Analysis and Classification of Logistics Function of Bohai Sea Port Based on Fuzzy Clustering

HONGMEI JU, WEI YIN and QIQI LIU

ABSTRACT

In recent years, the national "Beijing-Tianjin-Hebei integration" strategy has brought new challenges and opportunities to the ports in the Bohai Sea region, so the port operators should sort out their own logistics service function positioning and implementation of the corresponding strategy. This paper chooses fuzzy clustering analysis method to classify Bohai Bay Port Logistics service function from the aspects of comprehensive service, basic production, auxiliary operation and derivative service of port logistics. The port of Bohai Bay should be positioned according to the characteristics of port logistics function development and reasonable development direction of Port. At the same time, the regional port group development is divided into different levels of governance mode, speeding up regional port resources integration and Port Group development overall International competitiveness promotion.

KEYWORDS
Bohai Sea, Port logistics, Service function, Fuzzy clustering.

INTRODUCTION

There are many excellent ports by the two hinterland of North China and Northeast along with Bohai Bay. Thanks to China's long-term high-speed development, many Bohai port throughput increased significantly, especially coal and iron ore and other resource-based goods, many of them grow into functional ports. However, in recent years, the global economy and China's supply side reform both internal and external factors, China's port production situation further sluggish, the port throughput continued to decline, the Bohai Sea port is the first to bear the brunt. The port not only to adjust the economic structure and positioning for their own development also need to rethink, and some port logistics functions of the rational classification and development model is not clear enough, so the Bohai Sea port logistics function of a reasonable classification, the implementation of the corresponding strategy is necessary.

Hongmei Ju, juhongmei@bwu.edu.cn, School of Information, Beijing WUZI University, Beijing, China
Wei Yin, 1533933270@qq.com, Qiqi Liu, YoloDaisy@163.com, Graduate school of Beijing WUZI University, Beijing, China
Traditionally, the basic function of the port is located in the transport, especially in the early stages of port production, the port as a cargo transshipment point and storage, the core task is to ensure that the goods quickly, safe, high quality, cheap loading or loading ashore. With the gradual improvement of the market economy system, the port has become an important intersection of economy, trade and culture in the process of interactive development between port and city. The 1999 United Nations Conference on Trade and Development provided the concept of a fourth-generation port\[1\]. The fourth generation port has not existed as an isolated point in the transportation chain, but as a component part of the global supply chain, emphasizing the fine operation of Port logistics and Agile Flexible service, the port logistics function is characterized by knowledge-intensive and technology diffusion as an important feature\[2\]. At the same time, according to the Conference on the port and its logistics functions, it can be seen that the port logistics function has diversified and stage evolution of the two characteristics\[3\].

In fact, from the development process of the world port, the port is mainly accompanied by the process of industrialization and corresponding development. In the early stage of industrialization, the industrial production was mainly distributed in the coastal port area, and the port logistics production was developed in advance to support the development of port freight. In the middle of industrialization, the basic industry of port city improved obviously, the city industrial supply chain lengthened and the port logistics developed rapidly, then the logistics production operation was the stage of vigorous development. In the later period of industrialization, the development of regional economy depends not only on the logistics operation, but also on the supporting service of the port logistics, and the corresponding auxiliary features of logistics freight forwarder and ship supply are obviously. In the post-industrialization period, the port logistics service function adapts to the globalization trend, breaks through the basic function of the ship and the freight production, the relative dependence on the port hardware production system gradually decreases. So the port logistics quantity growth is limited and trended to the port logistics knowledge, the information consultation, the technology innovation and so on the neighborhood extension\[4\].

THE BOHAI SEA PORT LOGISTICS SERVICE FUNCTION CLASSIFICATION ANALYSIS INDICATORS AND METHODS

The index system of logistics service function of Bohai Sea port

The development of Port logistics and its function is a comprehensive system, each function related association and function, and the formation of the Port Logistics integrated service function\[5\]. Although the complete index system can comprehensively evaluate the function system of port logistics, in the actual evaluation, the index selection has some complexity, which involves the concrete intension of the index and the availability of data\[6\].
Therefore, the selection of indicators should have the following characteristics: First, the indicators have a certain coverage, to reflect the port logistics functions of the three aspects. Second, to reflect the logistics service function indicators in the statistical data is not available, some important factors is difficult to quantify directly or lack of statistical data. The design index system should try to reflect the key factor indicators; these indicators which difficult to quantify uses expert research score to obtain the index data. Therefore, the index data sources are divided statistical data and expert research into two categories; the third selected indicators of meaning, statistical methods and expert research with the corresponding consistency. According to the experience of the port logistics function system, the experts of the port industry and the necessary analysis of the indicators, the port logistics service function classification of the main indicators shown in Figure 1.

**Fuzzy clustering method and procedure for logistics service function classification of Bohai Sea port**

The function system of port logistics belongs to the fuzzy system with incomplete information. Some of the index data in the index system can be obtained through the statistical data, while the remaining part of the index needs to be given by the fuzzy value of the expert\(^{[6]}\). This paper chooses the fuzzy clustering analysis method to classify the logistics service function of the Bohai Sea port. The main steps are as follows:

1. Establish the data matrix. Set the domain \(U = \{x_1, x_2, \ldots, x_n\}\) for the classified Port object, each object is represented by \(m\) indicators of its logistics service features, namely: \(x_i = \{x_{i1}, x_{i2}, \ldots, x_{im}\}\) \((i = 1, 2, \ldots, n)\). Thus, the raw data matrix of the Bohai Sea port logistics function can be classified as \(X = \{x_{ik}\}_{n \times m} \) \((i = 1, 2, \ldots, n; k = 1, 2, \ldots, m)\).

2. Standardization of data. In practical problems, different data generally have different dimensions, in order to eliminate the impact of the dimension, we need to do the appropriate transformation of the data, we need to do the appropriate transformation of the data.

   \[
   x'_{ik} = \frac{x_{ik} - \bar{x}_k}{S_k} \quad (i = 1, 2, \ldots n; k = 1, 2, \ldots m) \tag{1}
   \]

   Among them \(\bar{x}_k = \frac{1}{n} \sum_{i=1}^{n} x_{ik}\), \(S_k = \sqrt{\frac{1}{n} \sum_{i=1}^{n} (x_{ik} - x_k)^2}\).
After transformation, the mean of each variable is 0, the standard deviation is 1, and the effect of the dimension is eliminated. But this is to get the $x'_{ik}$ not necessarily in the [0,1] interval. In this case, a further differential transformation is required.

$$x''_{ik} = \frac{x'_{ik} - \min_{1 \leq s \leq n} (x'_{ik})}{\max_{1 \leq s \leq n} (x'_{ik}) - \min_{1 \leq s \leq n} (x'_{ik})} (k = 1,2, \ldots, n)$$ (2)

Calibration to establish fuzzy similarity matrix. The data elimination dimension is normalized and the data is compressed to the interval [0,1] according to the requirements of the fuzzy matrix. Set $U = \{x_1, x_2, \ldots, x_n\}, x_i = \{x_{i1}, x_{i2}, \ldots, x_{im}\}$

According to the traditional clustering method to determine the similarity coefficient, establish a fuzzy matrix $x_i$ and $x_j$ similar degree of $r_{ij} = R(x_i, x_j)$, determine the $r_{ij} = R(x_i, x_j)$ can be used in the similarity coefficient method of quantitative product method.

$$r_{ij} = \begin{cases} 1, & i = j \\ \frac{1}{M} \sum_{k=1}^{m} x_{ik} \cdot x_{jk}, i \neq j \end{cases}$$ (3)

Among them $M = \max (\sum_{k=1}^{m} x_{ik} \cdot x_{jk})$. Obviously $r_{ij} \in [0,1]$. If there is a negative value in the $r_{ij}$, you can further convert $r_{ij}$ to the [0,1] interval by using the transformation method,

$$r'_{ij} = \frac{r_{ij} + 1}{2}$$ (4)

where $r'_{ij} \in [0,1]$.

Fuzzy cluster analysis is used to classify the logistics service function of Bohai Sea port, and the specific method is the transmission closure. According to the calibrated fuzzy matrix, a fuzzy similarity matrix $R$ is not necessarily transitive; that is, $R$ is not necessarily a fuzzy equivalent matrix. In order to classify, it is also necessary to transform $R$ into a fuzzy equivalent matrix $R^*$. There is a minimum natural number $k (k \leq n)$ such that $R \in \mu_{n \times n}$ is a fuzzy similarity matrix, so that the transport closure $t(R) = R^k$ is given for all natural numbers $q$. At this time, $t(R)$ is a fuzzy equivalent matrix. The formula is as follows: $A = (a_{ik})_{m \times s}$, $B = (b_{kj})_{s \times n}$, the fuzzy matrix $A \cdot B = (c_{ij})_{m \times n}$ for the matrix $A$ and $B$ synthesis. In this case,

$$c_{ij} = \vee_{k=1}^{q} (a_{ik} \land b_{kj})$$ (5)

Starting from the fuzzy similarity matrix $R$, followed by seeking the second power, that is $R \rightarrow R^2 \rightarrow R^4 \rightarrow \cdots \rightarrow R^{2^l} \rightarrow \cdots$. When the first occurrence of $R^k \circ R^k = R^k$, $R^k$ is the required transitive closure $t(R)$. That is, after using the above quadratic method to obtain the transitive closure $t(R)$ of $R$, the resulting $t(R)$ is the required fuzzy equivalent matrix $R^*$, that is, $t(R) = R^*$. The clustering of $\lambda$ level is carried out by different thresholds. According to the $R^*$ of the fuzzy equivalence relation matrix, the corresponding clustering results can be obtained by using different thresholds for $\lambda$ level clustering.
EMPIRICAL ANALYSIS ON THE CLASSIFICATION OF LOGISTICS SERVICE FUNCTION IN BOHAI SEA PORT

Port samples and raw data

According to the "China Port Statistical Yearbook 2015", we selected 13 samples of Bohai Sea port and their data as shown in Table 1.

Service function classification and result analysis

Port logistics service function classification process

First of all, the Port Integrated Logistics services function classification. From the original data in Table 1, the original matrix can be normalized by the translation-standard deviation transformation using the formula (1) to obtain the standard initial data matrix.

\[
\begin{align*}
-0.756 & -0.488 -0.485 -0.571 -0.491 -0.971 -0.727 0.421 0.004 0.330 0.972 0.701 0.529 \\
0.826 & 0.909 0.805 2.547 0.973 1.486 1.416 1.100 1.368 1.423 0.939 1.122 1.443 \\
0.369 & 0.262 0.479 0.087 0.381 0.223 0.281 0.262 0.138 -0.064 0.116 -0.027 0.167 \\
-1.450 & -0.760 -0.986 -0.932 -1.572 -1.297 -1.067 -1.324 -0.910 -1.113 -0.856 -1.459 -0.312 \\
-1.106 & -0.674 -0.952 -0.963 -1.407 -1.294 -1.609 -1.688 -1.554 -1.223 -0.991 -1.189 -1.428 \\
-0.142 & -0.732 -0.330 -0.195 0.185 -0.078 -0.860 0.031 -0.997 -0.308 0.152 -0.120 -0.655 \\
1.293 & -0.545 0.686 0.197 0.697 0.393 0.380 0.222 0.345 -0.261 0.188 0.637 0.401 \\
1.578 & 1.764 1.942 1.388 1.352 1.467 1.520 1.329 1.636 1.711 1.514 1.290 1.091 \\
-0.659 & -0.732 -1.044 -0.760 0.346 -0.360 -0.611 -0.457 -0.500 -0.405 0.052 -0.196 -0.491 \\
-0.150 & -0.374 1.058 0.212 0.275 0.469 0.463 0.480 -0.180 0.072 0.250 0.674 0.792 \\
-1.404 & -0.696 -1.523 -1.089 -1.641 -1.288 -0.632 -0.878 -1.405 -1.122 -1.524 -1.296 -1.483 \\
0.361 & -0.308 -0.553 -0.493 -0.437 -0.291 -0.167 -1.173 -0.458 -0.597 -1.879 -1.381 -1.373 \\
1.240 & 2.374 0.906 0.573 1.338 1.480 1.582 1.575 1.612 1.758 1.036 1.244 1.320 \\
\end{align*}
\]

<table>
<thead>
<tr>
<th>Port</th>
<th>C1</th>
<th>C2</th>
<th>C3</th>
<th>C4</th>
<th>C5</th>
<th>C6</th>
<th>C7</th>
<th>C8</th>
<th>C9</th>
<th>C10</th>
<th>C11</th>
<th>C12</th>
<th>C13</th>
</tr>
</thead>
<tbody>
<tr>
<td>DanDong</td>
<td>15040.00</td>
<td>182.90</td>
<td>14372.00</td>
<td>48.00</td>
<td>7.88</td>
<td>6.77</td>
<td>7.45</td>
<td>8.47</td>
<td>8.21</td>
<td>7.73</td>
<td>9.31</td>
<td>8.65</td>
<td>8.54</td>
</tr>
<tr>
<td>DaLian</td>
<td>41482.00</td>
<td>944.90</td>
<td>27318.00</td>
<td>247.00</td>
<td>9.54</td>
<td>9.98</td>
<td>9.77</td>
<td>9.30</td>
<td>9.67</td>
<td>9.01</td>
<td>9.28</td>
<td>9.12</td>
<td>9.32</td>
</tr>
<tr>
<td>YingKou</td>
<td>33849.00</td>
<td>592.20</td>
<td>24051.00</td>
<td>90.00</td>
<td>8.87</td>
<td>8.33</td>
<td>8.54</td>
<td>8.27</td>
<td>8.35</td>
<td>7.27</td>
<td>8.49</td>
<td>7.84</td>
<td>8.23</td>
</tr>
<tr>
<td>PanJin</td>
<td>3443.00</td>
<td>35.000</td>
<td>9521.00</td>
<td>25.00</td>
<td>6.65</td>
<td>6.35</td>
<td>7.08</td>
<td>6.33</td>
<td>7.23</td>
<td>6.04</td>
<td>7.56</td>
<td>7.65</td>
<td>7.92</td>
</tr>
<tr>
<td>JinZhou</td>
<td>9192.00</td>
<td>81.900</td>
<td>9678.00</td>
<td>23.00</td>
<td>6.84</td>
<td>6.35</td>
<td>6.50</td>
<td>5.89</td>
<td>6.54</td>
<td>5.91</td>
<td>7.43</td>
<td>6.65</td>
<td>6.87</td>
</tr>
<tr>
<td>Qinhuangdao</td>
<td>25309.00</td>
<td>50.100</td>
<td>15928.00</td>
<td>72.00</td>
<td>8.65</td>
<td>7.94</td>
<td>7.34</td>
<td>7.99</td>
<td>8.10</td>
<td>6.75</td>
<td>8.52</td>
<td>7.73</td>
<td>7.53</td>
</tr>
<tr>
<td>TangShan</td>
<td>49285.00</td>
<td>152.00</td>
<td>26121.00</td>
<td>97.00</td>
<td>9.23</td>
<td>8.55</td>
<td>8.65</td>
<td>8.45</td>
<td>8.87</td>
<td>7.04</td>
<td>8.56</td>
<td>8.58</td>
<td>8.43</td>
</tr>
<tr>
<td>TianJin</td>
<td>54051.00</td>
<td>1411.00</td>
<td>38729.00</td>
<td>173.00</td>
<td>9.97</td>
<td>9.95</td>
<td>9.88</td>
<td>9.58</td>
<td>9.95</td>
<td>9.35</td>
<td>9.86</td>
<td>9.31</td>
<td>9.02</td>
</tr>
<tr>
<td>HuangHua</td>
<td>16657.00</td>
<td>50.200</td>
<td>8761.00</td>
<td>36.00</td>
<td>8.83</td>
<td>7.57</td>
<td>7.57</td>
<td>7.39</td>
<td>7.67</td>
<td>6.87</td>
<td>8.43</td>
<td>7.65</td>
<td>7.67</td>
</tr>
<tr>
<td>YanTai</td>
<td>25163.00</td>
<td>245.000</td>
<td>29857.00</td>
<td>98.00</td>
<td>8.75</td>
<td>8.65</td>
<td>8.74</td>
<td>8.54</td>
<td>8.01</td>
<td>7.43</td>
<td>8.62</td>
<td>8.62</td>
<td>8.76</td>
</tr>
<tr>
<td>WeiHai</td>
<td>4213.00</td>
<td>69.600</td>
<td>3944.00</td>
<td>15.00</td>
<td>6.57</td>
<td>6.44</td>
<td>7.55</td>
<td>6.88</td>
<td>6.70</td>
<td>6.03</td>
<td>6.92</td>
<td>6.42</td>
<td>6.83</td>
</tr>
<tr>
<td>Rizhao</td>
<td>33707.30</td>
<td>281.00</td>
<td>13683.00</td>
<td>53.00</td>
<td>7.94</td>
<td>7.66</td>
<td>8.05</td>
<td>6.52</td>
<td>7.71</td>
<td>6.64</td>
<td>6.58</td>
<td>6.33</td>
<td>6.92</td>
</tr>
<tr>
<td>QingDao</td>
<td>48400.00</td>
<td>1744.00</td>
<td>28335.00</td>
<td>121.00</td>
<td>9.96</td>
<td>9.97</td>
<td>9.95</td>
<td>9.88</td>
<td>9.93</td>
<td>9.40</td>
<td>9.37</td>
<td>9.25</td>
<td>9.21</td>
</tr>
</tbody>
</table>

Note: C1 to C4 dimension units are: Million tons, million TEU, kilometers, one.

TABLE 1. BOHAI PORT SAMPLES AND THEIR DATA.
And then through the formula (2) translation of the difference transformation to obtain a standardized matrix.

\[
\begin{bmatrix}
0.229 & 0.300 & 0.142 & 0.394 & 0.117 & 0.276 & 0.646 & 0.489 & 0.521 & 0.832 & 0.786 & 0.680 \\
0.752 & 0.532 & 0.672 & 1.000 & 0.873 & 1.000 & 0.948 & 0.855 & 0.916 & 0.888 & 0.823 & 0.939 \\
0.601 & 0.326 & 0.578 & 0.323 & 0.676 & 0.546 & 0.592 & 0.598 & 0.530 & 0.389 & 0.582 & 0.521 \\
0.000 & 0.000 & 0.155 & 0.043 & 0.023 & 0.000 & 0.170 & 0.112 & 0.202 & 0.037 & 0.299 & 0.000 \\
0.114 & 0.027 & 0.165 & 0.034 & 0.078 & 0.001 & 0.000 & 0.000 & 0.000 & 0.259 & 0.098 & 0.019 \\
0.432 & 0.009 & 0.345 & 0.246 & 0.610 & 0.438 & 0.244 & 0.527 & 0.457 & 0.240 & 0.593 & 0.487 \\
0.906 & 0.068 & 0.638 & 0.353 & 0.781 & 0.607 & 0.623 & 0.616 & 0.595 & 0.323 & 0.603 & 0.762 \\
1.000 & 0.805 & 1.000 & 0.681 & 1.000 & 0.993 & 0.981 & 0.925 & 1.000 & 0.984 & 1.000 & 1.000 \\
0.261 & 0.009 & 0.138 & 0.091 & 0.664 & 0.337 & 0.313 & 0.377 & 0.331 & 0.274 & 0.564 & 0.459 \\
0.429 & 0.123 & 0.745 & 0.358 & 0.640 & 0.635 & 0.649 & 0.644 & 0.643 & 0.434 & 0.622 & 0.776 \\
0.015 & 0.020 & 0.000 & 0.000 & 0.000 & 0.025 & 0.306 & 0.248 & 0.047 & 0.034 & 0.104 & 0.059 \\
0.598 & 0.144 & 0.280 & 0.164 & 0.402 & 0.362 & 0.452 & 0.158 & 0.344 & 0.210 & 0.000 & 0.028 \\
0.888 & 1.000 & 0.701 & 0.457 & 0.996 & 0.998 & 1.000 & 1.000 & 0.993 & 1.000 & 0.851 & 0.983 \\
0.460 & 0.767 & 0.129 & 0.160 & 0.106 & 0.406 & 0.185 & 0.965 & 0.359 & 0.159 & 0.128 & 0.299 \\
0.460 & 0.767 & 0.129 & 0.160 & 0.106 & 0.406 & 0.185 & 0.965 & 0.359 & 0.159 & 0.128 & 0.299 \\
0.460 & 0.767 & 0.129 & 0.160 & 0.106 & 0.406 & 0.185 & 0.965 & 0.359 & 0.159 & 0.128 & 0.299 \\
0.460 & 0.767 & 0.129 & 0.160 & 0.106 & 0.406 & 0.185 & 0.965 & 0.359 & 0.159 & 0.128 & 0.299 \\
\end{bmatrix}
\]

The fuzzy similarity matrix \( R \) of the above normalized matrices is solved by using the similarity matrix number product (3) and (4).

When \( \lambda = 0.8522 \), classified as \{Dalian, Tianjin, Qingdao\}, \{Dandong\}, \{Shandong\}.

When \( \lambda = 0.9649 \), classified as \{Tianjin, Qiqingdao\}, \{Dalian\}, \{Yingkou\}, \{Panjin\}, \{Jinzhou\}, \{Qinhuangdao\}, \{Tangshan\}, \{Huanghua\}, \{Yantai\}, \{Weihai\}, \{Rizhao\}.

In the fuzzy equivalent matrix \( t ( R ) \), we obtain different intercepts of \( \lambda \) (0≤\( \lambda \)≤1).

From small to large followed by 0. 4475, 0. 4599, 0. 4762, 0. 4776, 0. 4820, 0. 4888, 0. 4918, 0. 6900, 0. 8522, 0. 9649, 1. 000 and other 13 values. The integrated service function of the Bohai Sea port based on the Intercept array from different \( \lambda \) is listed.

When the \( \lambda = 1.000 \), classified as \{Tianjin\}, \{Qingdao\}, \{Dalian\}, \{Yingkou\}, \{Panjin\}, \{Jinzhou\}, \{Qinhuangdao\}, \{Tangshan\}, \{Huanghua\}, \{Yantai\}, \{Weihai\}, \{Rizhao\}.

When the \( \lambda = 0.9649 \), classified as \{Tianjin, Qingdao\}, \{Dalian\}, \{Yingkou\}, \{Panjin\}, \{Jinzhou\}, \{Qinhuangdao\}, \{Tangshan\}, \{Huanghua\}, \{Yantai\}, \{Weihai\}, \{Rizhao\}.

When the \( \lambda = 0.8522 \), classified as \{Dalian, Tianjin, Qingdao\}, \{Dandong\}, \{Yingkou\}, \{Panjin\}, \{Jinzhou\}, \{Qinhuangdao\}, \{Tangshan\}, \{Huanghua\}, \{Yantai\}, \{Weihai\}, \{Rizhao\}.
When the $\lambda = 0.6900$, classified as \{Dalian, Tianjin, Qingdao\}, \{Jinzhou, Weihai\}, \{Dandong\}, \{Yingkou\}, \{Panjin\}, \{Qinhuangdao\}, \{Tangshan\}, \{Huanghua\}, \{Yantai\}, \{RiZhao\}.

When the $\lambda = 0.4918$, classified as \{Dalian, Tianjin, Qingdao\}, \{Panjin, Jinzhou, Weihai\}, \{Qinhuangdao, Tangshan\}, \{Dandong\}, \{Yingkou\}, \{Huanghua\}, \{Yantai\}, \{RiZhao\}.

When the $\lambda = 0.4888$, classified as \{Dalian, Tianjin, Qingdao\}, \{Yingkou, Qinhuangdao, Tangshan\}, \{Panjin, Jinzhou, Weihai\}, \{Huanghua\}, \{Yantai\}, \{RiZhao\}.

When the $\lambda = 0.4820$, the classification is, \{Dandong, Yingkou, Qinhuangdao, Tangshan\}, \{Dalian, Tianjin, Qingdao\}, \{Panjin, Jinzhou, Weihai\}, \{Huanghua\}, \{Yantai\}, \{RiZhao\}.

When the $\lambda = 0.4819$, classified as \{Dandong, Yingkou, Qinhuangdao, Tangshan, Yantai\}, \{Dalian, Tianjin, Qingdao\}, \{Panjin, Jinzhou, Weihai\}, \{Huanghua\}, \{RiZhao\}.

When the $\lambda = 0.4776$, classified as \{Dandan, Yingkou, Qinhuangdao, Tangshan, Yantai, RiZhao\}, \{Dalian, Tianjin, Qingdao\}, \{Panjin, Jinzhou, Weihai\}, \{Huanghua\}.

When the $\lambda = 0.4762$, classified as \{Dandan, Yingkou, Qinhuangdao, Tangshan, Huanghua, Yantai, RiZhao\}, \{Dalian, Tianjin, Qingdao\}, \{Panjin, Jinzhou, Weihai\}, \{Huanghua\}.

When the $\lambda = 0.4599$, classified as \{Dandong, Dalian, Yingkou, Qinhuangdao, Tangshan, Huanghua, Tianjin, Yantai, Weihai\}.

When the $\lambda = 0.4475$, classified as \{Dandong, Dalian, Yingkou, Qinhuangdao, Tangshan, Huanghua, Tianjin, Yantai, Rizhao, Qingdao\}, \{Panjin, Jinzhou, Weihai\}, \{Huanghua\}.

In the same way, we can take the above steps to 13 port samples of Bohai Bay Port Logistics Basic production Service function (index C1 to C6), the Port Logistics Auxiliary Service function (index C7 to C10), the Port Logistics Derivative Support Service function (index C11 to C13) and other single functions to classify. The results of the classification of logistics services in Bohai Bay are shown in Table 2.

<table>
<thead>
<tr>
<th>service function</th>
<th>Types of Port classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integrated service function</td>
<td>I Dalian, Tianjin, Qingdao</td>
</tr>
<tr>
<td></td>
<td>II Dandong, Yingkou, Qinhuangdao, Tangshan, Yantai, Rizhao</td>
</tr>
<tr>
<td></td>
<td>III Panjin, Jinzhou, Weihai</td>
</tr>
<tr>
<td></td>
<td>IV Huang Hua</td>
</tr>
<tr>
<td>Basic production function</td>
<td>I Dalian, Tianjin, Qingdao</td>
</tr>
<tr>
<td></td>
<td>II Dandong, Yingkou, Qinhuangdao, Tangshan, Huanghua, Yantai, sunshine</td>
</tr>
<tr>
<td></td>
<td>III Panjin, Jinzhou, Weihai</td>
</tr>
<tr>
<td>Auxiliary job function</td>
<td>I Dandong, Dalian, Yingkou, Panjin, Jinzhou, Qinhuangdao, Tianjin, Yantai, Weihai, Qingdao</td>
</tr>
<tr>
<td></td>
<td>II TangShang</td>
</tr>
<tr>
<td></td>
<td>III HuangHua</td>
</tr>
<tr>
<td></td>
<td>IV Rizhao</td>
</tr>
<tr>
<td>Derivative service function</td>
<td>I Dalian, Tianjin, Qingdao</td>
</tr>
<tr>
<td></td>
<td>II Dandong, Yingkou, Panjin, Jinzhou, Qinhuangdao, Tangshan, Huanghua, Weihai, Rizhao</td>
</tr>
<tr>
<td></td>
<td>III YanTai</td>
</tr>
</tbody>
</table>

TABLE 2. BOHAI BAY LOGISTICS BUSINESS CLASSIFICATION RESULTS.
Analysis and Countermeasure of Port Logistics Service Function Classification

Result

As can be seen from Table 2, different port logistics functions form different ports types. In the integrated service function of port logistics, the Bohai Sea port comes down to four categories, including Dalian Port, Tianjin Port, Qingdao Port which are hub in Northeast Asia, Naturally have a comparative advantage of the logistics integrated services; Huanghua Port has some advantages in logistics basic production service and auxiliary operation service, but the development of derivative services is relatively insufficient. In the Port Logistics Basic Production service function aspects, Dalian Port, Tianjin Port, Qingdao port which have relatively large throughput belongs to the first category, its basic production services function in the region as the forefront, while the other ports are mainly in the second and third categories. In aspects of Port logistics auxiliary operation function, the development gap of the Bohai Bay port is not obvious, but Tangshan Port, Huanghua Port, Rizhao for their own reasons belong to a category; other ports are classified as the first category. In the derivative support service function is divided into three categories, and Dalian, Tianjin, Qingdao also classified as the first category, and Yantai because of excellent location advantage classified as the third category, the other ports are divided into a class, in fact, the inner harbor city logistics Derivative Support Service development gap is not big.

According to the Bohai Bay port logistics service function classification, the following countermeasures should be taken in the future: (1) According to the characteristics of port logistics development, the reasonable development direction of port should be positioned. For example, Dalian Port, Tianjin Port, Qingdao port by virtue of its vast hinterland and long-term accumulation, logistics production operations have an absolute advantage, ancillary service industry has a considerable competitive strength, the future focus on improving the derivative service function, and Huanghua port has demonstrated a good foundation production capacity and auxiliary operation capacity. (2) The development of regional port group should combine the development with the government's reasonable guidance. From the classification can be seen in the Bohai Bay, Dalian Port, Tianjin Port, Qingdao Port, they are in the functional classification of the forefront, the government should actively guide the common and port operators to create their own international competitiveness of the port. The Qinhuangdao, Tangshan, Huanghuadue to energy-based positioning which goods concentrated in the coal, steel and other bulk cargo, so they have pore basic production capacity and auxiliary operations, the company should seize their own positioning to take effective transformation. And Yingkou, Yantai, Dandong, Panjin, Weihai and other cities due to the location advantages, although their basic production capacity is relatively poor, but have their own characteristic in auxiliary operations and derivative support services, so the ports should be combined with the local economic development plan and promote port city linkage in future. (3) Accelerate the integration of regional port resources and the improvement of international competitiveness of Port Group development as a whole. Because the Bohai Bay port have closely interrelated, the port logistics service function has the homogeneous competition and the structure similarity phenomenon, therefore we should accelerate the regional port resources conformity development according to the different level of the port logistics function, to establish the overall international competitive power idea.
SUMMARY

Port logistics service function model is the key factor of port development orientation and transformation and upgrading, it is very important to construct port logistics service function classification system and carry on empirical research. The classification of Port logistics service function is a fuzzy system with incomplete information, which can be classified and evaluated by using fuzzy clustering method. Based on the statistic survey data of 13 main ports in Bohai Rim of China, this paper uses the method of fuzzy clustering to determine the main indexes and analysis data of Port Logistics service function classification by means of the combination of statistic data and expert investigation, and then combine the quantitative and qualitative methods to get more objective results. The research shows that the method of fuzzy clustering is effective to study the classification of port logistics service function. Through the comparison and analysis of the classification results of this study, the characteristics and rational development direction of the logistics function development of Bohai Bay Port, the government's layered governance model of the development of the Bohai Sea Port group, and the determination of the regional port resource integration and the overall international competitiveness of Port Group development are of great reference significance.

ACKNOWLEDGEMENTS
This research was financially supported by The Funding Project of Beijing high level innovation and entrepreneurship program teaching teacher.
Corresponding author: Wei Yin. Graduate school of Beijing WUZI University, Beijing, China. 1533933270@qq.com

REFERENCES
4. Chen Jihong, Xu Xiangming, Meng Jian, etc. Coastal city port logistics comprehensive service capacity evaluation system and application, J. Shanghai Management Science, 2014, 36 (1), 24-30