

Huang, Chong; Zhang, Shilong; Zhang, Hongshuo

Article

Analysis of the competitiveness development of China's marine industry clusters

Marine Economics and Management (MAEM)

Provided in Cooperation with:

Ocean University of China, Qingdao

Suggested Citation: Huang, Chong; Zhang, Shilong; Zhang, Hongshuo (2024) : Analysis of the competitiveness development of China's marine industry clusters, Marine Economics and Management (MAEM), ISSN 2516-158X, Emerald, Leeds, Vol. 7, Iss. 2, pp. 120-138, <https://doi.org/10.1108/MAEM-10-2024-0018>

This Version is available at:

<https://hdl.handle.net/10419/320080>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.



<https://creativecommons.org/licenses/by/4.0/legalcode>

Analysis of the competitiveness development of China's marine industry clusters

Chong Huang, Shilong Zhang and Hongshuo Zhang
*School of Management Science and Engineering,
Shandong University of Finance and Economics, Jinan, China and
Institute of Marine Economics and Management,
Shandong University of Finance and Economics, Jinan, China*

Abstract

Purpose – The purpose of this study is to analyze the current situation of the competitiveness development of China's marine industrial clusters, reveal the existing problems and challenges, provide theoretical support and practical guidance for improving the competitiveness of China's marine industrial clusters so as to promote industrial upgrading and high-quality development and help China realize the strategic transformation from a marine power to a marine power.

Design/methodology/approach – This report first provides a detailed review of the current development status and existing issues of marine industry clusters in China. Second, it constructs an evaluation index system for the competitiveness development of China's marine industry clusters and conducts competitiveness analysis and evaluation of typical marine industry clusters in China. Third, it explores the development trends and prospects of typical marine industry clusters in China. Finally, the report proposes countermeasures and suggestions for enhancing the competitiveness of marine industry clusters in China, focusing on resource optimization, cluster structure and cluster efficiency.

Findings – (1) Significant competitiveness of marine shipbuilding and ocean engineering equipment clusters: Through technological innovation and policy support, the marine shipbuilding and ocean engineering equipment clusters have shown a marked improvement in competitiveness, advancing toward high-quality development despite facing macroeconomic fluctuations. (2) Continuous improvement in marine energy and offshore wind power clusters: The competitiveness of marine energy and offshore wind power clusters has been continuously enhanced under supportive policies. However, there is still a need to optimize resource allocation and strengthen innovation stability to meet market challenges. (3) Strong growth potential of desalination and comprehensive utilization clusters: The desalination and comprehensive utilization clusters demonstrate robust growth potential in technological innovation and regional collaborative development. Future efforts should focus on the application of environmentally friendly and energy-saving technologies to ensure a balance between economic and ecological benefits.

Originality/value – By strengthening the competitiveness of industrial clusters, China can effectively respond to international competition, accelerate the transformation and upgrading of the marine industry and support its transition from a maritime power to a strong maritime nation. Hence, this study will focus on analyzing the competitiveness development of China's marine industry clusters, identifying existing problems

© Chong Huang, Shilong Zhang and Hongshuo Zhang. Published in *Marine Economics and Management*. Published by Emerald Publishing Limited. This article is published under the Creative Commons Attribution (CC BY 4.0) licence. Anyone may reproduce, distribute, translate and create derivative works of this article (for both commercial and non-commercial purposes), subject to full attribution to the original publication and authors. The full terms of this licence may be seen at <http://creativecommons.org/licences/by/4.0/legalcode>

We thank all referees for their constructive advice which helped to improve the completeness and clarity of this paper.

Funding: This work was supported by the National Social Science Found Major Projects of China (grant no. 22&ZD126), National Social Science Found General Projects of China (grant no. 23BGL031), Natural Science Foundation Youth Program of Shandong, China (grant no. ZR2023QG040) and China Postdoctoral Science Foundation General project (grant no. 2023M742051).



and challenges and providing theoretical support and practical guidance for enhancing the competitiveness of China's marine industry clusters.

Keywords Competitiveness, Marine economy, Index system, Marine industry clusters

Paper type Research paper

1. Introduction

The marine economy is an indispensable component of the global economic system. According to the International Marine Research Association, approximately 40% of global economic activities are directly or indirectly related to marine resources, encompassing various sectors such as shipping, fisheries, marine energy, and tourism. The ocean not only provides abundant biological, mineral, and energy resources but also serves as a vital transportation channel for the global economy (Kildow and McIlgorm, 2009). Maritime trade accounts for over 90% of the total volume of global goods trade, highlighting the ocean's increasingly strategic position in global economic activities. From a national development perspective, the marine economy significantly impacts a country's long-term sustainable growth. For a maritime nation like China, the ocean is not only a new engine for economic growth but also a crucial area for ensuring national economic security and territorial integrity (Yan *et al.*, 2015). In 2023, China's marine gross production value reached 99,097 billion yuan, representing a 6.0% increase compared to 2022. As the global economy shifts toward greener, low-carbon, and intelligent development, the marine economy will play an even more significant role in energy transition, industrial upgrading, and technological innovation (Ding *et al.*, 2014). In recent years, China's marine industry has rapidly emerged as a vital force driving economic growth (Xiong *et al.*, 2020). China's marine economy comprises multiple industries, including marine fisheries, marine oil and gas, shipbuilding, marine tourism, and marine biomedicine. From 2001 to 2023, China's marine industry has experienced rapid development in dominant industries, pillar industries, and high-growth industries. The dominant marine industries (marine tourism, marine transportation, and marine fisheries) grew from 335.44 billion yuan to 2,697.6 billion yuan, accounting for 27.22% of the national marine production value in 2023. The pillar industries (marine tourism, marine transportation, and marine chemical industries) increased from 245.31 billion yuan to 2,670.1 billion yuan, with an annual growth rate of 11.46%, contributing 26.94% to the national marine production value in 2023. High-growth industries (marine power, marine pharmaceuticals and biological products, seawater desalination and comprehensive utilization, marine engineering equipment manufacturing, and marine engineering construction) rose from 11.78 billion yuan to 448.2 billion yuan, with an average annual growth rate of 17.99%. However, the development of China's marine industry still faces numerous challenges. In particular, there is a significant gap in key marine technologies and high-end equipment manufacturing compared to developed countries. The issue of low industrial added value remains prominent, with many industries still at the initial processing and low-end manufacturing stages, making it difficult to promote high-quality growth (Fan *et al.*, 2023). Traditional marine industries, such as marine fisheries and oil and gas extraction, are highly resource-dependent, resulting in significant environmental pressures. In high-end marine equipment and deep-sea resource development, the innovation capacity of the marine industry is insufficient, and there is still a gap in technology levels compared to developed countries.

Against this backdrop, the formation of marine industry clusters has become an inevitable choice for enhancing industrial competitiveness and achieving sustainable development. Marine industry clusters promote collaboration and technological innovation among enterprises by concentrating related industries in specific regions, optimizing resource allocation, and improving overall efficiency and competitiveness. This cluster

development model not only strengthens the tight connections along the industrial chain but also facilitates industrial upgrading, while enhancing regional economic resilience and innovation capabilities (Zhang *et al.*, 2024). Marine industry clusters are gradually emerging as a new type of industrial organization and are becoming an important pathway for driving high-quality development of the marine economy (Zhang *et al.*, 2024). Several influential marine industry clusters have formed in China's coastal regions, such as the Shandong Peninsula Blue Economic Zone and the Zhoushan Archipelago New Area, playing a positive role in promoting regional economic development and industrial transformation and upgrading. Despite the rapid rise of marine industry clusters in China and their significant development potential, there are still a series of issues that need to be addressed, including insufficient innovation capability, weak independent research and development ability, lack of independent innovation, and inadequate integration of the industrial chain. Additionally, as the scale of clusters expands, resource consumption and environmental pressures are also increasing (Yang and Zhao, 2024). How enterprises within these clusters achieve a balance between economic benefits and environmental protection has become a critical issue for future development. Moreover, the issue of sustainable utilization of marine resources is becoming increasingly severe, necessitating institutional innovation and management measures to achieve sustainable development goals (Mo *et al.*, 2020).

In an era of globalization and rapid technological advancement, the marine industry has become a strategic area for development among nations. High-competitiveness marine industry clusters can effectively integrate resources, promote the collaborative development of upstream and downstream sectors, enhance overall industrial efficiency and innovation capabilities, and possess stronger competitive advantages in international markets, thereby generating greater economic benefits and strategic leverage for the country (Li *et al.*, 2020). With the profound transformation of the global economic landscape and the urgent demand for industrial upgrading, marine industry clusters have become a vital manifestation of national competitiveness. Enhancing the competitiveness of marine industry clusters is crucial for improving China's economic development and international standing (Xiao *et al.*, 2016). However, China's marine industry clusters still face shortcomings in technological innovation, resource integration, and international market expansion, with significant gaps compared to developed countries. Therefore, in-depth exploration of the current situation and pathways for enhancing the competitiveness of marine industry clusters has become key to promoting high-quality development of the marine economy. By strengthening the competitiveness of industrial clusters, China can effectively respond to international competition, accelerate the transformation and upgrading of the marine industry, and support its transition from a maritime power to a strong maritime nation. Therefore, the purpose of this study is to analyze the current situation of the competitiveness development of China's Marine industrial clusters, reveal the existing problems and challenges, provide theoretical support and practical guidance for improving the competitiveness of China's Marine industrial clusters, so as to promote industrial upgrading and high-quality development, and help China realize the strategic transformation from a Marine power to a Marine power.

2. Literature review

2.1 Current status of domestic research on marine industry clusters

In recent years, domestic scholars have conducted increasingly in-depth research on marine industry clusters, primarily focusing on regional agglomeration characteristics, government policy promotion, technological innovation, marine energy development, regional disparities, and sustainable development. First, the spatial distribution of marine industry clusters in China exhibits significant regional agglomeration characteristics. Coastal

provinces such as Shandong, Zhejiang, and Guangdong have formed relatively complete industrial chains encompassing marine fisheries, shipbuilding, marine engineering equipment, desalination, and marine biomedicine. The marine fishery cluster in the Shandong Peninsula boasts a strong industrial chain encompassing fishing, aquaculture, processing, and logistics, making it a vital component of the national marine economy (Li and Cui, 2024). Leveraging its advantageous port conditions, Zhejiang has developed high-end shipbuilding and marine engineering equipment industries, forming a robust industrial agglomeration effect supported by government assistance (Huang *et al.*, 2024). Guangdong has established a comprehensive industrial chain, particularly in the shipbuilding and marine engineering equipment sectors, relying on the industrial foundation of the Pearl River Delta, while marine energy development is also on the rise (Du *et al.*, 2022). Overall, the formation and development of these regional marine industry clusters provide essential support for the rapid growth of China's marine economy.

Government policy support has emerged as a significant driving force behind the development of domestic marine industry clusters. In recent years, the Chinese government has introduced a series of policies and plans aimed at encouraging and promoting marine economic development, such as the "14th Five-Year Plan for Shipbuilding and Marine Engineering Equipment Industry" and the "13th Five-Year Plan for Marine Economic Development." These policies not only provide local governments with clear development goals and directions but also promote the formation and expansion of marine industry clusters through fiscal subsidies, tax incentives, technological investment, and infrastructure development. For example, with national policy support, Jiangsu Province has rapidly developed into a core region for China's marine shipbuilding and offshore equipment industry, creating agglomeration effects in areas such as Taizhou, Yangzhou, and Nantong, where renowned enterprises like Yaxing Anchor Chain and Runbang Co. have concentrated, establishing the Nantong Marine Engineering Equipment Manufacturing Base (Shen and Zhao, 2024). The development of these clusters driven by policy has gradually improved the domestic marine industry chain and enhanced industrial competitiveness.

Technological innovation is also a critical factor in the development of domestic marine industry clusters. In recent years, China's investment in marine technology has significantly increased, leading to breakthroughs in marine equipment manufacturing, desalination, and deep-sea development technologies. For instance, the seawater desalination industry clusters in Shanghai and Tianjin (Wang and Zhang, 2014) have become leading domestic bases for comprehensive water resource utilization, relying on reverse osmosis and multi-effect distillation technologies. Additionally, advancements in marine renewable energy technology, particularly in the offshore wind power sector (Gu *et al.*, 2023), have made significant progress in provinces like Jiangsu and Zhejiang. As wind power equipment manufacturing technology continues to improve, China's offshore wind power industry cluster has begun to take shape, providing robust momentum for economic growth and green energy development in coastal regions.

However, the development of domestic marine industry clusters is not balanced, with significant disparities among regions. Coastal provinces such as Jiangsu, Shandong, and Zhejiang, due to their advantageous geographical locations and strong industrial foundations, have mature marine industry clusters that are gradually achieving scale effects (Wenwen *et al.*, 2016). In contrast, underdeveloped areas in the central and western regions, as well as some coastal regions, lag in the development of marine industry clusters, lacking complete industrial chains and high value-added industries. For example, certain northern coastal regions have long relied on traditional heavy industries and manufacturing, resulting in a relatively simple industrial structure and facing environmental pollution issues, which restrict sustainable development in their marine industry clusters. Additionally, some domestic marine industry clusters still have shortcomings in

technological innovation, particularly in high-end technologies and equipment, which remain heavily reliant on imports, necessitating improvements in innovation capabilities.

In summary, the current research status on domestic marine industry clusters showcases three main characteristics: regional agglomeration, policy promotion, and technological innovation. Despite significant development potential, issues such as unbalanced cluster development across regions and insufficient technological innovation persist (Yang and Hou, 2019). Future research should focus on enhancing the overall innovation capability of industrial clusters, promoting coordinated development across regions, and achieving sustainable development of clusters amid global climate change and resource pressures.

2.2 Current status of foreign research on marine industry clusters

International scholars have concentrated their research on marine industry clusters primarily in areas such as regional development, international cooperation, specialized division of labor, government support, and sustainable development, revealing a high degree of diversification and specialization. The United Kingdom, as a global leader in marine technology innovation, exhibits strong competitiveness in its marine industry clusters in offshore wind power, deep-sea oil and gas extraction, and marine biotechnology. The development of the UK's marine industry clusters benefits from the combination of government policy support and technological innovation, particularly the robust support provided by higher education and research institutions for technological advancements (Gerke *et al.*, 2015). The UK government has propelled research and commercialization of relevant technologies through various policies and funding initiatives. For example, the offshore wind power industry cluster in the UK has rapidly developed into a world-leading offshore wind power center, leveraging favorable natural conditions and policy incentives along its East Coast. In the fields of deep-sea oil and gas extraction and marine biotechnology, UK enterprises and research institutions also hold significant positions in the global market, demonstrating strong innovation capabilities and technological advantages.

In the United States, marine industry clusters are characterized by a high degree of specialization, forming refined division of labor and collaborative models. U.S. enterprises have established complete industrial chains in various fields, including marine fisheries, offshore oil and gas, marine engineering equipment, and marine transportation (Riddle *et al.*, 2013). Companies focus on their core businesses, enhancing the production efficiency and technological innovation capacity of the entire industrial chain through the division of labor and collaboration across upstream and downstream products. U.S. marine fishing and oil and gas extraction technologies are leading globally, particularly in deep-sea sectors where advanced exploration and development capabilities are present. Moreover, U.S. marine industry clusters emphasize integration with international markets, continuously expanding market channels and enhancing competitive advantages through international trade and technological collaboration. The government provides substantial support through funding, favorable policies, and promoting multinational cooperation, ensuring the sustainable development of marine industry clusters.

The European Union's marine industry clusters are characterized by diversified development, with a strong emphasis on sustainable development and international cooperation (Maskell and Malmberg, 1999). Countries along the North Sea coastline, including the Netherlands, Belgium, Germany, and Denmark, have formed relatively mature industrial clusters centered on offshore wind energy and marine engineering (Monteiro *et al.*, 2013). Denmark has witnessed rapid development in its offshore wind power industry, thanks to government policy support and corporate technological innovation. The country has advanced wind energy technology development and application through a comprehensive policy framework and funding support, establishing a world-leading offshore wind energy

industrial cluster (Sornn-Friese and Iversen, 2014). The Netherlands and Germany have demonstrated excellence in the marine engineering equipment manufacturing sector, particularly in shipbuilding, port infrastructure construction, and offshore wind power equipment manufacturing, showcasing strong technological capabilities (Salvador *et al.*, 2015).

Countries along the Mediterranean coast, such as Spain, Italy, and France, have developed high-value-added industrial clusters in marine tourism and marine food processing, leveraging their rich natural resources and cultural heritage. Spain and Italy have adopted an economic model centered on marine tourism, attracting numerous international visitors due to their unique natural landscapes and historical cultural resources (Boschma and Iammarino, 2009). These countries have actively promoted the development of marine food processing industries, utilizing abundant marine resources to create specialized marine products and high-end food processing industrial clusters, thereby enhancing their international competitiveness.

Canada has leveraged its abundant marine resources, particularly in the fields of marine fisheries and oil and gas, to establish robust industrial clusters. Canada possesses advanced marine fishing technologies and rich fishery resources, with its seafood exports holding significant positions in the global market (Doloreux and Shearmur, 2009). The government has ensured the long-term development of marine industry clusters through policy support, driving technological innovation and sustainable development.

In summary, marine clusters in the United Kingdom, the United States and the European Union have maintained their technological leadership in offshore wind power, deep-sea oil and gas, and marine biotechnology through a highly specialized division of labor, strong government support, and international cooperation. Nevertheless, China's marine clusters have demonstrated increasing influence globally, particularly in marine transportation, fisheries and some high-growth industries, and have gained significant scale advantages. China's marine industry clusters have gradually realized the expansion of industry chain and the improvement of competitiveness by relying on national policy support and huge market demand while developing rapidly (Holte and Moen, 2020). In the future, China is expected to play a more strategic and important role in the global marine economy by learning from successful experiences abroad and further improving its independent innovation capability and international cooperation, thus promoting the sustainable development of the global marine industry.

2.3 Analysis of issues in marine industry cluster development

Despite significant progress in research on marine industry clusters, several apparent issues remain. First, there is a notable imbalance in research focus, as most studies, both domestic and international, tend to concentrate on specific economically developed coastal regions such as the Yangtze River Delta, Pearl River Delta, and Bohai Rim, while the marine industry clusters in the central and western coastal regions and economically underdeveloped areas have received insufficient attention. This leads to a skewed understanding of the overall development of marine industry clusters across the country and hinders in-depth analysis of regional disparities. Second, the content of research is relatively singular; although there is a wealth of literature addressing traditional fields such as marine fisheries, shipbuilding, and marine engineering equipment, there is comparatively less focus on emerging high-tech industries like marine biomedicine, marine energy, and desalination and comprehensive utilization, particularly regarding the pathways for enhancing the global competitiveness of these new industries. Additionally, existing studies often emphasize the roles of technological innovation and policy promotion, yet lack in-depth analysis of industrial chain synergies, inter-enterprise technology transfer, and international cooperation, failing

to comprehensively reveal how industrial clusters can enhance competitiveness through international collaboration in the context of globalization. In summary, the current research on marine industry clusters still faces certain limitations in aspects such as regional focus, industrial dynamics, technological collaboration, and sustainable development. Future research should strengthen investigations in these areas to promote further integration of theory and practice.

3. Construction of indicator system and data sources

3.1 Design of the competitiveness evaluation indicators for China's marine industry clusters

The design of the competitiveness evaluation indicator system for China's marine industry clusters follows the framework of "relevant factor analysis—comprehensive identification of indicators—classification and stratification of indicators—indicator system paradigm." By synthesizing the relevant literature on industrial cluster competitiveness, the study clarifies the connotations, extensions, and influencing factors of three main aspects: the development capacity of industrial clusters, the innovation capacity of industrial clusters, and the macroeconomic support capacity. Following the principle of selecting evaluation indexes and on the basis of considering data availability, this study categorizes the influencing factors and then selects the indexes to construct an evaluation index system for the development of competitiveness of China's marine industry clusters. This system consists of three secondary indicators: development capacity of industrial clusters, innovation capacity of industrial clusters, and macroeconomic support capacity. Additionally, it includes six tertiary indicators: cluster scale level, cluster growth capacity, innovation environment level, innovation development capacity, macroeconomic environment level, and macroeconomic development capacity, as well as 50 quaternary indicators, as detailed in [Table 1](#).

3.2 Data processing for the competitiveness evaluation indicators of China's marine industry clusters

To ensure the comparability of indicator data, it is necessary to eliminate dimensional discrepancies between different indicators. This study primarily employs the Min-Max normalization method to remove dimensional differences.

For positive indicators, the formula is as follows:

$$\bar{y}_i = \frac{y_i - y_{\min}}{y_{\max} - y_{\min}} (i = 1, 2, \dots, n) \quad (1)$$

For negative indicators, the formula is as follows:

$$\bar{y}_i = \frac{y_{\max} - y_i}{y_{\max} - y_{\min}} (i = 1, 2, \dots, n) \quad (2)$$

In these equations, y_i represents the original data, while $\bar{y}_i$ denotes the standardized data.

3.3 Evaluation method for the competitiveness of China's marine industry clusters

The entropy method is an objective weighting approach widely applied in multi-indicator comprehensive evaluations. The weight of entropy method measures the variability of the index information by calculating its entropy value. The greater the

Table 1.
China ocean industry
cluster
competitiveness
evaluation index
system

Primary indicators	Secondary indicators	Tertiary indicators	Quaternary indicators
China Ocean Industry Cluster Competitiveness Evaluation Index System	Cluster Development Capacity	cluster scale level	Number of Enterprises Above Designated Size in Industrial Clusters (units)
			Number of Fortune Global 500 Companies in Industrial Clusters (units)
			Number of Top 500 Domestic Companies in Industrial Clusters (units)
			Number of Listed Companies in Industrial Clusters (units)
			Number of Employees in Industrial Clusters (people)
			Total Assets at Year-End of Industrial Clusters (ten thousand yuan)
			Total Tax and Profit of Industrial Clusters (ten thousand yuan)
			Total Main Business Revenue of Industrial Clusters (ten thousand yuan)
			Area of Regional Sea (ten thousand square kilometers)
			Length of Regional Coastline (kilometers)
			Employment Growth Rate (%)
			Enterprise Growth Rate (%)
			Tax and Revenue Growth Rate (%)
	Innovation Growth Capacity	cluster growth capacity	Proportion of Marine Gross Output Value to National Total (%)
			Output Capacity per Unit of Sea Area (ten thousand yuan/square kilometer)
			Output Capacity per Unit of Coastline (billion yuan/kilometer)
			Number of Scientific Researchers (people)
			Number of High-Level Marine Talents (people)
			Number of Universities and Research Institutes (units)
			Number of R&D Projects (units)
			Per Capita R&D Expenditure (ten thousand yuan)
			Gross Output Value of Marine Science, Education, and Management Services (billion yuan)
			Number of Patents Authorized (units)
			Number of Scientific Publications (units)
			Growth Rate of Scientific Researchers (%)
			Growth Rate of R&D Expenditure (%)
	Macroeconomic Support Capacity	innovation environment level	Growth Rate of Per Capita R&D Expenditure (%)
			Growth Rate of High-Level Marine Talents (%)
			Growth Rate of Patent Authorizations (%)
			Growth Rate of Scientific Publications (%)
			Intensity of R&D Investment (%)
			Land Area (square kilometers)
			Port Throughput Capacity (ten thousand tons)
			Port Cargo Throughput Capacity (ten thousand tons)
			Regional GDP per Capita (yuan)
			Fiscal Revenue per Capita (yuan)
			Output Value of Marine-Related Industries (billion yuan)
			Total Number of Universities and Research Institutions (units)
			Number of High-Level Talents in the Region (people)
		innovation development capacity	Number of University Students at Undergraduate Level and Above (people)
			Government Efficiency
			Business Environment
			Regional GDP Growth Rate (%)
			Regional Fiscal Revenue Growth Rate (%)
			Marine-Related Industries Output Growth Rate (%)
			Port Throughput Capacity Growth Rate (%)
			Business Environment Improvement Rate (%)
			High-Level Talent Growth Rate (%)
			Road, Railway, and Inland Waterway Mileage (kilometers)
			Output Capacity per Unit of Land Area (billion yuan/square kilometer)
		macroeconomic development capacity	

Source(s): Authors' own creation

variability, the greater the contribution of the index in the comprehensive evaluation and the higher the weight.

This method is based on information entropy theory and reflects the variability and informational content of each indicator by measuring the information entropy value of the indicators, thereby determining the weight of each indicator. Its weight is measured by calculating the entropy value of the indicator information. The greater the variability, the greater the contribution of the indicator in the comprehensive evaluation and the higher the weight. The steps involved in the entropy method are as follows:

(1) Data Normalization:

The normalized value z_{ij} is obtained from the original data value x_{ij} , where $\max(x_j)$ and $\min(x_j)$ represent the maximum and minimum values of the j th indicator, respectively.

- For positive indicators: $z_{ij} = \frac{x_{ij} - \min(x_j)}{\max(x_j) - \min(x_j)}$
- For negative indicators: $z_{ij} = \frac{\max(x_j) - x_{ij}}{\max(x_j) - \min(x_j)}$

(2) Calculate the Weight of Each Indicator p_{ij} : $p_{ij} = \frac{z_{ij}}{\sum_{i=1}^m z_{ij}}$

(3) Calculate the Information Entropy of the j th Indicator e_j : $e_j = -k \sum_{i=1}^m p_{ij} \ln(p_{ij})$

Where k is a constant related to the number of samples m , typically set such that $k = 1/\ln(m)$ and $k > 0$. When $p_{ij} = 0$, $p_{ij} \ln(p_{ij}) = 0$ is the proportion of the i th sample to the total for the j th indicator.

(4) Calculate the Weights w_i : $w_i = \frac{1 - e_i}{\sum_{j=1}^n (1 - e_j)}$

(5) Compute the Comprehensive Score $S_i = \sum_{j=1}^n w_j \cdot z_{ij}$

3.4 Data sources

The data used in this study primarily come from the 2017–2021 China Marine Economic Statistical Bulletin, the China Statistical Yearbook, and the statistical yearbooks of various provinces (autonomous regions and municipalities). Micro-level data are derived from listed companies on the Shanghai and Shenzhen A-shares, with relevant data sourced from the Wind Database, the CSMAR Database, and the official website of the National Intellectual Property Administration. For certain qualitative indicators, the expert scoring method was employed. After scoring the indicators, arithmetic averages were calculated to obtain the final scores. The software used for data processing and empirical analysis is Stata 16.0.

4. Analysis of competitiveness evaluation for typical marine industry clusters in China

4.1 Competitiveness evaluation of the marine shipbuilding and marine engineering equipment industry cluster in China

According to the results calculated using the entropy method (as shown in Table 2, Weight 1), among the evaluation indicators of the competitiveness of China's marine shipbuilding and marine engineering equipment industry cluster, innovation capability is the most critical factor. Particularly, innovation development capability and R&D expenditure intensity play key roles in enhancing overall innovation capacity. Following innovation capability, cluster development capacity also significantly influences competitiveness, with cluster scale being a notable contributing factor. In contrast, the impact of macroeconomic support capability on cluster competitiveness is relatively weaker, though macroeconomic development capacity still exerts some influence, especially regarding output capacity per unit area, which stands out as an important factor.

Primary indicators	Secondary indicators	Weight	Tertiary indicators	Weight	Quaternary indicators	Weight1	Weight 2	Weight 3
China Ocean Industry Cluster Competitiveness Evaluation Index System	Cluster Development Capacity	Weight1:0.3197	cluster scale level	Weight1:0.6572	Number of Enterprises Above Designated Size in Industrial Clusters (units)	0.0775	0.2248	0.3013
		Weight2		Weight2	Number of Fortune Global 500 Companies in Industrial Clusters (units)	0.0840	/	/
		0.3287		0.5541	Number of Top 500 Domestic Companies in Industrial Clusters (units)	0.0845	0.2248	0.0907
		Weight3		Weight3	Number of Listed Companies in Industrial Clusters (units)	0.0900	0.1216	0.3013
		0.1465		0.4552	Number of Employees in Industrial Clusters (people)	0.1390	0.2248	0.0656
			cluster growth capacity		Total Assets at Year-End of Industrial Clusters (ten thousand yuan)	0.0739	0.0496	0.0255
					Total Tax and Profit of Industrial Clusters (ten thousand yuan)	0.0689	0.0814	0.0155
					Total Main Business Revenue of Industrial Clusters (ten thousand yuan)	0.0702	0.0111	0.0187
					Area of Regional Sea (ten thousand square kilometers)	0.1024	0.0804	0.0907
					Length of Regional Coastline (kilometers)	0.0607	0.1225	0.0907
				Weight1:0.3428	Employment Growth Rate (%)	0.1487	0.0840	0.0982
				Weight2	Enterprise Growth Rate (%)	0.0210	/	/
				0.4459	Tax and Revenue Growth Rate (%)	0.0466	0.1495	0.0936
				Weight3	Proportion of Marine Gross Output Value to National Total (%)	0.0398	/	/
				0.5448	Output Capacity per Unit of Sea Area (ten thousand yuan/square kilometer)	0.0721	0.0586	0.4613
	Innovation Growth Capacity	Weight1:0.4930	innovation environment level	Weight1:0.4681	Output Capacity per Unit of Coastline (billion yuan/kilometer)	0.0477	0.4567	0.3470
		Weight2		Weight2	Number of Scientific Researchers (people)	0.4599	0.3352	0.1229
		0.3769		0.4756	Number of High-Level Marine Talents (people)	0.0729	0.1048	0.1711
		Weight3		Weight3	Number of Universities and Research Institutes (units)	0.2400	0.1492	0.1854
		0.2003		0.4296	Number of R&D Projects (units)	0.0693	0.1687	0.0936
			innovation development capacity		Per Capita R&D Expenditure (ten thousand yuan)	0.2341	0.1189	0.0780
					Gross Output Value of Marine Science, Education, and Management Services (billion yuan)	0.0693	0.0694	0.0882
					Number of Patents Authorized (units)	0.0352	0.1173	0.1565
				Weight1:0.5319	Number of Scientific Publications (units)	0.0880	0.1595	0.1042
				Weight2	Growth Rate of Scientific Researchers (%)	0.1021	0.0771	0.0941
				0.5244	Growth Rate of R&D Expenditure (%)	0.0973	0.1433	0.1333
				Weight3	Growth Rate of Per Capita R&D Expenditure (%)	0.1077	0.1489	0.1562
				0.5734	Growth Rate of High-Level Marine Talents (%)	0.1091	0.1047	0.1523
	Macroeconomic Support Capacity	Weight1:0.1873	macroeconomic environment level	Weight1:0.4440	Growth Rate of Patent Authorizations (%)	0.0880	0.1544	0.1072
		Weight2		Weight2	Growth Rate of Scientific Publications (%)	0.1084	0.0912	0.1452
		0.2944		0.3605	Intensity of R&D Investment (%)	0.2643	0.1368	0.2143
		Weight3		0.4149	Land Area (square kilometers)	0.0368	0.2197	0.1366
		0.6532			Port Throughput Capacity (ten thousand tons)	0.1369	0.1299	0.1276
			macroeconomic development capacity		Port Cargo Throughput Capacity (ten thousand tons)	0.2502	0.1118	0.1336
					Regional GDP per Capita (yuan)	0.2035	0.0784	0.0553
					Fiscal Revenue per Capita (yuan)	0.1227	0.0595	0.1054
					Output Value of Marine-Related Industries (billion yuan)	0.1617	0.0914	0.0344
					Total Number of Universities and Research Institutions (units)	0.1321	0.0554	0.1171
					Number of High-Level Talents in the Region (people)	0.0821	0.0706	0.0795
					Number of University Students at Undergraduate Level and Above (people)	0.0836	0.0744	0.0890
					Government Efficiency	0.1446	0.0724	0.0511
					Business Environment	0.1917	0.0647	0.0703
				Weight1:0.5560	Regional GDP Growth Rate (%)	0.0814	0.1915	0.0430
				Weight2	Regional Fiscal Revenue Growth Rate (%)	0.1313	0.0176	0.0516
				0.6395	Marine-Related Industries Output Growth Rate (%)	0.1203	0.0270	/
				Weight3	Port Throughput Capacity Growth Rate (%)	0.1056	0.0963	0.1444
				0.5851	Business Environment Improvement Rate (%)	0.1469	0.4194	0.4481
					High-Level Talent Growth Rate (%)	0.1174	0.0699	0.0652
					Road, Railway, and Inland Waterway Mileage (kilometers)	0.1377	0.1780	0.1317
					Output Capacity per Unit of Land Area (billion yuan/square kilometer)	0.2409	0.1918	0.1159
Note(s): Weight 1: Marine Shipbuilding and Marine Engineering Equipment Industry Cluster Weight 2: Marine Energy and Offshore Wind Power Industry Cluster Weight 3: Desalination and Comprehensive Utilization Industry Cluster Source(s): Authors' own creation								

Table 2.
Weight values of
competitiveness
evaluation indicators
for typical marines
industry clusters
in China

Based on the indicator weights determined in the previous sections, the comprehensive competitiveness index and the indices of the three secondary indicators for the marine shipbuilding and marine engineering equipment industry cluster were calculated for the coastal provinces and cities of Shandong, Jiangsu, Shanghai, and Guangdong between 2017 and 2021. Table 3 presents the calculated competitiveness index results for these four provinces and cities. At the provincial level, Shanghai maintains a leading position in the marine shipbuilding and marine engineering equipment industry cluster, and its advantage continues to grow. Shandong and Guangdong show some fluctuations, but the overall trend is positive. Notably, Shandong experienced a recovery after a downturn, while Guangdong has maintained stable growth. Although Jiangsu has shown significant progress in recent years, its overall cluster competitiveness still needs to be further enhanced to narrow the gap with the leading provinces.

Analyzing the competitiveness of the marine shipbuilding and marine engineering equipment industry cluster in Shandong, Jiangsu, Shanghai, and Guangdong (as shown in Figure 1), the results indicate that from 2017 to 2021, the competitiveness of these regional clusters significantly improved. The steady increase in competitiveness was driven by the continuous enhancement of innovation capability and macroeconomic support. Although the macroeconomic environment and cluster development capacity exhibited fluctuations between 2017 and 2019, the growing innovation capacity remained the key driver of competitiveness. By 2020 and 2021, with improvements in the economic environment and breakthroughs in innovation, the competitiveness of these industry clusters reached new heights.

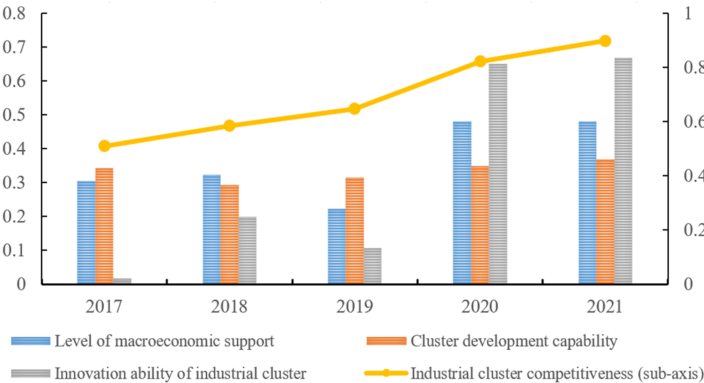
Figure 2 shows the development trends of the competitiveness and core indicators of the marine shipbuilding and marine engineering equipment industry cluster in Shandong, Jiangsu, Shanghai, and Guangdong. Shanghai consistently leads over the five-year period,

Table 3.
Comprehensive competitiveness index for marine shipbuilding and marine engineering equipment industry cluster in four provinces/cities in China (2017–2021)

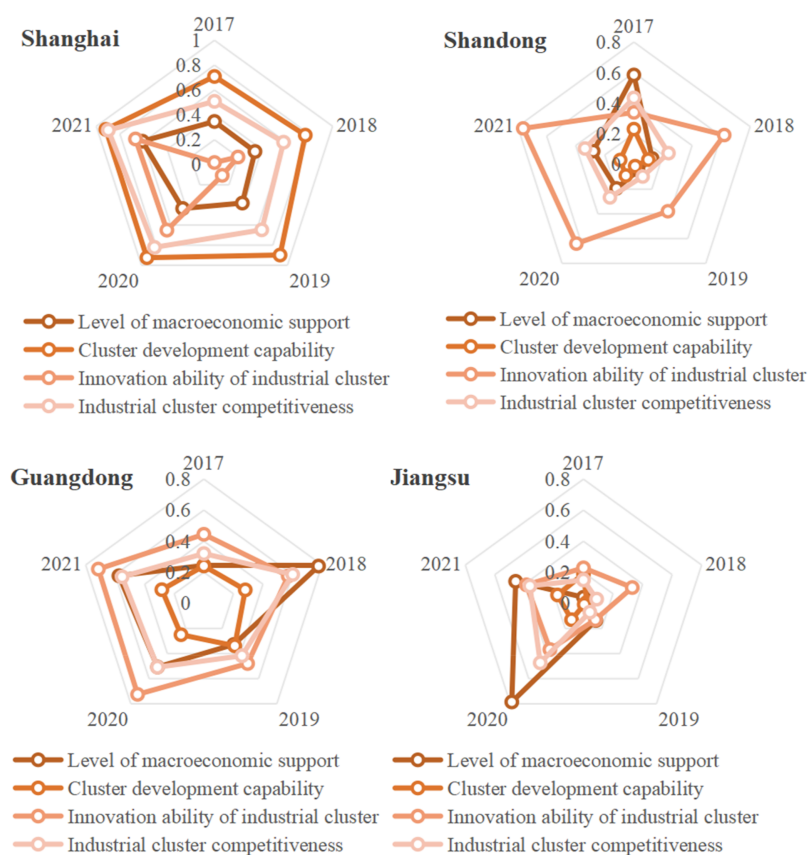
Year	Shanghai	Shandong	Guangdong	Jiangsu
2017	0.5094	0.4352	0.3207	0.1507
2018	0.5850	0.2382	0.6017	0.0893
2019	0.6480	0.0979	0.4177	0.0699
2020	0.8221	0.2669	0.5087	0.4736
2021	0.8982	0.3365	0.5533	0.3629

Source(s): Authors' own creation

Figure 1.
Time evolution trend of competitiveness and core secondary indicators of China's marine shipbuilding and offshore engineering equipment industry cluster



Source(s): Authors' own creation



Source(s): Authors' own creation

Figure 2.
Temporal characteristics of competitiveness and core secondary indicators of marine shipbuilding and offshore engineering equipment industry clusters in four provinces

particularly excelling in innovation capability and cluster development capacity. Guangdong and Shandong exhibit similar levels of competitiveness, with Guangdong slightly outperforming in innovation capability and Shandong having an advantage in cluster development capacity. Although Jiangsu has made progress, its overall competitiveness remains lower than the other provinces, particularly in terms of the macroeconomic environment and cluster development capacity. From a trend perspective, Shanghai continues to show steady growth, Guangdong demonstrates strong innovation capability, Shandong leads in cluster scale, and Jiangsu needs to overcome bottlenecks in the macroeconomic environment and innovation capability.

4.2 Evaluation and analysis of competitiveness in China's marine energy and offshore wind power industry cluster

Based on the results obtained using the entropy method, the weights for the evaluation indicators of competitiveness in the marine energy and offshore wind power industry cluster are shown in Table 2 (Weight 2). The findings indicate that both the innovation capability and the development capability of the industry cluster have the most significant impact on the competitiveness of China's marine energy and offshore wind power industry cluster, while the

influence of macroeconomic support capability is relatively weaker. Within the framework of industry cluster innovation and development capabilities, the level of cluster scale and development capability is particularly important, with the number of large-scale enterprises and listed companies making notable contributions. Table 4 presents the calculated comprehensive competitiveness index for the marine energy and offshore wind power industry clusters in four provinces and municipalities in China. From 2017 to 2021, Jiangsu showed excellent performance in the competitiveness of the marine energy and offshore wind power industry cluster, while Shandong and Tianjin exhibited a fluctuating upward trend, indicating an overall improvement. Shanghai, starting from a relatively low level in 2017, steadily increased its competitiveness, ranking second in 2021 and demonstrating strong growth potential.

To analyze the overall level of competitiveness, the annual averages of the marine energy and offshore wind power industry cluster competitiveness and core secondary indicators for the coastal provinces of Shandong, Jiangsu, Shanghai, and Tianjin were calculated (see Figure 3). Between 2017 and 2021, the competitiveness of China's marine energy and offshore wind power industry cluster exhibited a fluctuating upward trend, showcasing an overall positive trajectory. The development levels of each core secondary indicator reveal that, although the macroeconomic support level experienced some fluctuations and declines, it has shown steady growth afterward, occupying the primary position by 2021. Coupled with the rapid enhancement of innovation capability within the industry cluster in 2020, the comprehensive competitiveness of China's marine energy and offshore wind power industry cluster has significantly improved, demonstrating a trend of steady growth thereafter.

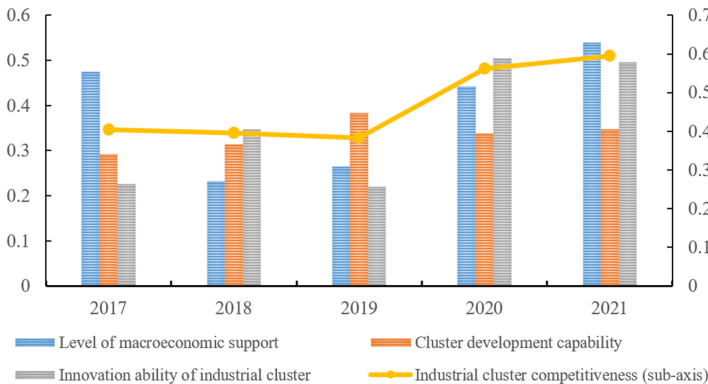
Figure 4 illustrates the trend of competitiveness and development levels of core secondary indicators for the marine energy and offshore wind power industry clusters in the coastal provinces of Shandong, Jiangsu, Shanghai, and Tianjin. From 2017 to 2021, both Jiangsu and Shanghai demonstrated notable advantages in industry cluster competitiveness.

Table 4.
Comprehensive competitiveness index of the marine energy and offshore wind power industry clusters in four provinces of China (2017–2021)

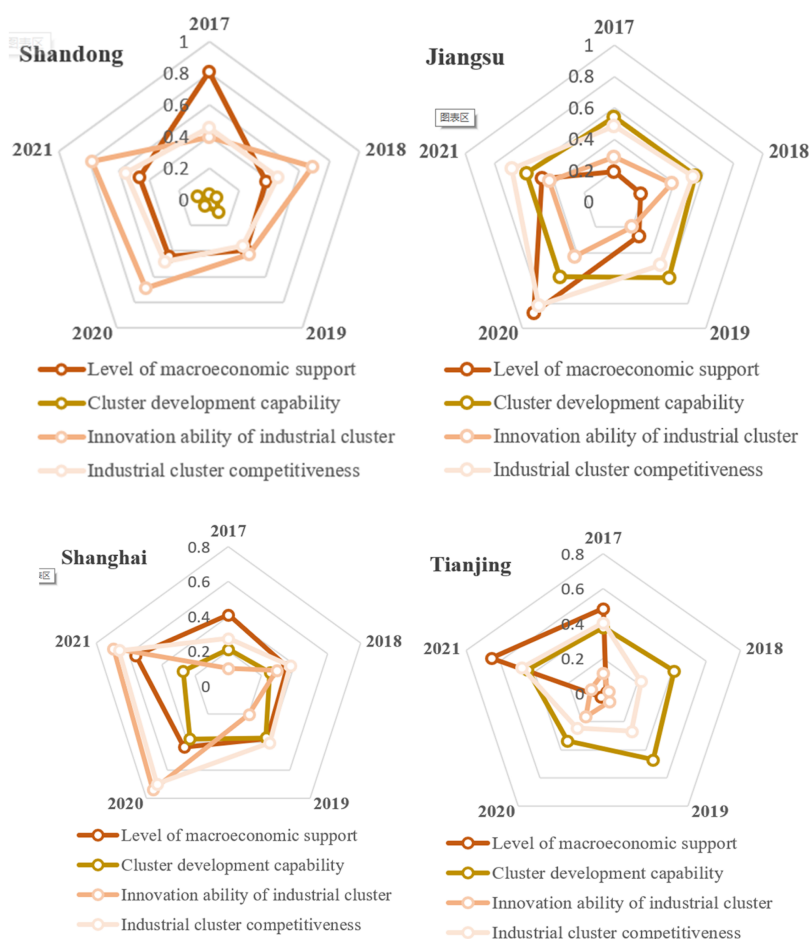
Year	Shandong	Jiangsu	Shanghai	Tianjin
2017	0.4559	0.4836	0.2718	0.4051
2018	0.4573	0.5309	0.3727	0.2197
2019	0.3625	0.4971	0.4037	0.2685
2020	0.4828	0.8192	0.6968	0.2463
2021	0.5572	0.6862	0.6598	0.4754

Source(s): Authors' own creation

Figure 3.
Time evolution trend of competitiveness and core secondary indicators of China's marine energy and offshore wind power industry cluster



Source(s): Authors' own creation



Source(s): Authors' own creation

Figure 4.
Temporal characteristics of competitiveness and core secondary indicators of marine energy and offshore wind power industry clusters in four provinces

Specifically, Jiangsu leads in cluster development capability and innovation, while Shanghai shows a clear advantage in macroeconomic support levels. This may be related to its introduction of the “Action Program for the Development of Marine Industry in Jiangsu Province,” and other policy documents, the introduction of the policy to fully promote the development of marine energy and offshore wind power industry clusters on a large scale. Shandong, although relatively lagging in cluster development capability, possesses significant strengths in innovation and macroeconomic support levels. Tianjin lags behind in all indicators, particularly in macroeconomic support levels, which notably hinders its competitiveness.

4.3 Evaluation and analysis of competitiveness in China's desalination and comprehensive utilization industry cluster

Using the entropy method, the weights for the evaluation indicators of competitiveness in the desalination and comprehensive utilization industry cluster in China were determined, as

shown in Table 3 (Weight 3). The results indicate that the competitiveness of China's desalination and comprehensive utilization industry cluster is primarily influenced by macroeconomic support capability, particularly the capability for macroeconomic development. In contrast, innovation capability and cluster development levels have a weaker impact. Among the key tertiary indicators, the output capacity per unit of sea area, the improvement rate of the business environment, and the output capacity per unit of coastline make significant contributions. Table 5 provides the calculated comprehensive competitiveness index for the desalination and comprehensive utilization industry clusters in two provinces of China. Between 2017 and 2021, Jiangsu's industry cluster competitiveness steadily improved, reaching its peak in 2020. Shanghai exhibited steady growth from 2017 to 2019, with a significant acceleration beginning in 2020, indicating a strong growth momentum in the later stages.

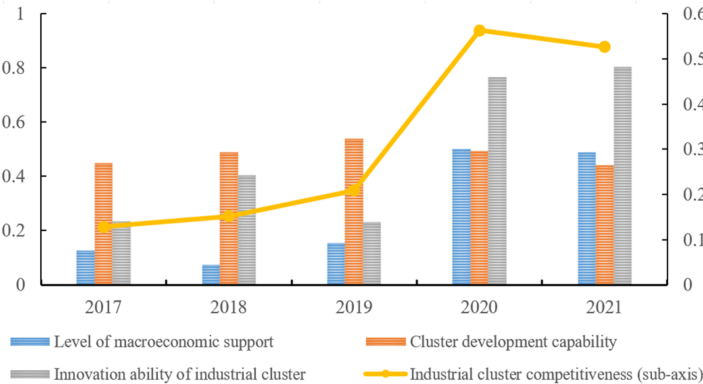
By calculating the annual averages of competitiveness and core secondary indicators for the desalination and comprehensive utilization industry clusters in Jiangsu and Shanghai (see Figure 5), the analysis reveals that the desalination and comprehensive utilization industry cluster demonstrated robust competitiveness enhancement from 2017 to 2021, particularly driven by macroeconomic support and innovation capabilities. However, after the rapid growth experienced in 2020, some core indicators, such as macroeconomic support and cluster development capabilities, experienced slight adjustments, which may signal that the desalination and comprehensive utilization industry cluster is entering a relatively stable development phase. Moving forward, it is essential to continuously optimize macroeconomic policies, enhance innovation capabilities within the cluster, and overcome the bottlenecks in

Table 5.
Comprehensive competitiveness index of desalination and comprehensive utilization industry clusters in two provinces of China (2017–2021)

Year	Jiangsu	Shanghai
2017	0.1306	0.1261
2018	0.2042	0.0991
2019	0.3150	0.1027
2020	0.8635	0.2630
2021	0.5022	0.5501

Source(s): Authors' own creation

Figure 5.
Temporal evolution of competitiveness and core secondary indicator development levels of China's desalination and comprehensive utilization industry cluster



Source(s): Authors' own creation

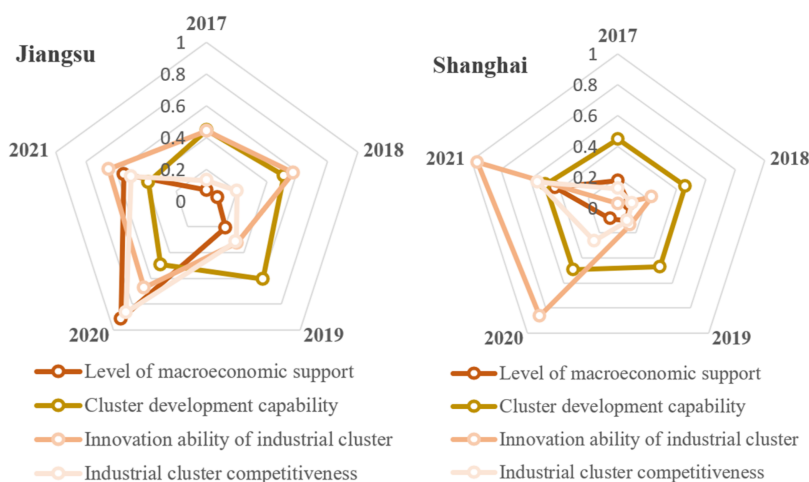
cluster development capability to ensure the stability and sustainability of China's desalination and comprehensive utilization industry cluster development.

Figure 6 illustrates the trends in competitiveness and the development levels of core secondary indicators for the desalination and comprehensive utilization industry clusters in Jiangsu and Shanghai. The results indicate that Jiangsu's breakthrough in macroeconomic support and cluster innovation capabilities in 2020 significantly enhanced its industry cluster competitiveness, demonstrating strong innovation-driven growth. In contrast, Shanghai exhibited stable cluster development capabilities and gradually improving cluster innovation capabilities, resulting in overall competitiveness that remains stable but grows relatively slowly. In the future, to further enhance competitiveness, Jiangsu must continue to leverage its innovation-driven approach while addressing the decline in cluster development capabilities. Meanwhile, Shanghai needs to seek greater breakthroughs in macroeconomic support and cluster development capabilities.

5. Conclusions and policy recommendations

Based on the evaluation and analysis of the competitiveness of typical marine industry clusters in China, the following conclusions can be drawn:

- (1) Significant Competitiveness of Marine Shipbuilding and Ocean Engineering Equipment Clusters: Through technological innovation and policy support, the marine shipbuilding and ocean engineering equipment clusters have shown a marked improvement in competitiveness, advancing toward high-quality development despite facing macroeconomic fluctuations.
- (2) Continuous Improvement in Marine Energy and Offshore Wind Power Clusters: The competitiveness of marine energy and offshore wind power clusters has been continuously enhanced under supportive policies. However, there is still a need to optimize resource allocation and strengthen innovation stability to meet market challenges.



Source(s): Authors' own creation

Figure 6.
Temporal characteristics of competitiveness and core secondary indicator development levels of the desalination and comprehensive utilization industry clusters in two provinces

- (3) Strong Growth Potential of Desalination and Comprehensive Utilization Clusters: The desalination and comprehensive utilization clusters demonstrate robust growth potential in technological innovation and regional collaborative development. Future efforts should focus on the application of environmentally friendly and energy-saving technologies to ensure a balance between economic and ecological benefits.
- (4) Regional competitiveness is characterized by outstanding features: Shanghai has demonstrated significant advantages in innovation and macroeconomic support in the industries of marine vessels and offshore engineering equipment, and marine energy and offshore wind power, while Jiangsu has demonstrated strong competitiveness in the cluster development capacity of marine energy and seawater desalination relying on policy drivers.
- (5) The direction of improvement varies: Jiangsu needs to strengthen macroeconomic support and maintain innovation advantages to enhance sustained competitiveness; Shanghai needs to make greater breakthroughs in macroeconomics and cluster development capabilities. Shandong and Tianjin need to improve their innovation capacity and cluster size to enhance regional competitiveness.

Based on these conclusions, the following three policy recommendations are proposed:

- (1) Dynamic Resource Optimization Mechanism: Utilize big data and artificial intelligence technologies to establish real-time monitoring platforms that promote regional resource sharing and collaboration. Develop supportive policies to ensure the efficient and balanced utilization of marine resources, thereby enhancing the overall effectiveness of the marine economy.
- (2) Industry Cluster Networks Led by Leading Enterprises: Centered around large enterprises, promote collaborative innovation among small and medium-sized enterprises. Through policy and financial support, facilitate technology transfer and market expansion, optimize the industrial chain structure, achieve resource complementarity, and enhance overall competitiveness.
- (3) Application of Intelligent Technologies to Improve Operational Efficiency: Promote intelligent manufacturing and Internet of Things (IoT) technologies to optimize logistics and supply chain management. Streamline administrative approval processes to enhance operational efficiency and market responsiveness of enterprises, thus improving the competitiveness of marine industry clusters.

References

- Boschma, R. and Iammarino, S. (2009), "Related variety, trade linkages, and regional growth in Italy", *Economic Geography*, Vol. 85 No. 3, pp. 289-311, doi: [10.1111/j.1944-8287.2009.01034.x](https://doi.org/10.1111/j.1944-8287.2009.01034.x).
- Ding, J., Ge, X. and Casey, R. (2014), "'Blue competition' in China: current situation and challenges", *Marine Policy*, Vol. 44, pp. 351-359, doi: [10.1016/j.marpol.2013.09.028](https://doi.org/10.1016/j.marpol.2013.09.028).
- Doloreux, D. and Shearmur, R. (2009), "Maritime clusters in diverse regional contexts: the case of Canada", *Marine Policy*, Vol. 33 No. 3, pp. 520-527, doi: [10.1016/j.marpol.2008.12.001](https://doi.org/10.1016/j.marpol.2008.12.001).
- Du, X., Liu, Q., Yang, L., Zhu, J. and Qiao, J. (2022), "Research on the path for Guangdong to build a strong marine economy from the perspective of the marine power strategy", *Science and Industry*, Vol. 22, pp. 288-296.
- Fan, F., Chenqi, Z. and Zhenguo, Y. and others (2023), "China's marine manufacturing export growth: policy, status, and driving components", *Marine Policy*, Vol. 149, 105495, doi: [10.1016/j.marpol.2023.105495](https://doi.org/10.1016/j.marpol.2023.105495).

- Gerke, A., Desbordes, M. and Dickson, G. (2015), "Towards a sport cluster model: the ocean racing cluster in Brittany", *European Sport Management Quarterly*, Vol. 15 No. 3, pp. 343-363, doi: [10.1080/16184742.2015.1019535](https://doi.org/10.1080/16184742.2015.1019535).
- Gu, Y., Qian, L., Zhou, H. and Zhang, X. (2023), "Research on the innovation development path and countermeasures of Jiangsu's offshore wind power industry", *Marine Development and Management*, Vol. 40, pp. 106-115, doi: [10.20016/j.cnki.hykyfjgl.20230426.001](https://doi.org/10.20016/j.cnki.hykyfjgl.20230426.001).
- Holte, E. and Moen (2020), "Successful maritime clusters: key drivers and criteria", IGLO-MP 2020 Working Paper 01–2010.
- Huang, B., Shao, J., Wang, Z., Wang, J., Wei, N., Luo, H. and Chen, F. (2024), "Construction of a new marine ecological environment evaluation system ('Blue Ocean' Index): a case study of Zhejiang Province", *Journal of Applied Oceanography*, Vol. 2023 No. 14, pp. 1-11.
- Kildow, J. and McIlgorm, A. (2009), "The importance of estimating the contribution of the oceans to national economies", *Marine Policy*, Vol. 34 No. 3, pp. 367-374, doi: [10.1016/j.marpol.2009.08.006](https://doi.org/10.1016/j.marpol.2009.08.006).
- Li, R. and Cui, W. (2024), "Research on the spatiotemporal evolution and influencing factors of China's marine environmental protection technology innovation capability", *Marine Bulletin*, Vol. 2024 No. 9, pp. 1-12.
- Li, H., Xu, W. and Zhang, Y. and others (2020), "Evaluation of factors influencing the sustainable development of the marine equipment manufacturing industry cluster", *Journal of Coastal Research*, Vol. 106 No. sp1, pp. 440-444, doi: [10.2112/si106-099.1](https://doi.org/10.2112/si106-099.1).
- Maskell, P. and Malmberg, A. (1999), "The competitiveness of firms and regions: Ubiquitification' and the importance of localized learning", *European Urban and Regional Studies*, Vol. 6 No. 1, pp. 9-25, doi: [10.1177/096977649900600102](https://doi.org/10.1177/096977649900600102).
- Mo, C., He, C. and Yang, L. (2020), "Structural characteristics of industrial clusters and regional innovation", *Economics Letters*, Vol. 188, 109003, doi: [10.1016/j.econlet.2020.109003](https://doi.org/10.1016/j.econlet.2020.109003).
- Monteiro, P., De Noronha, T. and Neto, P. (2013), "A differentiation framework for maritime clusters: comparisons across Europe", *Sustainability*, Vol. 5 No. 9, pp. 4076-4105, doi: [10.3390/su5094076](https://doi.org/10.3390/su5094076).
- Riddle, E.E., Stoner, M.B., Johnson, N.C., L'Heureux, M.L., Collins, D.C. and Feldstein, S.B. (2013), "The impact of the MJO on clusters of wintertime circulation anomalies over the North American region", *Climate Dynamics*, Vol. 40 Nos 7-8, pp. 1749-1766, doi: [10.1007/s00382-012-1493-y](https://doi.org/10.1007/s00382-012-1493-y).
- Salvador, R., Simões, A. and Soares, C.G. (2015), "Features of the European maritime clusters", *Louvain-la-Neuve: European Regional Science Association (ERSA)*.
- Shen, K. and Zhao, Q. (2024), "Research on the high-quality development of Jiangsu's marine economy", *Journal of Jiangsu Administration College*, Vol. 2024 No. 3, pp. 39-46.
- Sornn-Friese, H. and Iversen, M.J. (2014), "The establishment of the Danish International Ship Register (DIS) and its connections to the maritime cluster", *International Journal of Maritime History*, Vol. 26 No. 1, pp. 82-103, doi: [10.1177/0843871413514164](https://doi.org/10.1177/0843871413514164).
- Wang, S. and Zhang, X. (2014), "Analysis of the path to promote marine economic development in coastal areas using the "Belt and Road" strategy: a case study of Tianjin", *Theoretical Circle*, Vol. 2014 No. 11, pp. 35-40, doi: [10.13221/j.cnki.ljj.2014.11.007](https://doi.org/10.13221/j.cnki.ljj.2014.11.007).
- Wenwen, X., Bingxin, Z. and Lili, W. (2016), "Marine industrial cluster structure and its coupling relationship with urban development: a case of Shandong Province", *Polish Maritime Research*, Vol. 23 No. s1, pp. 115-122, doi: [10.1515/pomr-2016-0055](https://doi.org/10.1515/pomr-2016-0055).
- Xiao, W., Zhao, B. and Wang, L. (2016), "Marine industrial cluster structure and its coupling relationship with urban development: a case of Shandong Province", *Polish Maritime Research*, Vol. 23 No. s1, pp. 115-122, doi: [10.1515/pomr-2016-0055](https://doi.org/10.1515/pomr-2016-0055).
- Xiong, W., Li, T. and Hao, Z. (2020), "Characteristics of economic structure change of marine industry based on the principle of information entropy", *Journal of Coastal Research*, Vol. 103 No. sp1, pp. 714-717, doi: [10.2112/si103-146.1](https://doi.org/10.2112/si103-146.1).

- Yan, X., Yan, L. and Yao, X. and others (2015), "The marine industrial competitiveness of blue economic regions in China", *Marine Policy*, Vol. 62, pp. 153-160, doi: [10.1016/j.marpol.2015.09.015](https://doi.org/10.1016/j.marpol.2015.09.015).
- Yang, L. and Hou, G. (2019), "Study on the strategic innovation and industrial development effect of marine industry", *Journal of Coastal Research*, Vol. 94 No. 1, pp. 581-584, doi: [10.2112/SI94-115](https://doi.org/10.2112/SI94-115).
- Yang, H. and Zhao, X. (2024), "The coupling relationship between marine industry agglomeration and ecological environment system from the perspective of ecological environment", *Journal of Sea Research*, Vol. 198, 102485, doi: [10.1016/j.seares.2024.102485](https://doi.org/10.1016/j.seares.2024.102485).
- Zhang, R., Gao, Q. and Gao, K. (2024), "Impact of marine industrial agglomeration on the high-quality development of the marine economy—a case study of China's coastal areas", *Ecological Indicators*, Vol. 158, 111410, doi: [10.1016/j.ecolind.2023.111410](https://doi.org/10.1016/j.ecolind.2023.111410).

Corresponding author

Hongshuo Zhang can be contacted at: zhanghongshuo@mail.sdufe.edu.cn