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Study on port competitiveness in sharing hinterland

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Abstract

With the continuous development of shipping logistics, the number of ports in the same area continuous growth. Some ports whose scale similar, function similar or complementary and geographic concentration constitute the port group of shared hinterland. The ports in the port group are competing with each other. In this paper, according to the characteristics of the port group of shared hinterland, get the weight of the factors of port competitiveness in sharing hinterland with FAHP.

Keywords

Port competitiveness; Sharing hinterland; Evaluation index system; FAHP model.

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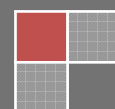
INTRODUCTION

With the importance of the port in the transportation system and regional economic system becomes noticeable, the number of ports in the same area continuous growth. Some ports whose scale similar,function similar or complementary and geographic concentration constitute the port group of shared hinterland[1]. These ports can cooperation with other port groups as a whole, mutual competition existed among them because of irrational distribution of port resources. In this paper, according to the characteristics of the port group of shared hinterland, calculate the weight of the factors of port competitiveness in port group of sharing hinterland with FAHP, let the port determine its own advantages and disadvantages, adjust their management strategy, thus promoting core port competitiveness in port group effectively.

In the present research of port competitiveness, focuses on influencing factors of competitiveness. In 1970s Mayer[2] proposed that the location is not the only influencing factors, there were many factors common influence. Haezendonck and Notteboom[3] found out that influencing factors of port competitiveness including productivity level, accessibility of hinterland,quality, goods produce results and port reputation. John• R• M• Gordon[4] proposed that resources integration including government support policies, sufficient investment capital supply, advanced information technology and port location promote port competitive advantage. In china,Xu Changxin[5] proposed that the factors of formation port competitiveness are port location, inland transport connection, the port's service items and efficiency, service prices and telecommunication systems. Sun Guangqi[6] makes a scientific evaluation with the fuzzy evaluation method to Da Lian port competitiveness from operating conditions,. quality of service, infrastructure conditions and the level of management. There are less research on the port group of shared hinterland. Zhu Yongli[7] treat an independent system, establishes a index system for overall efficiency of port group, and found out that the ways of improve overall efficiency of port group from the level of port in the port group.

MATERIALS AND METHODS

The characteristic of the port group of shared hinterland

the port group of shared hinterland is the port of group which services for same hinterland. These ports's function, size and nature of the development both check each other and complement,their geographically adjacent or close to each other. Here are the characteristic of the port group of shared hinterland.

Close geographical

Every port's hinterland has limited scope. If they want share hinterland's cargo,their geographical must be closed, land distance in a certain range,then they can share hinterland each other. In the same time,close geographical cause increase in the choice of the owner of the port the same geographic area[8]. So port's hardware and software facilities situation become the important factor of choose port in the same area.

Intense competition

The hinterland's transportation demand is regular in a certain period. Shared within the group in the port hinterland cargo port within the group would inevitably lead to competition between the port and the port. And because the increasing of the port's construction in recent year, the handling capacity of the five port group of china exceed their hinterland's transportation demand,it makes more intense competition between ports. In this situation, excellent port development and management has become an important factor affecting the competitiveness of the port.

Functional alternative

The industrial structure of the economy and mainstay industry of hinterland cause the diverse needs of the hinterland of the port cargo transportation. Sharing hinterland within the port group cause port's function overlapping,and alternative exists between the ports in the same port group.

FAHP model principle

The fuzzy analytic hierarchy process is the comprehensive evaluation method of qualitative and quantitative. It is an improvement of AHP. It can be more satisfied with the results of the evaluation for things that have numerous and fuzziness indexes.

Establishing evaluation index system

Based on the analysis of the problem, determine evaluation indexes and stratified evaluation indexes factor, the highest level for the overall objective, namely the target layer. The middle layer is a factor associated with the overall goal, namely the criterion level, the criterion level can be one or more. The bottom is relevant indicators under each criterion, namely index layer.

Establish fuzzy complementary matrix

Fuzzy complementary matrix R represents the hierarchy comparison between the relative importance of the factors related to the level of a factor for contrast.

Assumed on a level with the next level of factor A factor $B_1, B_2,..., B_n$ are linked, then the fuzzy consistent matrix can be expressed as:

$$R = \begin{bmatrix} r_{11} & \cdots & r_{1n} \\ \vdots & \ddots & \vdots \\ r_{n1} & \cdots & r_{nn} \end{bmatrix} \qquad \qquad (1)$$

Where r_{ij} represents the factors B_i and B_j when compared to A for factor B_i and factor B_j has a fuzzy relationship "... more important than..." membership. In order to make any of the two options regarding the relative importance of the criteria to obtain a quantitative description, in this paper, 0,0.5,1 to be the number of scale. as shown in TABLE 1:

TABLE 1 : The number of scale and significance of expression

Scale	Significance of Expression
$r_{ij} = 1$	Factors B_i is more important than factors B_j
$r_{ij} = 0.5$	Factors B_i as important as factors B_j
$r_{ij} = 0$	Factors B_i is more important than factors B_j

Establish the fuzzy consistent matrix

Use $r_{ij} = \frac{r_i - r_j}{2n} + 0.5$ transformed the fuzzy complementary matrix into the fuzzy consistent matrix. Then use $r_i = \sum_{k=1}^{n} r_{ik}, i = 1,2, \dots, n$ transformation the priority relation matrix into the fuzzy consistent matrix. In this case, the matrix satisfies $r_{ij} = r_{ik} - r_{jk} + 0.5$ and through transformed the fuzzy complementary matrix into the fuzzy consistent matrix, any difference between the two lines corresponds to the specified factors is constant.

calculate the highest level of each factor relative weights

Order of importance of the use of fuzzy consistent matrix to calculate the level of each factor, normalization process the index weights.

$$\overline{\omega}_i = \frac{1}{n} \sum_{j=1}^{n} X_{i,j} (i.j = 1,2, \dots, n) \qquad \qquad (2)$$

$$\overline{\omega} = (\overline{\omega_1}, \overline{\omega_2}, \dots, \overline{\omega_n})^T \qquad \qquad (3)$$

Normalization process $\overline{\omega_i}$, then $\omega_i = \frac{\overline{\omega_i}}{\sum_{i=1}^{n} \overline{\omega_i}}, \omega = (\omega_1, \omega_2, \dots, \omega_n)^T$ is each factor relative to the upper layer of the weight vector.

In the calculation of the indicators index layer to the right when the target layer's weight, from top to bottom of the layers need to be synthesized to calculate the weight. The weights of criterion layer elements B_m to target layer is b_m, The weights of index layer elements C_n to the top layer elements B_m is C_{mn}.

Analyzed according to the evaluation results of the weight

RESULTS

Evaluation index system of port competitiveness in port group of sharing hinterland

Port competitive strength is determined by a variety of factors integrated. By drawing on the results of the relevant literature[9] and the characteristic of the port group of shared hinterland, in this paper, eventually Evaluation index system of port competitiveness in port group of sharing hinterland for three layers: target layer is that port competitiveness in port group of sharing hinterland (A);then criterion layer that is port of economic status, port space superiority, port facilities and port development and management model. Specific indicators system as shown in Figure 1.
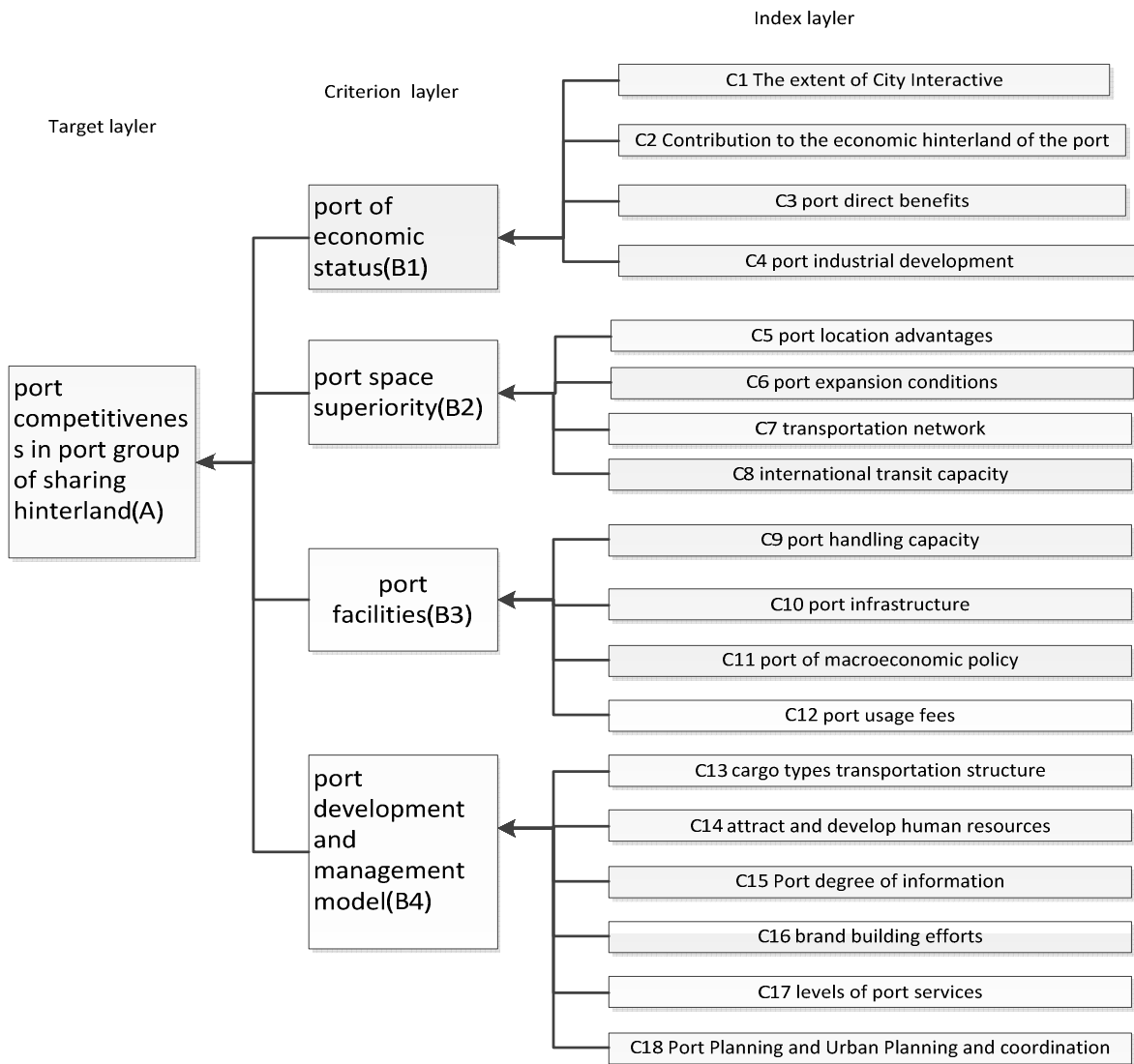
Index layler

Criterion layler

Target layler

| C1 The extent of City Interactive |
| C2 Contribution to the economic hinterland of the port |
| C3 port direct benefits |
| C4 port industrial development |

port of economic status(B1)

| C5 port location advantages |
| C6 port expansion conditions |
| C7 transportation network |
| C8 international transit capacity |

port space superiority(B2)

port competitivenes s in port group of sharing hinterland(A)

| C9 port handling capacity |
| C10 port infrastructure |
| C11 port of macroeconomic policy |
| C12 port usage fees |

port facilities(B3)

| C13 cargo types transportation structure |
| C14 attract and develop human resources |
| C15 Port degree of information |
| C16 brand building efforts |
| C17 levels of port services |
| C18 Port Planning and Urban Planning and coordination |

port development and management model(B4)

Figure 1 : Index system of port competitiveness in port group of sharing hinterland

Establish fuzzy complementary matrix

A-B fuzzy complementary matrix

$$S_{A-B} = \begin{bmatrix} 0.5 & 0 & 0 & 1 \\ 1 & 0.5 & 0 & 1 \\ 1 & 1 & 0.5 & 1 \\ 0 & 0 & 0 & 0.5 \end{bmatrix} \tag{4}$$

B1-C fuzzy complementary matrix

$$S_{B_1-C} = \begin{bmatrix} 0.5 & 1 & 1 & 1 \\ 0 & 0.5 & 1 & 1 \\ 0 & 0 & 0.5 & 1 \\ 0 & 0 & 0 & 0.5 \end{bmatrix} \tag{5}$$

B2-C fuzzy complementary matrix

$$S_{B_2-C} = \begin{bmatrix} 0.5 & 1 & 1 & 1 \\ 0 & 0.5 & 1 & 1 \\ 0 & 0 & 0.5 & 1 \\ 0 & 0 & 0 & 0.5 \end{bmatrix} \tag{6}$$

B3-C fuzzy complementary matrix

$$S_{B_3-C} = \begin{bmatrix} 0.5 & 0 & 1 & 0 \\ 1 & 0.5 & 1 & 0 \\ 0 & 0 & 0.5 & 0 \\ 1 & 1 & 1 & 0.5 \end{bmatrix} \tag{7}$$

B4-C fuzzy complementary matrix

$$S_{B_4-C} = \begin{bmatrix} 0.5 & 0 & 1 & 0 & 0 & 0 \\ 1 & 0.5 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0.5 & 0 & 0 & 0 \\ 1 & 1 & 1 & 0.5 & 1 & 1 \\ 1 & 1 & 1 & 0 & 0.5 & 1 \\ 1 & 1 & 1 & 0 & 0 & 0.5 \end{bmatrix} \tag{8}$$

Establish fuzzy consistent matrix

A-B fuzzy consistent matrix

$$S = \begin{bmatrix} 0.5 & 0.375 & 0.25 & 0.625 \\ 0.625 & 0.5 & 0.375 & 0.75 \\ 0.75 & 0.625 & 0.5 & 0.875 \\ 0.375 & 0.25 & 0.125 & 0.5 \end{bmatrix} \tag{9}$$

B1-C fuzzy consistent matrix

$$S_1 = \begin{bmatrix} 0.5 & 0.625 & 0.75 & 0.875 \\ 0.375 & 0.5 & 0.625 & 0.75 \\ 0.25 & 0.375 & 0.5 & 0.625 \\ 0.125 & 0.25 & 0.375 & 0.5 \end{bmatrix} \tag{10}$$

B2-C fuzzy consistent matrix

$$S_2 = \begin{bmatrix} 0.5 & 0.625 & 0.75 & 0.875 \\ 0.375 & 0.5 & 0.625 & 0.75 \\ 0.25 & 0.375 & 0.5 & 0.625 \\ 0.125 & 0.25 & 0.375 & 0.5 \end{bmatrix} \tag{11}$$

B3-C fuzzy consistent matrix

$$S_3 = \begin{bmatrix} 0.5 & 0.615 & 0.75 & 0.875 \\ 0.625 & 0.5 & 0.375 & 0.25 \\ 0.375 & 0.25 & 0.5 & 0.125 \\ 0.75 & 0.625 & 0.875 & 0.5 \end{bmatrix} \tag{12}$$

B4-C fuzzy consistent matrix

$$S_4 = \begin{bmatrix} 0.5 & 0.375 & 0.625 & 0.75 & 0.375 & 0.25 \\ 0.625 & 0.5 & 0.375 & 0.125 & 0.125 & 0.375 \\ 0.75 & 0.25 & 0.5 & 0.75 & 0.375 & 0.25 \\ 0.125 & 0.625 & 0.375 & 0.5 & 0.75 & 0.875 \\ 0.125 & 0.625 & 0.25 & 0.75 & 0.5 & 0.875 \\ 0.625 & 0.375 & 0.75 & 0.375 & 0.125 & 0.5 \end{bmatrix} \tag{13}$$

Calculated the relative weight of each factor on a layer

By the calculation, the criteria layer weights relative to the target layer $\omega = (0.12, 0.30, 0.52, 0.06)^T$. For each indicator   index   layer   right   weight   each   criterion

$\omega_1 = (0.47,0.30,0.15,0.07)^T$ $\omega_2 = (0.35,0.30,0.10,0.06)^T \omega_3 = (0.12,0.26,0.05,0.56)^T$ $\omega_4 = (0.06,0.10,0.03,0.38,0.26,0.17)^T$. Then top to bottom layers of the right to re-synthesis calculations. calculate the weight of the factors of port competitiveness in port group of sharing hinterland with FAHP. In this TABLE, B_1, B_2, B_3, B_4 is same meaning in Figure 1. As shown in TABLE 2:

TABLE 2 : The weight of the factors of port competitiveness in port group of sharing hinterland

	B_1(0.12)	B_2(0.30)	B_3(0.52)	B_4(0.06)	Synthetic heavy weight index layer
C_1 The extent of City Interactive	0.47				0.0564
C_2 Contribution to the economic hinterland of the port	0.30				0.0360
C_3 port direct benefits	0.15				0.0180
C_4 port industrial development	0.07				0.0084
C_5 port location advantages		0.35			0.0105
C_6 port expansion conditions		0.30			0.0900
C_7 transportation network		0.10			0.0300
C_8 international transit capacity		0.06			0.0180
C_9 port handling capacity			0.12		0.0624
C_{10} port infrastructure			0.26		0.1352
C_{11} port of macroeconomic policy			0.05		0.0260
C_{12} port usage fees			0.56		0.2912
C_{13} cargo types transportation structure				0.06	0.0036
C_{14} attract and develop human resources				0.10	0.0060
C_{15} Port degree of information				0.03	0.0018
C_{16} brand building efforts				0.38	0.0228
C_{17} levels of port services				0.26	0.0156
C_{18} Port Planning and Urban Planning and coordination				0.17	0.0102

DISCUSSION

Evaluation index system of port competitiveness in port group of sharing hinterland of FAHP, not only can evaluate the competitiveness of the port, but also evaluated for each hierarchy level of operation of criterion, such as the economic situation in the port, port space superiority, port hardware and software facilities, port development and other aspects of the business model. In addition, it can be sorted according to the level indicator system to identify heavily weighted criteria and indicators, resulting in port competitiveness in important areas of key indicators and criterion.

As a result, the port hardware and software facilities of this paper is to share the most important criterion in the hinterland of the port group port competitiveness. This shows that in the sharing hinterland of the port group, port hardware and software facilities, have the largest impact on the competitiveness of the ports, port compete with the port in the same port group, if you want to get advantage, improve their own hardware and software facilities are effective one of the measures.

From 18 specific indicators, the top three weights is port usage fees, port infrastructure and port cargo handling capacity. Analysis these three factors with the greatest weight criterion layer port facilities combined hardware and software, as can be seen,for the port in the port group of shared hinterland, the use of low port costs, improve port infrastructure and port powerful processing capabilities, can enhance the overall competitiveness of the port.

CONCLUSION

Based on the characteristic of the port group of shared hinterland, use AHP to evaluation index system of port competitiveness in port group of sharing hinterland. The results show that the port usage fees, port infrastructure and port cargo handling capacity is a key factor to improve port competitiveness in port group of sharing hinterland.

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