

Quantitative Evaluation on High-quality Development of Inland Waterway Transport Policies in Yangtze River Delta Area

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Abstract

As a green, low-carbon, intensive and efficient transport mode, inland waterway transportation plays an increasingly vital role in regional integrated transportation systems and coordinated economic development. As a pilot zone for high-quality development of inland waterway transportation, the Yangtze River Delta has witnessed intensive issuance of relevant policies by local governments to advance the construction of a modern inland waterway transportation system. Based on content analysis and the PMC index model, this paper constructs an evaluation system comprising 9 primary indicators (including policy nature, effectiveness and functions) and 36 secondary indicators, and quantitatively assesses 32 inland waterway transportation policy texts released by the three provinces and one municipality in the Yangtze River Delta over the past five years. The results indicate that the inland waterway transportation policies in the Yangtze River Delta are generally sound, with positive progress made in green transformation,

infrastructure upgrading and transport structure optimization. However, there remain deficiencies in the alignment of short-, medium- and long-term plans, cross-regional coordination, improvement of guarantee mechanisms and innovation incentives. Obvious regional differences exist in policy focus: Shanghai excels in financial and technical support; Jiangsu boasts superior policy coverage and completeness; Zhejiang's policies are highly directional; and Anhui has achieved notable results in guiding functions and green transformation. This study can provide quantitative support and practical reference for optimizing inland waterway transportation policies and enhancing regional collaborative governance in the Yangtze River Delta.

Keywords: Inland Waterway Transport, Policy Evaluation, PMC, Yangtze River Delta

1. Introduction

Inland waterway transport (IWT), with its unique advantages of being green, low-carbon, intensive, and efficient, plays an increasingly important role in global and regional integrated transport systems. Particularly in China's Yangtze River Delta (YRD) region, with rapid economic development and the deepening of regional integration strategies, the importance of IWT in reducing social logistics costs and promoting coordinated regional economic development has become more prominent. As one of the most dynamic, open, and innovative regions in China, the YRD possesses a uniquely endowed inland waterway network, with its inland waterway mileage exceeding 40,000 kilometers and its port cargo throughput surpassing 7 billion tons in 2024, both ranking among the top in the country, serving as a vital artery connecting the hinterland with the coast and supporting regional economic development. In June 2025, the "Opinions on Promoting the High-Quality Development of Inland Waterway Transport" issued by the Ministry of Transport of China elevated IWT development to a national strategic level, explicitly proposing to basically build a pilot zone for high-quality IWT development in the YRD by 2030, and setting higher requirements for waterway network upgrading, transport structure optimization, service level enhancement, and green and smart transformation. In addition to the central government, local governments in Anhui, Jiangsu, Shanghai, and Zhejiang have also successively issued a series of policies aimed at promoting inland waterway regulation, port infrastructure construction, ship type standardization, and green and intelligent transformation to achieve high-quality development of inland waterway shipping.

Despite the intensive issuance of IWT policies in the YRD region, systematic and quantitative evaluations of these policies, especially in-depth analyses of their structure and content, remain relatively scarce (Dai et al., 2021; Li et al., 2021; Liu & Zhao, 2022). Existing studies mostly focus on macro-strategies or the interpretation of single policies, failing to fully reveal the overall effectiveness of the regional policy system, regional differences, and structural shortcomings in areas such as the alignment of short-, medium-, and long-term planning, cross-regional coordination, improvement of guarantee mechanisms, and innovation incentives. The lack of unified quantitative evaluation standards and methods makes it difficult for policymakers to accurately grasp the effects of policy implementation and also restricts the

efficiency of regional collaborative governance.

This paper aims to use the PMC (Policy Modeling Consistency) index model to conduct a systematic and quantitative evaluation of 32 IWT policy texts issued by the three provinces and one municipality (Anhui, Jiangsu, Shanghai, and Zhejiang) in the YRD over the past five years (2020 to 2025). By constructing an evaluation system covering multiple dimensions such as policy nature, effectiveness, function, and field, this study deeply analyzes the overall performance, scores in various dimensions, and regional differences of IWT policies in the YRD region, identifies the strengths and weaknesses of the policy system, and proposes targeted optimization suggestions to provide a scientific basis for policy optimization and regional collaborative governance. This not only helps promote the high-quality development of IWT in the YRD but also provides reference experience for transport policy evaluation in other regions.

The structure of this paper is as follows: Section 2 will review relevant literature on high-quality IWT development and policy evaluation at home and abroad, summarizing the current research status and theoretical foundations. Section 3 will detail the construction process of the PMC index model, including model definition, sample processing, keyword analysis, and the determination of the evaluation index system. Section 4 will present the empirical analysis results of high-quality IWT development policies in the YRD region and provide an in-depth interpretation of policies in each area. Finally, Section 5 will summarize the research conclusions and propose policy recommendations and future outlooks.

2. Literature Review

As an environmentally friendly and cost-effective transport mode, the high-quality development of IWT has become a focus of attention in the global transport field. This concept not only covers the improvement of transport efficiency and economic benefits but also emphasizes the coordinated development of multiple dimensions such as environmental sustainability, social equity, and technological innovation (De Barros et al., 2022; Calderón et al., 2024). Calderón-Rivera et al. conducted a comprehensive review of the sustainable development of IWT, pointing out its huge potential in reducing carbon emissions and alleviating road congestion, and emphasizing the key role of technological innovation in enhancing its environmental performance. Barros et al. explored the link between IWT and the United Nations 2030 Agenda for Sustainable Development in depth, proposing a comprehensive conceptual framework for sustainable IWT and highlighting its key role in achieving global sustainable development goals, particularly its contribution to promoting economic growth, providing employment opportunities, and improving regional connectivity. Pratas et al. (2023) further proposed framework recommendations for sustainable IWT systems, providing guidance for practice covering infrastructure modernization, fleet greening, and operational intelligence. Lu et al. (2023) performed a decomposition analysis of the driving factors of IWT growth in China, finding that institutional reform, infrastructure construction, fleet standardization, and financing diversification are core elements driving its development, indicating that policy and institutional

environments play a crucial role in IWT development. Furthermore, Wang et al. (2022) explored the complex relationship between transport infrastructure, high-quality development, and industrial pollution emissions from a macro level, revealing that transport development may bring environmental pressure while promoting economic growth, which provides an important policy orientation for the green transformation of IWT.

Studies by Zhang et al. (2025) and Gbako et al. (2025) evaluated the comprehensive benefits of IWT from the perspectives of environmental sustainability and socio-economic performance, respectively, providing empirical support for understanding its multiple values. Yin & Qu (2023) focused on constructing an evaluation index system for high-quality shipping development, providing a theoretical tool for quantitatively measuring and evaluating the comprehensive development level of the shipping industry, which serves as an important reference for the construction of the policy evaluation index system in this study. These studies collectively outline a multi-dimensional picture of high-quality IWT development, emphasizing its comprehensive value at the economic, social, and environmental levels, and providing important theoretical basis and practical directions for policymakers.

In the context of regional development, transport integration is regarded as a key driver for promoting high-quality regional development. As one of the most dynamic economic regions in China, the coupling and coordination relationship between transport integration and high-quality development in the Yangtze River Delta (YRD) has received widespread attention (Li et al., 2023; Qu et al., 2024). Research by Li et al. shows that regional transport integration in the YRD significantly promotes high-quality economic development, and as an important component of the regional integrated transport system, the scientificity and coordination of IWT policies directly affect the process and efficiency of regional integration. Qu et al. further analyzed the socio-economic impact of transport network changes in the YRD, emphasizing the strategic position of transport policy in regional development. These studies collectively reveal the core position of IWT in regional economic development, environmental governance, and sustainable development, and emphasize the key role of policy in guiding its high-quality development.

Given the importance of policy in promoting high-quality IWT development, a systematic and quantitative evaluation of policies is particularly necessary. Traditional policy evaluation methods mostly rely on qualitative analysis, but with the advancement of data science and quantitative tools, quantitative evaluation models have gradually become mainstream. The PMC (Policy Modeling Consistency) index model has been widely used in the field of policy evaluation due to its rigorous structure and comprehensive variable analysis framework (Estrada, 2011). The theoretical basis of the model is the “*Omnia Mobilis*” hypothesis, which emphasizes the dynamic correlation between variables and can overcome the limitations of the traditional “*ceteris paribus*” assumption. It visually presents the strengths and weaknesses of policies through multi-input-output tables and 3D surface plots. In recent years, the PMC model has shown strong applicability in transport policy evaluation. For example, Dai et al. (2021) used this model to evaluate green development policies in China’s Yangtze River Economic Belt, finding

that the policies performed well in terms of completeness and scientificity, but there was still room for improvement in incentive and constraint mechanisms. In addition, Rao et al. (2024) applied the PMC model to the evaluation of green and low-carbon development policies in the express logistics field, further expanding its application scope and fully proving its effectiveness and universality in handling complex transport policy systems. Although existing literature has achieved fruitful results in defining the connotation of high-quality IWT development, analyzing driving factors, and quantitative policy evaluation methods, systematic quantitative evaluations specifically targeting high-quality IWT development policies in the YRD region are still relatively few.

3. Results

3.1 PMC index model

The PMC (Policy Modeling Consistency) index model is based on the “Omnia Mobilis” hypothesis, which emphasizes the dynamic correlation between variables, standing in methodological opposition to the traditional “Ceteris Paribus” (all other things being equal) assumption. The characteristics of the model include: 1) adopting a full-variable analysis framework to ensure the completeness of parameter selection; 2) visualizing policy evaluation through the PMC index and 3D surfaces; 3) possessing the dual functions of policy consistency testing and strength-weakness analysis. The implementation of the model involves four standardized steps: 1) variable classification and parameter identification; 2) construction of multi-input-output tables; 3) calculation of the PMC index; 4) generation of PMC surfaces. Among them, the PMC surface visually presents the evaluation results of various policy dimensions through 3D projection.

3.2 Sample Processing

The policy texts selected for this paper were published between January 2020 and June 2025, covering the main cycle of intensive issuance and continuous implementation of China’s inland waterway transport policies. 2020 served as the policy inheritance and preparation stage before the start of the “14th Five-Year Plan,” during which the Ministry of Transport issued several national strategic documents such as the “Outline for the Development of Inland Waterway Shipping,” marking the systematic advancement of a new round of high-quality IWT development and laying the foundation for the intensive issuance of policies at the local level. Combined with the conclusion of the “14th Five-Year Plan” in 2025, this provides a chronologically complete research perspective for a comprehensive analysis of the regional IWT policy system. Through preliminary screening, documents with duplicate content or low relevance were excluded and organized by region. Ultimately, 32 valid policy texts were identified, including 6 from Anhui Province, 12 from Jiangsu Province, 7 from Shanghai Municipality, and 7 from Zhejiang Province, as shown in Figure 1. All policies were assigned numbers, where P1-P6 belong to the Anhui group, P7-P18 to the Jiangsu group, P19-P25 to the Shanghai group, and P26-P32 to the Zhejiang group.

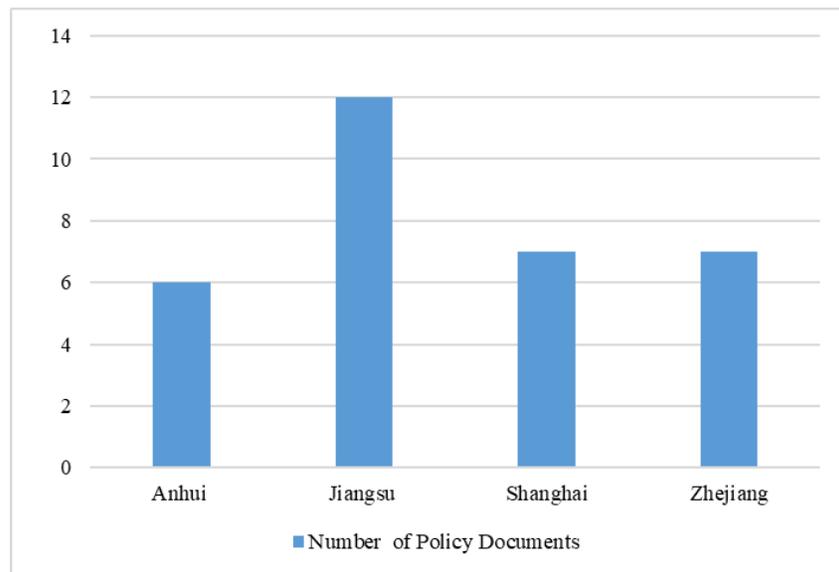


Figure 1. Number of policy documents on high-quality development of inland waterway transport in the Yangtze River Delta Area (2020–2025)

3.3 Keyword Analysis

Based on the aforementioned policy texts, ROSTCM6 software was used to extract and statistically analyze word frequencies. Based on the preliminary statistical results, general policy subject terms such as “transportation,” “country,” and “enterprise,” as well as high-frequency verbs with vague directions such as “carry out,” “promote,” “implement,” and “enhance,” were excluded. Terms that accurately reflect policy connotations were retained and further embedded into the original collection of 32 policy texts for pairwise high-frequency word co-occurrence frequency statistics. Through multiple rounds of term filtering and comparison, 40 core words with high policy relevance were finally selected.

To reveal the semantic associations and co-occurrence structures between high-frequency words, a visualization analysis was conducted based on the co-occurrence matrix, generating a heatmap to intuitively show their association strength (see Figure 2). The depth of color in the figure represents the frequency of co-occurrence between words. Based on the simplified heatmap of 40 high-frequency words, potential semantic links between some core terms can be observed, providing a preliminary basis for subsequent keyword construction and the policy evaluation index system.

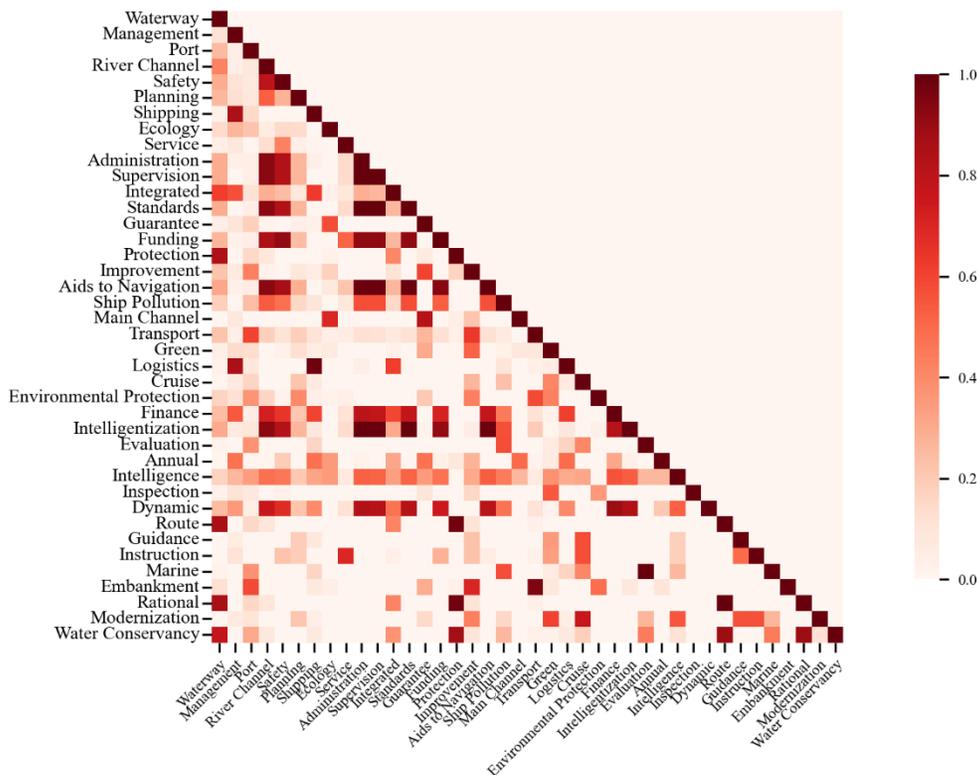


Figure 2. Heatmap of the similarity matrix for 40 high-frequency words

Based on the previous text mining and word frequency statistics, the keyword system for high-quality IWT development policies in the YRD region was finally determined as follows:

Table.1 High-frequency words of policies for high-quality development of inland waterway transport in the Yangtze River Delta

No.	Keyword	No.	Keyword	No.	Keyword
1	Waterway	12	Comprehensive	23	Environmental Protection
2	Management	13	Standard	24	Finance
3	Port	14	Guarantee	25	Intelligentization
4	River Channel	15	Funds	26	Evaluation
5	Safety	16	Protection	27	Smart
6	Planning	17	Improvement	28	Route

No.	Keyword	No.	Keyword	No.	Keyword
7	Shipping	18	Navigation Mark	29	Guidance
8	Ecology	19	Ship Pollution	30	Embankment
9	Service	20	Transportation	31	Water Conservancy
10	Administration	21	Green	32	Modernization
11	Supervision	22	Logistics		

Based on the above keyword system, the 32 policy texts for high-quality IWT development in the YRD region were compared and classified, and the matching of high-frequency words in each policy text was counted as the sample basis for subsequent policy evaluation and PMC model analysis.

3.4 Variables and Parameters

Referring to the index system research of Estrada (2011) and Zhang et al. (2025), this paper establishes 9 primary evaluation dimensions. As shown in Table 2, the selection of these 36 secondary indicators is based on the multi-input-output framework of the standard PMC model, integrated with 40 core high-frequency keywords extracted from the policy samples. These indicators were further validated through expert consultations to ensure they reflect the specific requirements of high-quality IWT development, such as green transformation and smart shipping.

Table 2. Evaluation index system for high-quality development policies of inland waterway transport in the Yangtze River Delta Area

Symbol	Primary Evaluation Variable	Symbol	Secondary Evaluation Variable	Symbol	Primary Evaluation Variable	Symbol	Secondary Evaluation Variable
X1	Policy Nature	X11	Guidance	X7	Policy Area	X71	Economic Development
		X12	Supervision			X72	Social Service
		X13	Planning			X73	Technological Innovation
		X14	Standard			X74	Environmental Protection
X2	Policy Effectiveness	X21	Short-term (≤ 3 years)	X8	Policy Focus	X81	Waterway Construction
		X22	Medium-term (4-5 years)			X82	Port Upgrading
		X23	Long-term (> 5 years)			X83	Pollution Prevention
X3	Design Features	X31	Implementability			X84	Safety Management
		X32	Innovation Breakthrough			X85	Smart Shipping
		X33	System Coordination			X86	Multimodal Transport

X4	Policy Scope	X41	Regional Coordination			X87	Green Development
		X42	Local Implementation			X88	Water Conservancy Guarantee
X5	Policy Function	X51	Normative Guidance			X89	Talent Cultivation
		X52	Openness Promotion	X9	Policy Object	X91	Government Departments
		X53	Innovation Incentive			X92	Enterprises/Institutions
		X54	Synergy Strengthening			X93	Social Organizations
X6	Guarantee Measures	X61	Financial Support				
		X62	Legal Guarantee				
		X63	Talent Guarantee				
		X64	Technical Guarantee				

3.5 Results and Analysis

The calculation method of the PMC-Index involves four key steps: 1) constructing a multi-input-output table, incorporating 9 primary variables and 36 secondary variables; 2) assigning binary values to secondary variables based on evaluation criteria. Specifically, a score

of 1 is assigned if the policy text explicitly mentions or embodies the indicator's attribute (e.g., X11 'Guidance' is scored 1 if the policy contains directional terms like 'guide' or 'encourage' and establishes strategic visions); otherwise, a score of 0 is assigned; 3) calculating the score of primary variables, which is the sum of the scores of the subordinate secondary variables divided by the number of secondary variables in that dimension; 4) calculating the total PMC-Index value, which is the sum of all primary variable scores. This calculation method ensures the objectivity and systematicity of policy evaluation through quantitative assessment.

$$X_i = \sum_j^n \frac{X_{ij}}{n} \quad (1)$$

$$I_{PMC} = \sum_{i=1}^9 X_i \quad (2)$$

Where, i is the index of the primary variable, $i \in [1,9]$; j is the index of the secondary variable, $j \in [1,9]$; n is the total number of secondary variables corresponding to each primary variable; X_{ij} represents the score of the j^{th} secondary variable under the i^{th} primary variable; X_i represents the standardized score of the i^{th} primary variable; I_{PMC} represents the total PMC index score. The model ensures the calculability of the evaluation process and the comparability of results through strict mathematical definitions.

Based on Estrada's (2011) policy evaluation standards and the setting of 9 primary variables, this paper sets the PMC index range to [0] [9] and establishes the following evaluation criteria: 1) Perfect: [8] [9]; 2) Excellent: [6,7.99]; 3) Good: [4,5.99]; 4) Poor: [0,3.99]. This evaluation system achieves a graded assessment of policy effects through interval division, where a score above 8 represents perfect policy design, 6-7.99 indicates good implementation effects, 4-5.99 reflects the need for local optimization, and below 3.99 suggests the need for systematic improvement.

4. Empirical Analysis

4.1 Keyword Analysis

Drawing on existing policy research and to systematically evaluate regional development differences, the evaluation objects are divided into the following four groups: Anhui group, Jiangsu group, Shanghai group, and Zhejiang group.

Based on the set variables and parameters, a multi-input-output table for 32 policies was constructed. Due to space limitations, the multi-input-output table for the policy nature of the Anhui group is shown as an example in Table 3. Subsequently, the PMC index was calculated by group, and the PMC index and evaluation for each policy group are shown in Table 4.

Table 3. Multi-input-output table (part)

Policy No.	X11	X12	X13	X14
P1	1	0	1	0
P2	1	1	1	0
P3	1	1	1	1
P4	1	1	0	1
P5	1	1	1	1
P6	1	0	1	0

Table 4. PMC index and rating of policies in the Yangtze River Delta Area

Variable	Anhui	Jiangsu	Shanghai	Zhejiang	Mean
X1 Policy Nature	0.75	0.854	0.857	0.929	0.847
X2 Policy Effectiveness	0.278	0.361	0.333	0.333	0.326
X3 Design Features	0.722	0.722	0.524	0.619	0.647
X4 Policy Scope	0.583	0.583	0.786	0.571	0.631
X5 Policy Function	0.833	0.646	0.821	0.679	0.745
X6 Guarantee Measures	0.667	0.708	0.857	0.679	0.728
X7 Policy Area	0.75	0.875	0.893	0.857	0.844
X8 Policy Focus	0.63	0.648	0.571	0.698	0.637
X9 Policy Object	1	1	0.905	1	0.976
I_PMC	6.213	6.398	6.548	6.365	6.381
Rating	Excellent	Excellent	Excellent	Excellent	Excellent

4.2 Result Analysis

To intuitively display the structural characteristics and differences of high-quality IWT development policies in the three provinces and one municipality of the YRD across nine primary indicators, and to facilitate the comparison of indicator scores with regional means and their distribution characteristics, this paper presents a radar chart (Fig. 3) and PMC surface plots (Fig. 4). The radar chart is used to clearly compare the relative positions and strengths of each region in various dimensions against the regional mean, while the PMC surface plots visualize the high and low fluctuations and distribution structures of scores for each policy across the nine dimensions, further revealing policy design focuses, structural integrity, and potential shortcomings.

The PMC index measurement results show that the overall scores of policies in the YRD’s three provinces and one municipality are all at the “Excellent” level (6.21–6.55), indicating that the regional policy system has good institutional design and content coverage in promoting high-quality IWT development, but structural differences and deficiencies remain.

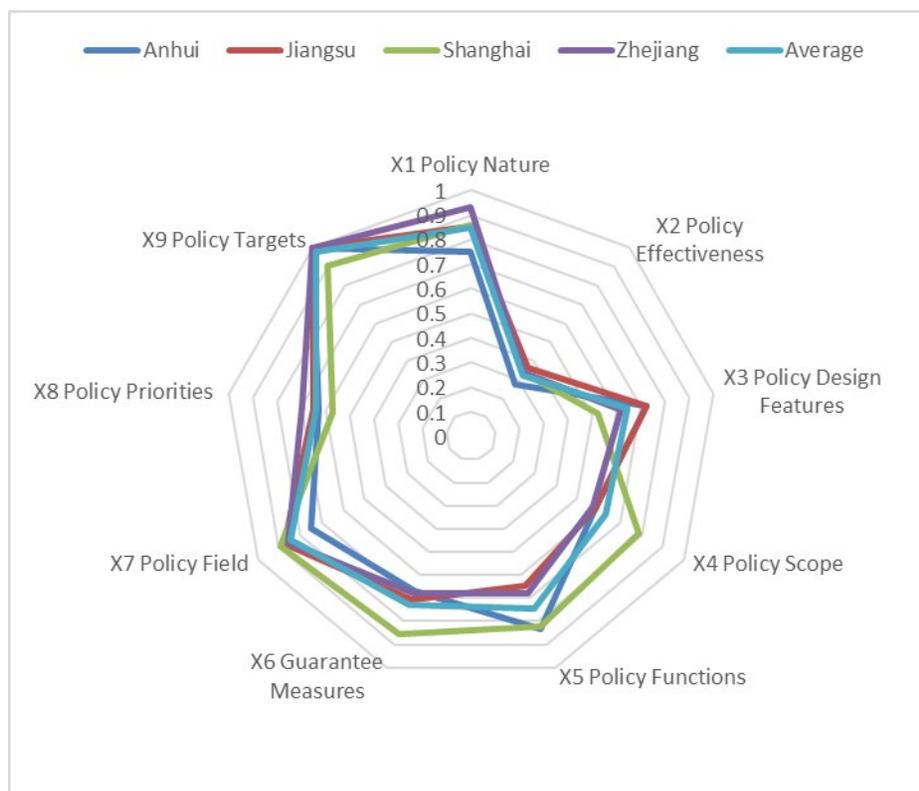


Figure 3. Comparison between the indicator scores of policy groups and the indicator mean values

From the radar chart, Shanghai's score in X6 (Guarantee Measures, 0.857) is significantly higher than the regional mean (0.728), showing advantages in financial, technical, institutional, and talent support, which is consistent with its sound port and shipping service guarantee system, sufficient project support funds, and refined talent introduction mechanisms. However, Shanghai's score in X2 (Policy Effectiveness, 0.333) is only on par with the regional mean (0.326). It is worth noting that the policy effectiveness dimension mainly measures the coverage of policies in the short, medium, and long term. Currently, most regional policies only focus on short-term or medium-term goals, lacking a complete institutional design for the coordination of short-, medium-, and long-term plans, reflecting insufficient policy planning continuity and strategy, making it difficult to meet the systemic needs of long-term regional integrated development. Jiangsu's score in X7 (Policy Field, 0.875) is close to full marks, indicating that its policies cover a comprehensive range of areas such as waterway dredging and upgrading, multimodal transport system construction, and shipping service optimization, consistent with Jiangsu's dense inland waterway network and continuously optimized transport structure. However, X5 (Policy Function, 0.646) is lower than the regional mean (0.745), suggesting that the upgrading of the shipping service system, incentive mechanisms, and model innovation still need to be strengthened, which restricts its transformation from scale to high-quality and high-efficiency transport. Zhejiang performs outstandingly in X1 (Policy Nature, 0.929), reflecting clear policy orientation and standardized content, corresponding to specific measures such as "Shipping Zhejiang" promoting inland shipping network construction and multimodal transport corridor layout. However, its score in X4 (Policy Scope, 0.571) is significantly lower than the regional mean (0.631), indicating that some policies have limited coverage, with insufficient cross-provincial connection and regional coordination, echoing the cross-regional coordination problems encountered in projects like the Zhejiang-Jiangxi Canal. Anhui has the highest score in X5 (Policy Function, 0.833), indicating that its policies have strong guidance in areas such as inland waterway improvement, ship type standardization, and service function refinement, consistent with the direction of key projects like the "Jianghuai Main Line Water Transport Corridor" and "Jianghuai Main Line Waterway Upgrading." However, its scores in X2 (Policy Effectiveness, 0.278) and X6 (Guarantee Measures, 0.667) are lower than the regional mean, reflecting Anhui's shortcomings in cross-cycle institutional planning and the improvement of guarantee measures, corresponding to problems such as aging waterways, inconsistent bridge clearance standards, and insufficient project funding support.

The PMC surface plots further reveal the structural characteristics and shortcoming distributions of the policies in the four regions across the nine primary indicators. Shanghai's (C1) surface shows a significant bulge in the X6 dimension, indicating perfect guarantee measures, but scores lower in the X2 and X3 (Policy Design Features) dimensions, suggesting that policy long-term continuity is insufficient and innovation and integrated design still need improvement, consistent with the actual situation of insufficient sustained momentum in some smart shipping and shore power promotion projects. Jiangsu's (C2) surface is generally smooth but shows a low depression in the X5 dimension, indicating that functional orientation and incentive measures are

insufficient, matching the slower progress in promoting smart shipping and transport organization optimization in the region. Zhejiang’s surface is significantly high in the X1 dimension but shows a deep depression in the X4 dimension, reflecting insufficient cross-regional coverage, corresponding to the inconsistent progress of cross-provincial water transport corridor projects. Anhui’s surface bulges significantly in the X5 dimension but forms deep depressions in the X2 and X6 dimensions, reflecting insufficient guarantee systems and policy effectiveness, consistent with problems such as insufficient funds, technology, and cross-cycle planning during waterway upgrading and project advancement. Overall, the PMC surface plots show a universal depression in the X2 dimension, revealing a general lack of systematic connection and strategic continuity between short-, medium-, and long-term regional policies, which is an important direction for future regional policy optimization.

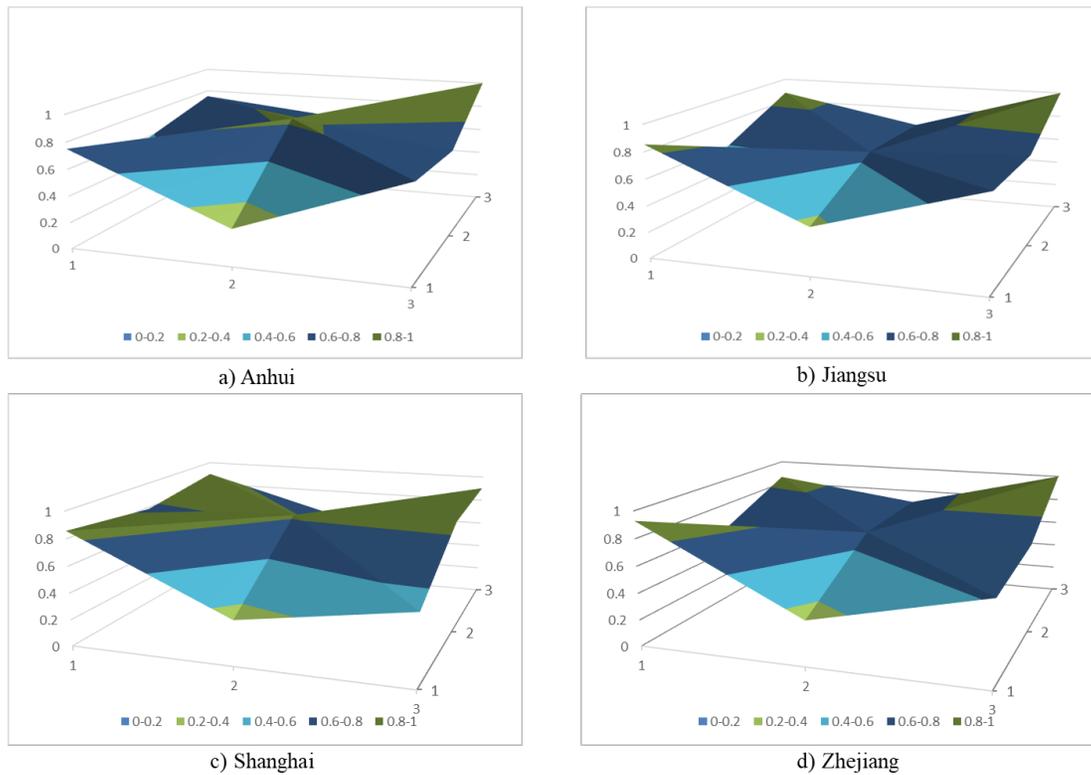


Figure.4 PMC surfaces of four policy groups

Combined with the analysis of the current status of inland shipping development in the YRD, Shanghai, relying on its ports and intelligent level, performs outstandingly in guarantee measures, but insufficient policy continuity limits the long-term promotion efficiency of some smart port and shipping projects; Jiangsu, relying on its perfect waterway network, has advantages in policy area coverage, but the lack of innovation incentives and service function optimization limits the

transformation to high-quality development; Zhejiang has a clear policy orientation, with significant results in promoting green and smart shipping and network construction, but insufficient cross-provincial project connection limits the extension of policy coverage; Anhui has achieved notable results in waterway construction and service function improvement, but insufficient financial and technical guarantees and cross-cycle planning affect policy implementation efficiency.

So far, the high-quality IWT development policies in the YRD have already established a good foundation in terms of overall institutional construction and content completeness, but continuous optimization is still needed in areas such as the systematic connection of short-, medium-, and long-term plans, cross-regional coordination, the improvement of guarantee systems, and the refinement of service functions to promote efficient regional synergy and sustained high-quality development.

5. Conclusion

This paper focuses on the high-quality development policies of inland waterway transport (IWT) in the three provinces and one municipality of the Yangtze River Delta (YRD). By constructing a PMC evaluation system comprising 9 primary indicators and 36 secondary indicators, 32 representative policy texts were subjected to in-depth quantitative mining. Empirical analysis results show that the regional policy system in the YRD is generally well-constructed, with the average PMC scores of the policies in the four regions all crossing the “Excellent” threshold, demonstrating a high degree of policy awareness and consistency among local governments in implementing national strategies, improving infrastructure, and promoting green transformation. Specifically, Shanghai plays a significant leading role in guarantee mechanisms and financial and technical support; Jiangsu achieves extremely high policy area coverage by virtue of its dense waterway network; Zhejiang’s policy orientation is precise, effectively driving the construction of multimodal transport corridors; and Anhui has made breakthrough progress in guiding functions and the upgrading of the Jianghuai Main Line. This differentiated policy landscape not only reflects the path choices made by each region based on its resource endowments but also lays an institutional foundation for complementary regional collaboration.

Despite the good overall performance, the study also reveals universal structural imbalances in the YRD policy system. First, the general depression in the policy effectiveness (X2) dimension reflects that current planning mostly focuses on short-term goals of 3-5 years, lacking cross-cycle strategic continuity and long-term connection, leading to a dilemma of insufficient sustained momentum for some long-cycle, high-investment smart shipping projects. Second, the relatively low score for cross-regional coordination (X4) indicates that administrative boundaries still constrain policy effectiveness, especially in the processes of cross-provincial waterway grade alignment, water conservancy guarantee, and standard unification, where the institutionalization level of collaborative governance urgently needs to be enhanced. Based on this, future policy optimization should focus on a dual-wheel drive model of “cross-cycle connection” and “regional linkage and synergy”: on the one hand, it is necessary to strengthen long-term

guarantee mechanisms and innovation incentives to establish long-term policy expectations for technological R&D and green transformation; on the other hand, exploring the establishment of a YRD IWT integration management committee or a permanent coordination body, and breaking the fragmented governance pattern through the formulation of unified regional technical standards and fund pool mechanisms, will drive the overall functional leap and high-quality transformation of the regional water transport system at a deeper level.

Overall, this study has certain limitations. First, the evaluation relies on the content of policy texts, which may not fully reflect the actual implementation effects and local enforcement nuances. Second, while the PMC model provides a robust quantitative framework, the binary scoring system (0/1) may oversimplify the intensity of certain policy measures. Future research could integrate multi-source data, such as field surveys and implementation performance metrics, to provide a more comprehensive assessment of policy effectiveness.

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References

- Calderón-Rivera, N., Bartusevičienė, I., & Ballini, F. (2024). Sustainable development of inland waterways transport: a review. *Journal of Shipping and Trade*, 9(1), 3. <https://doi.org/10.1186/s41072-023-00162-9>.
- Dai, S., Zhang, W., Zong, J., et al. (2021). How effective is the green development policy of China's Yangtze River Economic Belt? A quantitative evaluation based on the PMC-index model. *International Journal of Environmental Research and Public Health*, 8(14), 7676. <https://doi.org/10.3390/ijerph18147676>
- De Barros, B. R. C., de Carvalho, E. B., & Junior, A. C. P. B. (2022). Inland waterway transport and the 2030 agenda: Taxonomy of sustainability issues. *Cleaner Engineering and Technology*, 8, 100462. <https://doi.org/10.1016/j.clet.2022.100462>.
- Estrada, M. A. R. (2011). Policy modeling: Definition, classification and evaluation. *Journal of Policy Modeling*, 33(4), 523-536. <https://doi.org/10.1016/j.jpolmod.2011.02.003>.
- Gbako, S., Paraskevadakis, D., Ren, J., & Wang, J. (2025). Sustainable river-sea freight transport in major logistic gateways: a socio-economic and environmental performance evaluation of the United Kingdom's and Continental Europe's inland waterway transport. *Management of Environmental Quality: An International Journal*. <https://doi.org/10.1108/MEQ-09-2024-0382>.
- Li, N., Song, Y., Xia, W., & Fu, S. N. (2023). Regional transportation integration and

high-quality economic development, coupling coordination analysis, in the Yangtze River Delta, China. *Systems*, 11(6), 279. <https://doi.org/10.3390/systems11060279>.

Li, Y., He, R., Liu, J., Li, C., & Xiong, J. (2021). Quantitative evaluation of China's pork industry policy: A PMC index model approach. *Agriculture*, 11(2), 86. <https://doi.org/10.3390/agriculture11020086>.

Liu, Y., & Zhao, H. (2022). Quantitative evaluation of policy based on PMC index model: a case study of China's textile industry policy. *Mathematical Problems in Engineering*, 2022(1), 1870185. <https://doi.org/10.1155/2022/1870185>

Lu, C., Aritua, B., de Leijer, H., van Liere, R., & Lee, P. T. W. (2023). Exploring causes of growth in China's inland waterway transport, 1978-2018: Documentary analysis approach. *Transport Policy*, 136, 47-58. <https://doi.org/10.1016/j.tranpol.2023.02.011>.

Pratas, J., Garrido, S., & Pimentel, C. (2023). Sustainable Inland Waterway Transportation Systems: Framework Proposal. *European Journal of Sustainable Development*, 12(4), 40-40. <https://doi.org/10.14207/ejsd.2023.v12n4p40>.

Qu, J., Yang, T., Nam, K. M., Kim, E., Chen, Y., & Liu, X. (2024). Transport network changes and varying socioeconomic effects across China's Yangtze River Delta. *Journal of Transport Geography*, 121, 104051. <https://doi.org/10.1016/j.jtrangeo.2024.104051>.

Rao, Y., Xi, F., Yan, G., & Guan, Y. (2024, May). Research on the quantitative evaluation of the characteristics of China's express logistics green and low-carbon development policies based on the PMC index model. In *Proceedings of the 2024 International Conference on Digital Society and Artificial Intelligence* (pp. 271-284). <https://doi.org/10.1145/3677892.3677937>.

Wang, X., Dong, F., Pan, Y., & Liu, Y. (2022). Transport infrastructure, high-quality development and industrial pollution: fresh evidence from China. *International Journal of Environmental Research and Public Health*, 19(15), 9494. <https://doi.org/10.3390/ijerph19159494>.

Yin, X., & Qu, M. (2023, October). Research on Evaluation Index System of Shipping High-Quality Development. In *2023 4th International Conference on Management Science and Engineering Management (ICMSEM 2023)* (pp. 1470-1482). Atlantis Press. https://doi.org/10.2991/978-94-6463-256-9_149.

Zhang, L., Liu, Q., Mathisen, T. A., & Ge, Y. E. (2025). Navigating environmental sustainability in inland waterway transport: emission challenges and solutions. *Maritime Policy & Management*, 1-25. <https://doi.org/10.1080/03088839.2025.2523589>.

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