Research on Ningbo Zhoushan Port Sea-Rail Intermodal Transport Enterprise Alliance under the Background of Free Trade Port

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Abstract: Developing high-quality and stable sea-rail combined transport is the best way to improve port logistics service level and expand port hinterland. And provide rich port practical experience and realistic conditions for the construction of the free trade port. Based on this background, this paper analyzes the necessity and organizational structure of the sea-rail intermodal enterprise alliance in Ningbo Zhoushan Port, And use the gray correlation to build the model, Preferred alliance partners for the alliance, Therefore, we will vigorously promote cooperation with port companies, shipping companies, freight forwarding companies, railway enterprises and other sea-rail transport enterprises.

1. Introduction

The report of the 19th National Congress of the Communist Party of China clearly stated that “exploring the establishment of a free trade port”, it is necessary to further promote the construction of the China (Zhejiang) Free Trade Pilot Zone and provide a practical basis for the future construction of a free trade port. The development of Ningbo Zhoushan Port's sea-rail intermodal transport can promote the port logistics industry, enhance the port's competition in canvassing the cargoes, the strategic position of Ningbo Zhoushan Port in the country, and enhance its ability to serve the whole country.

2. Definition of Ningbo Zhoushan Port Sea-Rail Intermodal Transport Enterprise Alliance

The alliance is an agreement between individuals and individuals in the same goal, they can share information, equipment, talents and other resources, so as to obtain greater benefits. Therefore, Ningbo Zhoushan Port Sea-Rail Intermodal Enterprise Alliance refers to the enterprises involved in the Ningbo Zhoushan sea-rail Intermodal transport, and finally realizes the integrated and intensive transportation operation partnership through various media.

Table 1 Concept of Sea-Rail Intermodal Transport Enterprise Alliance

Participating companies	Medium	Achieved goal
Port enterprises of Sea-rail Intermodal Transport Operator of Sea-rail Intermodal Transport Railway transport enterprise	1.Information technology 2.Agreement Union	1.Cost sharing 2.Resource sharing 3.Complementary advantages 4.Reduce transportation costs 5.Improve the overall efficiency of transportation 6.Expand the transportation market 7.Simplify the operation process 8.Door to door transportation strategy

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3. Necessity of the construction of Ningbo Zhoushan Port Sea-Rail Intermodal Transport Enterprise Alliance

Ningbo Zhoushan Port optimizes the integration of container sea-rail combined transport platform resources. As of the end of 2017, Ningbo Zhoushan Port has a total of 11 sea-rail intermodal trains, covering 14 provinces and 36 cities across the country. The company has completed a total of 400500TEU of sea-rail combined transport containers, forming a network of Ningbo Zhoushan Port sea-rail combined transport. The rapid development benefited from the construction of infrastructure such as ports and railway transportation networks, and on the other hand, the government's support policies. Since 2009, Ningbo has issued three support policies to accelerate the development of sea-rail combined transport, increasing the subsidies for transport companies and other operating entities, expanding the sea-rail combined transport market, and achieving staged success. However, relying on government subsidies to develop sea-rail combined transport is not a long-term solution, and should play a leading role in shipping companies, freight forwarding and other sea-rail combined transport enterprises. Currently, the scale of Ningbo Zhoushan Port sea-rail combined transport enterprises are small and their investment and decentralized operations are outstanding. It is difficult to provide customers with low-cost, professional and integrated modern logistics services. The organizational structure is still traditional, which has led to the low enthusiasm of all enterprises to participate in Ningbo Zhoushan sea-rail combined transport. Therefore, it is urgent to study the alliance of sea-rail transport enterprises and the distribution of interests of alliance enterprises, and improve the cooperative relationship among intermodal enterprises to achieve mutual benefit and win-win results.

4. Organizational Structure of Ningbo Zhoushan Port Sea-Rail Transport Enterprise Alliance

Due to the large number of Ningbo Zhoushan Port sea-rail combined transport enterprises, the Ningbo Zhoushan Port sea-rail combined transport system is divided into a dominant layer, a maneuvering layer and an auxiliary layer. The organization of Ningbo Port Sea-rail Combined Transportation System is shown in the figure 1.

Adopting this kind of network structure can make Ningbo Zhoushan Port Sea-Rail Intermodal Alliance enterprises perform their duties, complement each other, supervise each other and share resources.

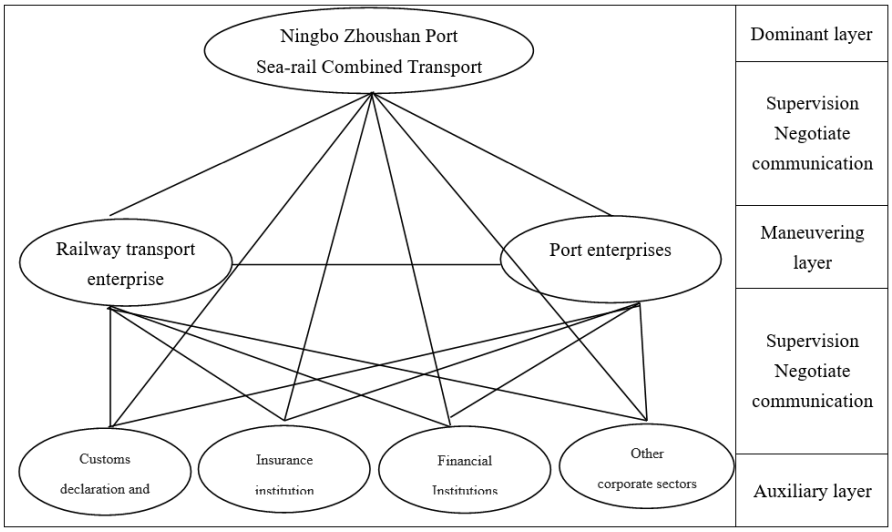

Figure 1 The Organization of Ningbo Port Sea-Rail Combined Transportation System

5. The Optimization of Ningbo Zhoushan Port Sea-Rail Intermodal Alliance Enterprise

5.1 Construction of the Evaluation Index System of Ningbo Zhoushan Port Sea-Rail Intermodal Alliance

Ningbo Zhoushan Port Sea-Rail Intermodal Alliance Enterprise provides services for cargo owners, so it is necessary to reflect the service characteristics, that is, service level and service quality are core factors. Secondly, the sea-rail intermodal alliance enterprises are a win-win strategic relationship with high degree of interdependence. They must have strategic compatibility and form a stable strategic cooperative relationship, that is, the stability of alliance relations. One of the most important reasons for the sea-rail intermodal enterprise alliance is to reduce costs, so cost is also an important factor. Furthermore, in addition to considering the strength, high quality, stability and development potential of the alliance, the financial level is also a factor that cannot be ignored. Combined with other scholars' evaluation index system for alliance enterprises, they are divided into six indicator levels and 27 specific rules as shown in the following table.

Table 2 Optimization Evaluation Index System of Ningbo Zhoushan Port Sea- Rail Transport Alliance Enterprise

Target layer	Indicator layer	Detailed layer
Optimization Evaluation Index System of Ningbo Zhoushan Port Sea- Rail Transport Alliance Enterprise	Enterprise strength A1	Sea-rail combined transport technology level A11
		Market share A12
		Advanced equipment level A13
		Sea-rail combined transport information level A14
	Quality of service B2	Damage rate B21
		On-time rate B22
		Task completion rate B23
		Customer complaints resolution time B24
		Cargo stay time B25
	Development potential C3	Employee quality C31
		Corporate Culture C32
		Management level C33
		Corporate reputation C34
		Market growth rate C35
	Alliance D4	Business philosophy D41
		Benefit and risk sharing D42
		Historical cooperation status D43
		Service price D44
	Financial level E5	Solvency E51
		Capital utilization rate E52
		Profitability E53
		Capital turnover rate E54
	Cost F6	Opportunity cost F61
		Management cost F62
		Information cost F63
		Operating cost F64

5.2 Optimization of Ningbo Zhoushan Port Sea-Rail Intermodal Alliance Enterprise

In this paper, the model is established by the preferred method of expert evaluation of gray correlation. Firstly, according to the detailed layer of the enterprise optimization index of the sea-rail combined transport alliance, the weight vector of the index layer is obtained. The experts select several criteria levels for the candidate companies, build a matrix from the score results, and perform a gray correlation analysis on the matrix. Finally, the weight vector is multiplied by the gray correlation matrix to calculate the result, and the alliance enterprise is determined.

Assume that the candidate enterprise set M={M_1, M_2, M_3, ..., M_n}, the evaluation index set V={V_1, V_2, V_3, ..., V_n}, formed A matrix A_{m*n} is preferred.

Normalize the preferred matrix according to the maximum index, and obtain the ideal optimal solution M_0 from the matrix A. M_0=[maxa_{i1},maxa_{i2},....,maxa_{in},]$_{1*n}$(i=1,2,....,n)=[a_{01},a_{02},....,a_{0n}].

The decision matrix A_{m*n} is normalized according to the ideal best solution set.

$$A'=\left|a_{ij}-a_{0n}\right|=\begin{bmatrix}\left|a_{11}-a_{01}\right| & \cdots & \left|a_{1j}-a_{0n}\right| \\ \vdots & \ddots & \vdots \\ \left|a_{i1}-a_{01}\right| & \cdots & \left|a_{ij}-a_{0n}\right|\end{bmatrix}=(a'_{ij})=\begin{bmatrix}a'_{11} & \cdots & a'_{1n} \\ \vdots & \ddots & \vdots \\ a'_{m1} & \cdots & a'_{mn}\end{bmatrix}$$

Grey correlation matrix calculation

$$\varepsilon_{ij}=\frac{\min\limits_i\min\limits_j\left|a'_{ij}-a_{0n}\right|+\rho\max\limits_i\max\limits_j\left|a'_{ij}-a_{0n}\right|}{\left|a'_{ij}-a_{0n}\right|+\rho\max\limits_i\max\limits_j\left|a'_{ij}-a_{0n}\right|}(i=1,2,\cdots,m;\ j=1,2,\cdots,n)$$

Among them, $\rho \in (0, 1)$ is the resolution coefficient, which can be determined, generally takes 0.5, and the correlation matrix can be obtained from the above formula.

$$E=\left(\varepsilon_{ij}\right)_{m*n}=\begin{bmatrix}\varepsilon_{11} & \cdots & \varepsilon_{1n} \\ \vdots & \ddots & \vdots \\ \varepsilon_{m1} & \cdots & \varepsilon_{mn}\end{bmatrix}$$

The calculation model of the preferred degree of association is:

$$\lambda=EW=(\lambda_1,\lambda_1,\cdots,\lambda_m)$$

$$\lambda_i=\sum_{j=1}^{n}\gamma_{ij}\times w_j$$

λ_i is the optimal correlation degree of the i scheme. The larger the value is, the closer it is to the ideal alliance enterprise, so the best sea-rail transportation alliance enterprise can also be selected.

Assuming that the Ningbo Zhoushan Port sea-rail combined transport operator issued a demand message, a number of sea-rail intermodal port enterprises responded to the port task of the container sea-rail combined transport. Therefore, the sea-rail combined transport operators conducted preliminary screening of these enterprises, and the screening process is as follows.

First, the needs of port enterprises are in line with some requirements of sea-rail transport cargo owners. If the owner does not have any requirements, they will directly enter the second step.

Second, examine the service performance of these port enterprises: satisfactory task completion rate; satisfactory on-time rate; lower error rate; can meet customer's emergency needs. Then we should examine the factors of external orientation of these enterprises, namely, the scope of business, the way of service and the background of each enterprise.

Thirdly, according to the above requirements, a large number of relevant port enterprises are collected. From the port enterprises of Ningbo Port, preliminary screening is carried out according to the characteristics of the industry. The list of candidates for screening results is three enterprises: port enterprise A, port enterprise B and port enterprise C.

Finally, a survey on the sea-rail combined transport situation of Ningbo port enterprises, according to the 10-point score survey, found that the Enterprise strength A1, service quality B2, development potential C3, alliance D4, financial level E5, cost F6 scores are: 6,9,7,9,5,8. The index weight W=[6,9,7,9,5,8] is obtained.

The four experts in the industry are invited by the operator to rate the three candidate companies (the quality of each service level and the development potential is 20 points, each level of firm strength, alliance, financial level and cost is 25 points) The relevant qualification reports of the four port companies were sent to the experts by e-mail. Finally, the summary of the scores of the experts was collected and averaged and two decimal places were retained. The results are shown in the following table.

Table 3 Results of The Comprehensive Evaluation of the Candidate Enterprise Alliance

Evaluation index Alternative company	Enterprise strengthA_1	service qualityB_2	Development potentialC_3	AllianceD_4	Financial levelE_5	costF_6
Enterprise A	88.23	71.01	62.39	72.56	83.56	90.21
Enterprise B	87.56	83.10	77.23	84.28	84.67	85.48
Enterprise C	75.78	61.24	82.36	86.11	87.34	78.53

The calculation flow of its correlation coefficient matrix is as follows.

Establish an initial preference matrix according to Table 2 as

$$A=\begin{bmatrix} 88.23 & 71.01 & 62.39 & 72.56 & 83.56 & 90.21 \\ 72.34 & 83.10 & 77.23 & 84.28 & 84.67 & 85.48 \\ 75.78 & 61.24 & 82.36 & 86.11 & 87.34 & 78.53 \end{bmatrix}$$

The best alliance enterprise can be derived from matrix A M0=[88.23,83.10,82.36,84.28,87.34,90.21]

Dimension and normalization of matrix A

$$A'=\begin{bmatrix} 0.00 & 12.09 & 19.97 & 13.55 & 3.78 & 0.00 \\ 15.89 & 0.00 & 5.13 & 0.98 & 0.97 & 0.95 \\ 12.45 & 21.86 & 0.00 & 0.00 & 0.00 & 11.68 \end{bmatrix}$$

The gray correlation matrix is calculated from the gray correlation

$$E=\begin{bmatrix} 1.00 & 0.47 & 0.35 & 0.45 & 0.74 & 1.00 \\ 0.41 & 1.00 & 0.68 & 0.86 & 0.80 & 0.70 \\ 0.47 & 0.33 & 1.00 & 1.00 & 1.00 & 0.48 \end{bmatrix}$$

The calculation has a preferred degree of association $\lambda = EW = (\lambda_A, \lambda_B, \lambda_C) = (28.48, 33.52, 30.67)$, from which it can be seen that B company B is the best alliance enterprise.

6. Conclusion

The Ningbo Zhoushan Port Sea-rail Combined Enterprise Alliance is based on the formation of binding documents. Therefore, this paper assumes that all enterprises participating in the alliance will complete the entire mission of Port Sea-rail Combined Transportation from the perspective of the overall interests of the alliance. This paper constructs a basic index system for selecting Ningbo Zhoushan Port sea-rail combined transport enterprise. The index system covers human, material, financial, potential, capability and charm, and uses this index system to try to optimize the alliance-building partners and conduct Case verification. Ningbo Zhoushan Port Sea-rail Combined Transport has great potential for development. The railway should strengthen the close connection between the railway and the waterway and innovate the transportation products of the railway transportation system according to the needs of the shippers and the market. Vigorously promote cooperation with port enterprises, shipping companies, freight forwarding enterprises, railway enterprises and other sea and rail transport enterprises, share the resource advantages of all parties, and jointly carry out the Ningbo Zhoushan Port sea-rail combined transport market to achieve a multi-win situation.

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