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Analysis of the Development Strategy of Nanjing Port under the Background of "Jianggang" Changing Into "Seaport"

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ABSTRACT. *In order to analyze in depth the opportunities and challenges that the Nanjing Port faces after the 12.5m deep water channel below the Yangtze River and Nanjing has been put into operation. Firstly, by investigating the relevant data of the berths of Nanjing Port, the throughput, and the comparative analysis of changes in and out of the ship, the development and changes of Nanjing Port before and after the operation of the deep-water channel were obtained, and a qualitative analysis of the opportunities and challenges facing Nanjing Port. Through the construction of the SWOT-AHP model, an in-depth quantitative study is conducted to analyze how Nanjing Port grasps and handles the opportunities and challenges brought by the operation of the deep-water channel, and formulates related development strategies.*

KEYWORDS: *Nanjing Port, 12.5m deep water channel, SWOT-AHP analytic model*

1. Research Background

The lower reaches of the Yangtze River and Nanjing are located at the “Belt and Road” junction. In December 2015, the deep-water channel from Taicang to Nantong was put into operation, which provided a basic guarantee for sea vessels to enter the river. The 12.5m deep-water channel below the Yangtze River and Nanjing opened in May 2018 [1]. Since then, the depth of water that restricted Nanjing Port to become a hub port has been insufficient, and the dilemma that sea vessels cannot reach directly has been lifted. In May 2019, the 12.5m deep-water channel below Nanjing on the Yangtze River was officially put into operation. As the deep-water channel was put into operation, Nanjing Port has achieved leapfrog development.

Below the Yangtze River and Nanjing is the busiest area for water transportation in our country, with an annual transportation volume of more than 1.6 billion tons, of which sea transportation capacity exceeds 800 million tons. Previously, the waterway below the Yangtze River and Nanjing was restricted by a depth of 10.5

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meters, and sea vessels above the 50,000-ton class were unable to sail at full load, which greatly restricted the efficiency of cargo transportation. Since the completion of the 12.5m deep-water channel, the main types of navigable ships are 50,000-ton class, which can meet the full-load two-way navigation of 50,000-ton container vessels, and 100,000-ton sea vessels can be sailed to Nanjing with reduced load.

The deep water routes below the Yangtze River and Nanjing have been put into operation. Nanjing Port has taken this opportunity to achieve great development, but at the same time, many external factors are restricting the development of Nanjing Port to the central hub port. Therefore, this paper mainly uses some data to study how Nanjing Port can fully develop Its geographical advantages and how to grasp the opportunities after the full-line operation of the deep-water channel, as well as some external challenges it faces and overcome them to better develop itself.

2. Analysis of related indicators before and after the completion of Nanjing Port Deepwater Channel

Since the opening of the deep-water channel below the Yangtze River and Nanjing, the port of Nanjing has undergone tremendous changes. This chapter mainly selects the relevant indicator data that can represent the development of the port, and compares and analyzes the development and change of the deep-water channel of Nanjing Port before and after its completion.

2.1 Analysis of the number of berths in Nanjing Port

The number of dock berths, as the name implies, is the number of vessels that a port or dock can moor at the same time. The number and size of quay or port berths are important indicators of the size of a quay or port. With the full-scale operation of the 12.5m deep-water channel below the Yangtze River in Nanjing, the number of berths and composition of berths in Nanjing Port have changed to some extent.

It is analyzed from Table 1 that the total number of berths for production at Nanjing Port is decreasing every year, but this does not mean that the development of Nanjing Port is going backwards. On the contrary, the number of 10,000-ton berths in Nanjing Port has been greatly developed since 2012 This is the result of the integration and optimization of berth resources at Nanjing Port. In measuring the size of a port, the proportion of 10,000-ton berths is one of the important indicators.

Table 1 Percentage of production berths, 10,000-ton berths, and 10,000-ton berths at Nanjing Port

Year	2012	2013	2014	2015	2016	2017	2018
Total berths for production / pcs	308	311	298	284	246	231	226
10,000-ton berths / eac	56	59	58	57	61	60	62
10,000-ton berths accounted for	18.2%	19.0%	19.5%	20.1%	24.8%	26.0%	27.4%

(Data source: China Port Statistical Yearbook)

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From Table 1, we can see that the proportion of berths of 10,000-ton berths in Nanjing Port is increasing every year. In 2016, the number of berths of 10,000-ton berths [2] increased by 4.8 percentage points compared with 2015, and exceeded the following two years More than 1 percentage point is growing. At the same time, as of the end of 2016, Nanjing Port had a total of 42 berths above 50,000 tons, and even 16 berths over 80,000 tons. The advance completion of these deepwater berths will also provide infrastructure guarantee for the formal operation of the 12.5m deepwater channel in the future.

The proportion of 10,000-ton berths is constantly increasing, which is greatly affected by the construction of 12.5m deep water channel. This is the performance of Nanjing Port to optimize and upgrade port berths in order to adapt to the requirements of berthing large ships after the completion of the deep water channel.

2.2 Analysis of Cargo Throughput of Nanjing Port

Port cargo throughput refers to the total amount of goods transported and imported by water in a port through loading and unloading operations within a certain period of time. It is another important indicator for measuring the size of a port. Through investigation, the cargo throughput of Nanjing Port from 2012 to 2018 [2] is shown in Table 2.

Table 2 Cargo Throughput of Nanjing Port in 2012-2018

Year	2012	2013	2014	2015	2016	2017	2018
Cargo throughput / 100 million tons	1.92	2.02	2.20	2.15	2.17	2.39	2.52

(Data source: China Port Statistical Yearbook)

Before 2017, the 12.5m deep-water channel did not pass through Nanjing. Although the cargo throughput of Nanjing Port increased every year, the annual growth rate was between 0.9% and 8.9%. Compared with the cargo throughput of Nanjing Port in 2014, Decline. After the 12.5m deep water channel opened to Nanjing in 2017, the cargo throughput in 2017 increased by 10.1% year-on-year. This increase is much higher than that before the 12.5m deep water channel opened to Nanjing in the same period. It is to curb the situation of Nanjing Port's decline in throughput caused by the sluggish shipping environment and promote the development of Nanjing Port.

With the completion of the 12.5m deep-water channel below the Yangtze River and Nanjing, the cargo throughput of Nanjing Port has rapidly increased through the opening of 2017, and it has steadily improved during the trial operation in 2018. It is not difficult to analyze that the improvement of the efficiency of Nanjing Port is due to the slight improvement of the Yangtze River shipping environment in the past two years, and the greater benefit of the completion and operation of the 12.5m deep water channel, which provides good navigation for ships entering and leaving the port condition. At the same time, Nanjing Port takes advantage of its obvious

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geographical location. Ships are more willing to load and unload cargo at Nanjing Port.

2.3 Analysis of ships entering and leaving port

With the deep-water channel officially put into operation, it will provide good navigation guarantee for sea vessels entering the river. The most obvious change for Nanjing Port is that there are more big ships and fewer boats. According to incomplete statistics, in 2018, 895 ships of 50,000 tons or more entered and left the port since trial operation for one year [3]. After the deep-water channel was officially put into operation in 2019, as of September 25, ships of 50,000-ton class or above entered and exited Nanjing Port at 766, a year-on-year increase of 11.2%. It is estimated that at the end of 2019, ships of 50,000-ton class or above entered and entered Nanjing Port at 1,000 sets. about.

By comparing the trial operation of the 12.5m deep-water channel to its formal operation, the number of large vessels entering and leaving Nanjing Port in such a short period of time can grow so rapidly. On the one hand, after the one-year trial operation, the infrastructure of Nanjing Port has been improved to provide good navigation, berthing and loading conditions for ships entering and leaving the port. The most important aspect is that both the shipping company and the cargo owner have experienced the economic benefits of transiting goods to Nanjing Port, and more and more choose Nanjing Port as a transit port.

3. Deep water channel brings opportunities to the development of Nanjing Port

Nanjing Port is located in the capital city of Jiangsu Province and enjoys excellent geographical conditions. However, Nanjing Port has always been difficult to become a first-class port in China. It is largely restricted by insufficient shipping channels to meet the needs of large ships for loading and unloading cargo. However, with the opening of the 12.5m deep water channel below Nanjing, the natural factors limiting the development of Nanjing Port have been eliminated. Therefore, Nanjing Port has ushered in a period of opportunity for development.

3.1 Promote the reconstruction and upgrading of old berths in Nanjing

Through the analysis of the previous series of data, it has been shown that Nanjing Port has made great progress after the deep water channel was put into operation. Both the throughput and the size of ships entering and leaving the port indicate that the berths of the Nanjing Port also need to be upgraded and upgraded, providing a good basis for the entry and exit of ships and cargo handling.

The Xinshengwei Port area is the terminal of the 12.5m deep water channel below Nanjing on the Yangtze River, and the largest bulk terminal in Nanjing Port. It was built in the 1980s. Before the completion of the deep-water channel, its docks

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had small berths and backward loading and unloading facilities. With the completion of the deep-water channel and the arrival of large-scale sea vessels, it is necessary to promote the reconstruction of the pier in the Xinshengwei Port area, including increasing the mooring piles and installing rubber guardrails, etc., and now it has 16 berths that can reliably berth 80,000 tons of sea vessels . The loading and unloading door machine at Huining Terminal was updated from 10 tons to the current 25 tons. A fast connection was achieved by a belt conveyor between the sea ship and the river ship [4].

The rapid development of Nanjing Port also puts forward higher requirements for the collection and distribution of ports. Longtan Port is the largest container terminal in Nanjing Port. The Shugang Avenue in front of the terminal has been completed and put into operation, which has greatly improved.

3.2 Save logistics costs and help the construction of the seaport hub economic zone

Before the 12.5m deep-water channel below the Yangtze River in Nanjing was not completed and used, the water depth of the 283-km channel from Nanjing to Taicang was only 10.5m, and it could only pass 30,000-ton sea vessels. Since the completion of the 12.5m deep-water channel, 50,000-ton ships have been allowed to enter the Nanjing Port. According to relevant data, the average transportation cost of roads and railways is 0.45 yuan / ton-km and 0.145 yuan / ton-km [4]. The Yangtze River transportation cost is only 0.025 yuan / ton-km. After calculation, 50,000-ton-class sea vessels are fully loaded from Taicang Port to Nanjing Port at a cost of RMB 35,375. The cost of transporting the same goods by rail and road is 2.03 million yuan and 5.715 million yuan, respectively. These do not include intermediate cargo turnover costs. After comparative analysis, the logistics cost of Nanjing to Taicang was greatly reduced with the completion of the 12.5m deep water channel.

Based on the 12.5m deep-water route and three national railway lines converging in Nanjing Port, the geographical location of Nanjing Port and the advantages of collection and transportation are fully utilized, and more ships call at Nanjing Port. These reasons led to the approval of the Nanjing Municipal People's Government in 2018 to build the Nanjing Seaport Economic Zone. Once the Nanjing Seaport Economic Zone is completed [5], cargoes of inland ports such as the upper reaches of the Yangtze River and the canal will choose Nanjing Port as a transit port, promoting Nanjing Port to become an important container ocean shipping route in the Yangtze River Basin and the originating port of domestic trade routes.

4. Nanjing Port faces external threats and challenges

The penetration of the 12.5m deep water channel just opened up the barriers that previously limited the development of Nanjing Port because of the insufficient water depth of the channel, which could not be reached by large sea vessels. However, if

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Nanjing Port is to take advantage of this opportunity to make itself an influential port, it still needs to face challenges from various aspects.

4.1 The poor shipping environment is difficult to accelerate the development of Nanjing Port

The port of Nanjing should have been able to develop rapidly by taking advantage of the deep-water channel penetration. Although the throughput of Nanjing Port has increased both in terms of throughput and the number of ships entering and leaving the port, there has not been a blowout development as expected.

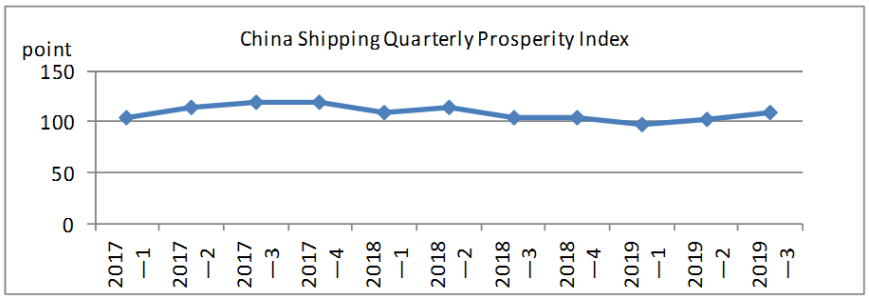

Figure. 1 China Shipping Prosperity Index by Quarter

(Data source: Shanghai International Shipping Center)

According to Figure 1, the China Shipping Quarterly Prosperity Index analysis shows that the China Shipping Prosperity Index has been hovering at the edge of the shipping boom interval, and the development of the Chinese shipping market has not been very friendly. This is also the main reason that it is difficult for Nanjing Port to develop rapidly after opening the channel barriers that previously restricted its development.

The Nanjing Port and relevant local authorities should grasp its inherent advantages such as location and navigation channels, improve the port's capacity for collection and transportation, and add relevant policies and regulations to create a good investment environment. These will be powerful measures that can develop oneself and improve one's own competitiveness in the slump of the shipping environment in the depths of Nanjing Port.

4.2 There is a certain gap between the competition between Nanjing Port and its downstream ports

Before the completion of the deep-water channel, Nanjing Port was always affected by the water depth of the channel. After the completion of the deep-water channel, the development of Nanjing Port has recovered to some extent, but it is

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unrealistic to want to catch up with its downstream ports in a short time. Ports such as Suzhou and Nantong are superior to Nanjing Port because of their location in the Shanghai metropolitan area and the opening of deep-water channels earlier than Nanjing Port. At present, in order to increase their own competitive advantages, ports such as Suzhou and Nantong have launched "Shanghai-Taitong" logistics mode. These reasons lead to great challenges in the development of Nanjing Port.

Facing the pressure of competition from surrounding ports, Nanjing Port should find its own shortcomings and change its development model. With its own location advantages, it can consider alliances with its upstream ports such as Wuhan and Chongqing. With its own advantage of the end point of the 12.5m deep water channel, it will develop itself into a central hub port in the lower and middle reaches of the Yangtze River. At the same time, we will vigorously develop multimodal transport and improve our capacity for collection and distribution.

5. SWOT-AHP Quantitative Analysis of Nanjing Port Development

5.1 Construct SWOT feature matrix based on the above analysis

In studying the impact of Nanjing Port on the 12.5m deep-water channel, the most important thing is to analyze the four elements of its own advantages (S) and disadvantages (W), external opportunities (O), and threats (T), as well as each The features contained within the feature. Only by studying the relationship between these factors can we get the degree of influence of Nanjing Port on the deep water channel.

Table 3 SWOT feature matrix

Differentiate	Content		
S	S110,000-ton berths increased	W	W1 Infrastructure lags
	S2 location advantage		W2 Cargo arrival is insufficient
	S3 Policy		W3 Low loading and unloading efficiency
	S4 Deep water channe		W4 Poor Capacity
O	O1 Logistics cost reduction	T	T1 Port competition around
	O2 Yangtze River Delta integration		T2 Shipping industry downturn
	O3Increase in inbound and outbound ships and upgrade of old berth		T3"Shanghai Taitong" Logistics Mode

5.2 Establish AHP Evaluation Index

Build the analysis layer according to Table 3 as shown in Figure 2.

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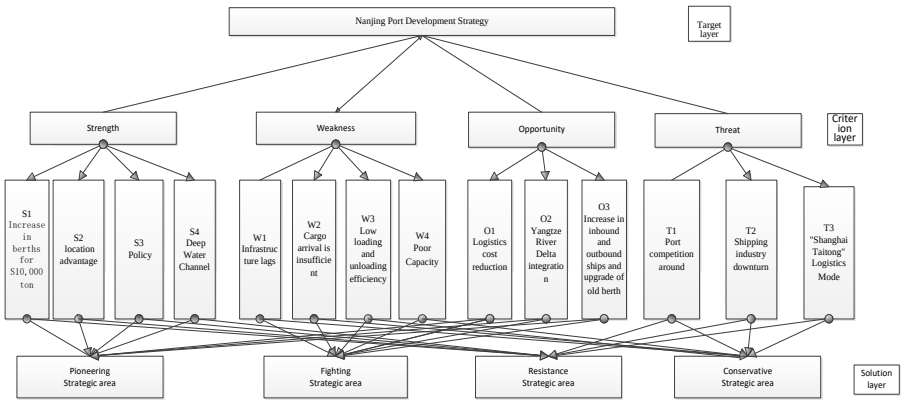

Figure. 2 Analysis of the strategic development of Nanjing Port

Based on the four factors of external opportunities, internal threats, own advantages and disadvantages of the construction of the 12.5m deep water channel to the development of Nanjing Port. Refer to relevant materials and score them after comparing them pair by pair. In the value of the "pairwise comparison" matrix aij, by referring to the numbers 1,2..5 and its reciprocal 1/2, ..., 1/5 as the measurement scale, their meanings are shown in Table 4

Table 4 Values of a_{ij}

Scale a_{ij}	Meaning
1	X_i and X_j influence the same ratio
3	X_i and X_j are slightly stronger
5	The ratio of X_i to X_j is significantly stronger
7	The ratio of X_i to Xj influence is very strong
9	The ratio of X_i to X_j influence is absolutely strong
2,4,6,8	The ratio of the influence of 2,4,6,8 X_i to X_j is between the above two adjacent levels
1/2,…,1/9	The ratio of the influence of X_i and X_j is the reciprocal number of a_{ij} above

(Source: Operations Research)

For the evaluation layer group, it mainly considers 4 aspects: internal advantages S, internal disadvantages W, external opportunities O, external threats T, and the indicator matrix B is obtained after scoring two pairs, as follows:

$$B = \begin{matrix} 1 & 5 & 2 & 4 \\ \frac{1}{5} & 1 & \frac{1}{3} & 2 \\ \frac{1}{2} & 3 & 1 & 3 \\ \frac{1}{4} & \frac{1}{2} & \frac{1}{3} & 1 \end{matrix}$$

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In the same way, the indicator matrices B1, B2, B3, and B4 can be obtained, as follows:

$$B1=\begin{matrix}1 & \frac{1}{3} & \frac{1}{2} & 4\\ 3 & 1 & 3 & \frac{1}{4}\\ 2 & \frac{1}{3} & 1 & \frac{1}{7}\\ 6 & 4 & 7 & 1\end{matrix} \quad B2=\begin{matrix}1 & 6 & 3 & 3\\ \frac{1}{6} & 1 & \frac{1}{4} & \frac{1}{3}\\ \frac{1}{3} & 4 & 1 & 2\\ \frac{1}{3} & 3 & \frac{1}{2} & 1\end{matrix} \quad B3=\begin{matrix}1 & 5 & 3\\ \frac{1}{5} & 1 & \frac{1}{2}\\ \frac{1}{3} & 2 & 1\end{matrix} \quad B3=\begin{matrix}1 & 3 & 4\\ \frac{1}{3} & 1 & 1\\ \frac{1}{4} & 1 & 1\end{matrix}$$

5.3 Calculation of AHP evaluation feature vector and consistency check based on Matlab program

Use Matlab software to calculate the eigenvectors of the AHP evaluation. The procedure is shown in Figure 3. The figure below is just the code of the indicator matrix B.

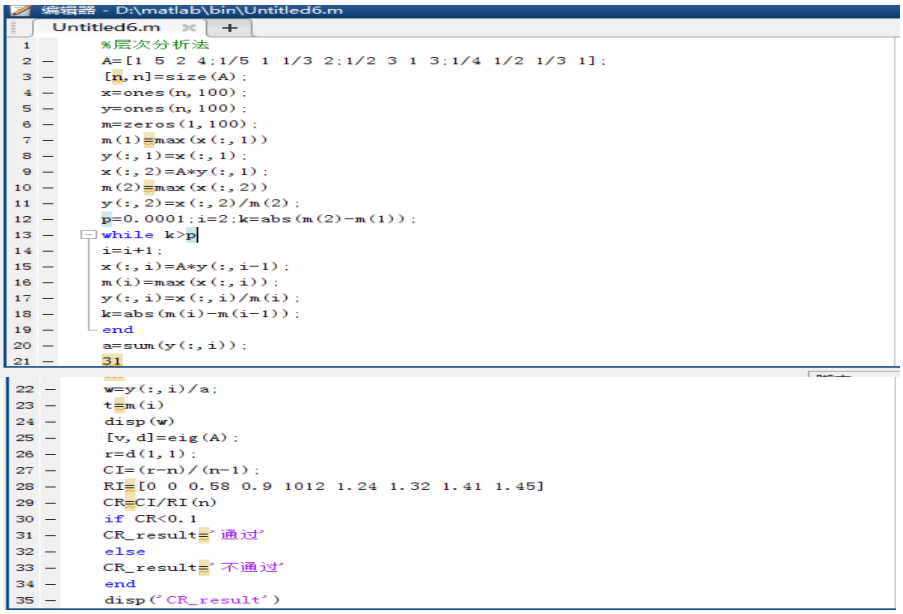

Figure. 3 Matlab program based on Figure2AHP analytic hierarchy process

Through the above code, the weight matrix of indicator matrix B can be obtained as shown in equation 1 From equation 1, Nanjing Port has obvious internal advantages (0.478), greater external opportunities (0.298), and weak internal disadvantages (0.141), The external threat is small (0.083).

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$$W = \begin{matrix} 0.478 \\ 0.141 \\ 0.298 \\ 0.083 \end{matrix} \quad (1)$$

Similarly, the B1, B2, B3, and B4 codes are adapted from the codes above. Calculating B1, B2, B3, and B4 through the indicator matrix can calculate W1, W2, W3, and W4 as follows:

$$W1 = \begin{matrix} 0.065 \\ 0.236 \\ 0.113 \\ 0.586 \end{matrix} \quad W2 = \begin{matrix} 0.483 \\ 0.065 \\ 0.272 \\ 0.180 \end{matrix} \quad W3 = \begin{matrix} 0.614 \\ 0.121 \\ 0.237 \end{matrix} \quad W4 = \begin{matrix} 0.636 \\ 0.185 \\ 0.179 \end{matrix}$$

The consistency check of the AHP evaluation index can also be obtained by running the above code, and the results are as follows: CRB = 0.0356 <0.1, CRB1 = 0.0461 <0.1, CRB2 = 0.0395 <0.1, CRB3 = 0.0032 <0.1, CRB4 = 0.0079 < 0.1. All passed the consistency test, which shows that the weights calculated above are acceptable. After the second weight consistency test, the total C.R. = 0.037 <0.1 is obtained, which shows that the total hierarchical ranking satisfies the consistency, so the calculated result is reliable.

5.4 Calculating weights within a group

The “relative importance” of all the factors required can be obtained through the calculation of the combined weights, which can be obtained from Table 5.

Table 5 Nanjing Port strategic choice portfolio weights

First-level indicators	Intra-group weights	Secondary indicators	Intra-group weights	Combined weight	Ranking
S	0.478	S110,000-ton berths increased	0.065	0.031	10
		S2 location advantage	0.236	0.113	3
		S3 Policy	0.113	0.054	6
		S4 Deep water channe	0.586	0.280	1
W	0.141	W1 Infrastructure lags	0.483	0.068	5
		W2 Cargo arrival is insufficient	0.065	0.009	14
		W3 Low loading and unloading efficiency	0.272	0.038	8
		W4 Poor Capacity	0.180	0.025	11
O	0.298	O1 Logistics cost reduction	0.641	0.191	2
		O2 Yangtze River Delta integration	0.121	0.036	9
		O3Increase in inbound and outbound ships and upgrade of old berth	0.237	0.071	4
T	0.083	T1 Port competition around	0.636	0.053	7
		T2 Shipping industry downturn	0.185	0.012	13
		T3"Shanghai Taitong" Logistics Mode	0.179	0.015	12

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By calculating the weight of the strategic combination of the development of Nanjing Port, Nanjing Port is mainly affected by the internal advantages of the 12.5m deep water channel below the Yangtze River and Nanjing. The reduction in logistics cost of goods arriving at Nanjing Port makes Nanjing Port attract ships to enter and leave the port to load and unload cargo. These factors promote Nanjing The development of ports and the competition of external ports are also the challenges they need to face in the process of development.

6. Summary

The 12.5m deep-water channel below the Yangtze River was officially put into operation, bringing unprecedented opportunities and challenges to Nanjing Port. In this paper, some data obtained through surveys are used to compare and analyze the changes of Nanjing Port before and after the opening of the deep-water channel. Through comparative analysis and the establishment of a SWOT-AHP analytic model to quantitatively analyze the development strategy of the Nanjing Port, the deep-water channel has indeed injected new vitality into the development of the Nanjing Port. Nanjing Port has entered a period of good opportunities for rapid development. Nanjing Port will therefore help the construction of the Nanjing Seaport Economic Zone, and better promote the development of itself and its related industries.

The deep-water channel has greatly benefited the Nanjing Port, but it also puts forward higher requirements for the development of the Nanjing Port and also faces greater challenges. However, through the analysis above, Nanjing Port has full potential and the ability to complete the difficulties and challenges brought by various large environments. In the future, it will develop into a first-class large port and a hub port in the upper and lower reaches of the Yangtze River.

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