.
https://doi.org/10.2991/978-94-6463-256-9_149

further enriched, and the evaluation standards for high-quality shipping will also change accordingly. Therefore, this article uses literature research and expert consultation methods to construct an evaluation index system for the high-quality development of shipping, which has important theoretical significance and practical application value.

Wen [1] evaluated the modernization of inland port and shipping management by building an evaluation index system based on DPSIR model. Deng [2] creatively established a green shipping and economic growth indicator system, calculated the comprehensive development index of the two systems, and further studied the coupling coordination degree and relative development degree of the comprehensive system. Qi [3] established an evaluation index system that includes 28 indicators to measure the high-quality development level of cities based on the new development concept. Zhou [4] built an evaluation system for knowledge-based international shipping centers, and used the evidential reasoning method to evaluate the development level of three knowledge-based international shipping centers, Shanghai, London and Hong Kong. Yang [5] established a green shipping system based on industry standards, environmental monitoring network and scientific research, with ecological ports, channels and new ship manufacturing as the core. Wang [6] established an evaluation index system for the core competitiveness of large dry bulk shipping enterprises, and used the grey clustering method based on triangular whitening weight function to evaluate the core competitiveness of large dry bulk shipping enterprises. Liu [7] established an evaluation index system for emergency capacity of inland waterway shipping from two aspects: basic institutional construction and response capacity. In order to improve the accuracy of shipping corporate identity in identifying potential crises, Cao [8] established a shipping enterprise crisis early warning indicator system, and applied the extension matter-element comprehensive evaluation method for evaluation. Qu [9] integrated ecological factors into the study of Yangtze River shipping culture and constructed an evaluation index system for Yangtze River ecological shipping culture. Zhong [10] established an ecological evaluation index system for shipping finance to study the ecological environment of Shanghai's shipping finance.

By reviewing domestic and foreign references, it can be found that there are few evaluation studies on the high-quality development of shipping in existing literature, which cannot meet the needs of objective analysis and evaluation of the development level of shipping in China. Therefore, the proposed study on the evaluation of high-quality development in shipping has certain reference significance for improving and supplementing the research on the evaluation theory of high-quality development in shipping by constructing an evaluation index system for high-quality development in shipping.

2 Correlation Analysis Method

Correlation analysis is a statistical method to measure the degree of correlation between factors. In the process of system development, if the change trends of the two factors are relatively consistent, the correlation between them is high; On the contrary, it is lower.

When there are too many evaluation indicators in an indicator system, there are sometimes problems such as high correlation between indicators and repeated weights.

This situation reduces the persuasiveness and credibility of the evaluation system, so it is necessary to screen the evaluation indicators. With the help of correlation analysis, we can screen out the evaluation indicators of information duplication. The principle of this method is that if the correlation coefficient of two evaluation indicators is greater than 0.900, it means that the information of these two indicators is highly repetitive, and one indicator can be retained. This helps to avoid the impact of repeated information on the evaluation results and improves the scientificity and rationality of the evaluation.

By using SPSS software to conduct Pearson correlation analysis, we can get the correlation coefficient between indicators, so as to achieve correlation analysis. The calculation formula of correlation coefficient is:

$$r = \frac{N\sum x_i y_i - \sum x_i \sum y_i}{\sqrt{N\sum x_i^2 - (\sum x_i)^2}\sqrt{N\sum y_i^2 - (\sum y_i)^2}} \tag{1}$$

In the formula, r is the correlation coefficient; N is the number of samples; xi is the x value in the i-th data; yi is the y value in the i-th data.

3 Construction of Evaluation Index System

3.1 Construction Principles of Indicator System

Whether the construction of the indicator system is reasonable or not will directly affect the scientificity and accuracy of the evaluation results. Therefore, in order to make the established evaluation index system of high-quality shipping development scientific and reasonable, the selection of indicators should follow the principles of systematicness, scientificity, representativeness, operability and data availability.

3.2 Preliminary Selection of Evaluation Indicators

According to the construction principle of the indicator system and fully considering the characteristics of high-quality development of shipping, five first level indicators, 15s level indicators and 44 third level indicators are preliminarily determined to form the preliminary indicator system for evaluation of high-quality development of shipping, as shown in Table 1.

3.3 Selection of Evaluation Indicators Based on Correlation Analysis

Collect the evaluation index data from 2015 to 2020, and use SPSS software to conduct Pearson correlation analysis on the evaluation index data. The given critical value is 0.900. The experimental results show that the correlation coefficients of 18 pairs of evaluation indexes are greater than the given critical value, as shown in Table 2.

Through correlation analysis, it is found that the correlation coefficients of the four indicators, namely “the number of berths for production in national ports” and “the length of ports above coastal scale”, “the number of berths in national ports of ten thousand tons and above”, “the volume of freight transport by water”, and “the connection of water transport with railways and highways”, are 0.953, 0.965, 0.978, and 0.994 respectively.

The correlation coefficient is greater than the critical value of 0.900, indicating that the information between the two evaluation indicators is highly similar, and only one evaluation indicator can be retained. Therefore, the evaluation index of "the number of berths for production in national ports" is deleted. Similarly, the evaluation indicators

Table 1. Preliminary evaluation index system of shipping high quality development

Target layer	One level indicators	Second level indicators	Third level indicators
Preliminary index system for evaluation of high-quality shipping development	Infrastructure	Channel	Navigation mileage of inland waterway
			Mileage proportion of grade channel
		Port	Length of ports above coastal scale
			Number of berths of 10000 tons and above in national ports
			The ports nationwide have berths for production
		Vessel	Number of water transport vessels
			Average ship age
	Shipping management	Transportation services	Passenger traffic volume of waterway transportation
			Freight volume of waterway transportation
			Connection between water transport and railway and highway
			Development level of shipping service industry
		Operation management	Container throughput of national ports
			Customs clearance efficiency
			International routes
			Coordination of route development

(*continued*)

Table 1. (*continued*)

Target layer	One level indicators	Second level indicators	Third level indicators
		Policies and regulations	Perfection of shipping policy
			Construction level of water transport standard system
	Green and safety	Energy consumption level	Fuel consumption for waterway transportation
			CO_2 emissions from waterway transport
		Energy saving and emission reduction	Emission level of air pollutants from ships
			Application degree of energy-saving and environmental protection equipment in ports
		Environmental protection investment	Proportion of ecological protection facilities in waterway environmental protection investment
			Proportion of pollution prevention facilities in waterway environmental protection investment
			Investment in waterway environmental protection
		Safety level	Maritime traffic accidents of transport vessels
			Production safety accidents in the field of water transport construction
			Direct property loss
		Emergency support capability	Maritime search and rescue operations

(*continued*)

Table 1. (*continued*)

Target layer	One level indicators	Second level indicators	Third level indicators
			Emergency response capability
	Open and lead	Shipping economic environment	Total import and export of goods
			Water transport construction investment
			Investment in inland river construction
			Investment in coastal construction
		International competitiveness	Profitability of shipping enterprises
			Anti risk ability of shipping enterprises
			Business environment construction level
			International shipping influence
	Innovative and advanced	Science and technology	Scientific research investment
			Number of scientific research institutions
			Number of key laboratories
			Application degree of digital, intelligent and other emerging technologies
		Talent team	Number of personnel engaged in scientific and technological activities
			Number of crew members registered
			Enrollment number of navigation majors

of "investment in waterway environmental protection", "investment in inland river construction", "investment in coastal construction" and "number of key laboratories" are deleted.

Table 2. Evaluation index with correlation coefficient greater than the critical value

Evaluating indicators	Evaluating indicators	Correlation coefficient	Significant level
*The ports nationwide have berths for production	Length of ports above coastal scale	0.953	0.003
	Number of berths of 10000 tons and above in national ports	0.965	0.002
	Freight volume of waterway transportation	0.978	0.001
	Connection between water transport and railway and highway	0.994	0.000
*Investment in waterway environmental protection	Emission level of air pollutants from ships	0.902	0.014
	Application degree of energy-saving and environmental protection equipment in ports	0.950	0.004
	Proportion of ecological protection facilities in waterway environmental protection investment	0.940	0.005
*Investment in inland river construction	Navigation mileage of inland waterway	0.901	0.014
	Connection between water transport and railway and highway	0.919	0.010
	Perfection of shipping policy	0.923	0.009
*Investment in coastal construction	The ports nationwide have berths for production	0.928	0.008
	Number of water transport vessels	0.929	0.007
	Coordination of route development	0.912	0.011

(*continued*)

Table 2. (*continued*)

Evaluating indicators	Evaluating indicators	Correlation coefficient	Significant level
	Water transport construction investment	0.938	0.006
*Number of key laboratories	Emission level of air pollutants from ships	0.982	0.000
	Application degree of energy-saving and environmental protection equipment in ports	0.916	0.010
	Anti risk ability of shipping enterprises	0.952	0.003
	Application degree of digital, intelligent and other emerging technologies	0.926	0.008

Note: * indicates the evaluation indicators to be deleted

After preliminary screening by the correlation analysis method, an evaluation index system of high-quality shipping development covering 5 first level indicators, 15s level indicators and 39 third level indicators is finally constructed, as shown in Table 3. Among them, the first level indicators are Ag, g = 1,2,…5; the second level indicators are Bh, h = 1,2,…15; and the third level indicators are Ci, i = 1,2,…39.

4 Conclusion

The evaluation index system of high-quality shipping development that this paper tries to build includes five first level indicators, 15s level indicators and 39 third level indicators, including infrastructure, shipping management, green and safety, open and lead, innovative and advanced. With reference to the new development concept proposed by the CPC Central Committee, the high quality evaluation of shipping is based on and measured by the concepts of shipping science and technology innovation, internal and external coordination of the shipping industry, green energy saving and low-carbon shipping, opening and integration of the shipping market, and extensive sharing of shipping achievements. It is an evaluation index system that can measure and promote the high quality development of China's shipping industry in main aspects and as a whole.

Table 3. Evaluation index system of shipping high quality development

Target layer	One level indicators	Second level indicators	Third level indicators
Preliminary index system for evaluation of high-quality shipping development	Infrastructure A_1	Channel B_1	Navigation mileage of inland waterway C_1
			Mileage proportion of grade channel C_2
		Port B_2	Length of ports above coastal scale C_3
			Number of berths of 10000 tons and above in national ports C_4
		Vessel B_3	Number of water transport vessels C_5
			Average ship age C_6
	Shipping management A_2	Transportation services B_4	Passenger traffic volume of waterway transportation C_7
			Freight volume of waterway transportation C_8
			Connection between water transport and railway and highway C_9
			Development level of shipping service industry C_{10}
		Operation management B_5	Container throughput of national ports C_{11}
			Customs clearance efficiency C_{12}
			International routes C_{13}
			Coordination of route development C_{14}
		Policies and regulations B_6	Perfection of shipping policy C_{15}

(*continued*)

Table 3. (*continued*)

Target layer	One level indicators	Second level indicators	Third level indicators
			Construction level of water transport standard system C_{16}
	Green and safety A_3	Energy consumption level B_7	Fuel consumption for waterway transportation C_{17}
			CO_2 emissions from waterway transport C_{18}
		Energy saving and emission reduction B_8	Emission level of air pollutants from ships C_{19}
			Application degree of energy-saving and environmental protection equipment in ports C_{20}
		Environmental protection investment B_9	Proportion of ecological protection facilities in waterway environmental protection investment C_{21}
			Proportion of pollution prevention facilities in waterway environmental protection investment C_{22}
		Safety level B_{10}	Maritime traffic accidents of transport vessels C_{23}
			Production safety accidents in the field of water transport construction C_{24}
			Direct property loss C_{25}

(*continued*)

Table 3. (*continued*)

Target layer	One level indicators	Second level indicators	Third level indicators
		Emergency support capability B_{11}	Maritime search and rescue operations C_{26}
			Emergency response capability C_{27}
	Open and lead A_4	Shipping economic environment B_{12}	Total import and export of goods C_{28}
			Water transport construction investment C_{29}
		International competitiveness B_{13}	Profitability of shipping enterprises C_{30}
			Anti risk ability of shipping enterprises C_{31}
			Business environment construction level C_{32}
			International shipping influence C_{33}
	Innovative and advanced A_5	Science and technology B_{14}	Scientific research investment C_{34}
			Number of scientific research institutions C_{35}
			Application degree of digital, intelligent and other emerging technologies C_{36}
		Talent team B_{15}	Number of personnel engaged in scientific and technological activities C_{37}
			Number of crew members registered C_{38}
			Enrollment number of navigation majors C_{39}

Acknowledgments. This paper is a phased achievement of the National Social Science Foundation Youth Program (22CJY066) and the Ministry of Transport Research Fund Program (2018-6-5).

References

1. Xiaofeng Wen, Ning Chen. Studies on Evaluation of Modernization of the Inland Port and Shipping Management based on DPSIR Model and Gray Correlation Evaluation Model[J]. Procedia - Social and Behavioral Sciences, 2013, 96: 1792-1800. https://doi.org/10.1016/j.sbspro.2013.08.204
2. Deng Gaodan, Li Xinchun, Chen Jingxiao. Research on Coupling Coordination and the Development of Green Shipping and Economic Growth in China[J]. Sustainability, 2021, 13(24), 13901. https://doi.org/10.3390/su132413901
3. Qi Lin. Measurement and Efficiency Decomposition of High Quality Urban Development Level in the New Era: Taking 34 prefecture level and above cities in three northeastern provinces as examples[J]. Journal of Dongbei University of Finance and Economics, 2020 (01): 89-97. https://doi.org/10.19653/j.cnki.dbcjdxxb.2020.01.010
4. Zhou Dequan, Le Meilong, Li Gang. Evaluation of Shanghai Knowledge based International Shipping Center[J]. Navigation of China, 2014, 37 (04): 110–114+119. https://doi.org/10.3969/j.issn.1000-4653.2014.04.024
5. Yang Shunyi, Luo Hongwei, Liu Yanjie, et al. Study on the Impact of Shipping on the Ecological Environment of the Yangtze River and the Green Shipping System[J]. Port & Waterway Engineering, 2017 (02): 33–38+66. https://doi.org/10.16233/j.cnki.issn1002-4972.2017.02.006
6. Wang Hongzhi, Zhao Yali, Wen Ruijun. Research on core competitiveness evaluation of large dry bulk shipping enterprises-bases on grey clustering method of triangular whitening weight function[J]. Journal of Dalian Maritime University (Social Science Edition), 2021, 20 (05): 69-74. https://doi.org/10.3969/j.issn.1671-7031.2021.05.008
7. Liu Li, Ji Yingye, Fan Chuirong. Research on the evaluation index system of emergency capacity for inland waterway shipping[J]. China Water Transport, 2010 (11): 20-21. https://doi.org/10.13646/j.cnki.42-1395/u.2010.11.002
8. Cao Jing, Yang Jiayin, Liu Jiaguo. Multi-index extension comprehensive evaluation method of the shipping enterprise crisis early warning[J]. Journal of Dalian Maritime University, 2016, 42 (03): 70-76. https://doi.org/10.16411/j.cnki.issn1006-7736.2016.03.012
9. Qu Qunzhen, Li Lixin. Construction of an evaluation index system for ecological shipping culture in the Yangtze River[J]. Logistics Engineering and Management, 2013, 35 (09): 147–150+173. CNKI:SUN:SPCY.0.2013–09–054
10. Zhong Hansheng. Ecological evaluation of shipping finance in Shanghai[J]. Guangxi Quality Supervision Guide, 2019 (03): 118-119. DOI: CNKI:SUN:GXZL.0.2019-03-086