The Evaluation of Logistics Performance of Harbor-Front Station Based on DEA

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Abstract. The evaluation of logistics performance of harbor-front station is conducive to the realization of efficient and coordinated logistics operations at harbor-front station, thereby achieving seamless connection between railways and ports, accelerating the turnover of sea-rail combined transport containers, thereby improving the logistics efficiency of sea-rail combined transport. This paper points out the role and responsibility of harbor-front station in sea-rail combined transportation. It uses C2R model of data envelopment (DEA) analysis method, in consideration of input and output indexes determined on the basis of the logistics evaluation index, then establishes horizontal logistics performance evaluation system to carry out the logistics performance evaluation. According to the results, this paper puts forward specific and constructive measures for the logistics operation and management of the harbor-front station.

1. Introduction
In 2013, China officially proposed the “One Belt and One Road” plan. The rapid development of global trade has led to a significant increase in the logistics demand for sea-rail combined transport. The efficient, fast and convenient seamless connection between sea and land has become the key to the sea-rail combined transport logistics system. Harbor-front Station is an important node in this logistics chain. Its efficient and coordinated logistics operation is conducive to the seamless connection between railway and port, thus improving the logistics efficiency of sea-rail combined transport and improving logistics service satisfaction. Therefore, the research and optimization of the logistics operation performance of Harbor-front Station has important significance in both theory and reality.

2. Literature Review
DEA is widely used in the business performance evaluation of enterprises and organizations in the field of logistics, port and aviation. Researchers can use DEA to conduct horizontal performance evaluation of the same type of enterprise organization, or to longitudinally view individual organizations or units. Longitudinal performance evaluation of multiple time units. Cai Jianbin [4] and others analyzed the development status of Yingkou Port logistics and based on the relevant impacts, based on the data...
collected and screened by Yingkou Port, conducted a reasonable theoretical study, using the data envelop model DEA to analyze the data, proposed for Yingkou Port. Policy recommendations; Li Jun, Lei Dingzhen [5] used the C2R model in the data envelopment analysis method to evaluate the horizontal operational performance of the railway freight yard, and selected the input funds, the freight yard area and the annual freight volume as input indicators, and selected the year. The income and annual freight volume are used as output indicators, and the relative efficiency of five railway freight yards is solved by DEA model, which verifies the validity of the model. This paper will select 17 Harbor-front stations and conduct a horizontal evaluation of logistics operation performance for individual site stations to evaluate the competitiveness level of the former station.

3. Analysis of Logistics Performance Evaluation of Harbor-front Station

The logistics performance evaluation system can be divided into the traditional logistics performance evaluation system and the input-output logistics performance evaluation system. The most prominent feature of the input-output performance evaluation system is to divide the performance evaluation into input indicators and output indicators. Therefore, it can fully consider the logistics resources and the cost and benefit of the logistics and production and operation of the enterprise or organization. The input indicator is the cost and resources invested by the harbor-front station in order to maintain the logistics business. The output indicator refers to the results obtained by the harbor-front station through the logistics operation, the profits obtained, and the value obtained.

4. Construction of Logistics Performance Evaluation System of Harbor-front Station

At present, data envelopment analysis is the most widely used model for scholars in the field of port logistics performance evaluation. The method takes the unit or department of the object to be evaluated as the decision unit DMU, and the unit or department to be evaluated constitutes the evaluation overall, and the decision unit is the same type of enterprise or organization, each enterprise selected as the decision unit or The organization should have the same input indicators and the same output indicators. After determining the decision-making unit and evaluation indicators, the DEA mathematical model is used to calculate the relative efficiency of each decision-making unit, and a comprehensive analysis of the input-output ratio is performed to determine whether the decision-making unit (DMU) is effective, and each evaluation of the decision-making unit based on the results. The indicators provide constructive comments.

The C2R model is the most widely used model in data envelopment analysis: if the efficiency index of the $j_0$ is targeted and the efficiency index $h_j \leq 1$ of all DMUs is used as constraints, the following C2R model is constructed:

$$
\max h_{j_0} = \frac{\sum_{r=1}^{s} u_r Y_{r/j_0}}{\sum_{i=1}^{n} v_i X_{i/j_0}}
$$

s.t. $h_j \leq 1$

$$
t = \frac{1}{\sum_{i=1}^{n} v_i X_{i/j_0}} = tv, \mu = tu,$$

(P) $\max h_{j_0} = \mu^T Y_0$

$$
\text{s.t.}\begin{align*}
& w^T X_j - \mu^T Y_j \geq 0, \\
& w^T X_0 = 1 \\
& w \geq 0, \mu \geq 0, j = 1, 2, ..., n
\end{align*}
$$

If $w_0 > 0, \mu T > 0$, and the target value $\mu TY_0 = h_{j0} = 1$ in the optimal solution of the linear programming (P), the decision unit $j_0$ is said to be DEA valid.
Taking the logistics performance of sea-rail combined transportation harbor-front station as the evaluation object, the purpose of the evaluation is to determine the relative effectiveness of the logistics business of Harbor-front Station. When using the horizontal evaluation method of data envelopment analysis, the input indicators that should be considered in general include: equipment, funds, number of operators, logistics operation area, stacking yard area, etc. Output indicators include: freight volume, sea-rail combined transport efficiency, service quality, annual income, logistics service satisfaction, etc., the decision-making unit selects different front-end stations with similar business operations. [1] [2]

5. Example Analysis - Horizontal Evaluation Based on DEA

Now adopting the model of data envelopment analysis, the operating performance of 17 Harbor-front stations is selected as the decision-making unit, and the performance evaluation of its logistics operation is carried out. 17 logistics facilities of the port station, logistics operators, logistics operation area and port the annual logistics operation cost of the station is determined as the input index. The sea-rail combined operation box and annual revenue of Harbor-front Station are determined as output indicators (as shown in Table 1, the indicators of the former stations of Hong Kong), and the data envelopment analysis software is used for calculation. Using DEA-Solver to solve the data table into DEA-Solver, select the CCR-I model to solve, get the $\lambda$ value of 17 DMU.

| No. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|-----|---|---|---|---|---|---|---|---|
| DMU | A | B | C | D | E | F | G | H |
| Score | 0.732491 | 0.84277 | 0.60573 | 0.541134 | 0.696903 | 0.955334 | 1 |
| Rank | 9 | 7 | 1 | 15 | 16 | 12 | 5 | 1 |

DEA-Solver was used to solve the problem. Import the data into DEA-Solver using CCR-I model The $\lambda$ of 17 DMUs are obtained as shown in table 2.

| No. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|-----|---|---|---|---|---|---|---|---|
| DMU | A | B | C | D | E | F | G | H |
| Score | 0.912574 | 0.663439 | 0.74946 | 0.478246 | 1 | 0.649473 | 0.7279 | 0.680784 |
| Rank | 6 | 1 | 13 | 8 | 17 | 1 | 14 | 10 | 11 |
According to the second line of the table, the relative logistics operation performance values of C, H, J and N stations are 1. According to the above DEA principle, the logistics operations of these four ports are relatively effective, and the remaining 13 ports are the relative operating performance values of the stations are all less than 1, so the logistics operations of the remaining port stations are relatively inefficient. Station B ranks 7th in the performance of 17 ports among all stations. The data is further analyzed to obtain the redundancy and deficiencies of each decision unit (DMU) in terms of each evaluation index, as shown in the table:

| No. | DMU I/O                  | Score Data | Difference | %    |
|-----|--------------------------|------------|------------|------|
| 2   | B                        | 0.84277    |            |      |
|     | Equipment investment/million | 468        | -83.984    | -17.95%|
|     | Number of operators      | 370        | -112.247   | -30.34%|
|     | Logistics operation area /hm2 | 38.9       | -7.7862   | -20.02%|
|     | Freight volume /TEU      | 10942      | 255.3468   | 2.33% |
|     | Annual income /million   | 770        | 0          | 0.00% |

Taking station B as an example for separate analysis, the logistics equipment of the former station of the port was excessively invested, exceeding 17.9%, and the logistics operators exceeded 112 (about 30%), despite its own sea-rail combined operation box. High, exceeding 255.3468TEU, its final operating performance has not yet reached 1, due to excessive redundancy in its input indicators. For its future development and progress, Station B should reasonably arrange the number of employees, reduce operating costs and input costs, and rationally arrange and plan the workload, and maximize the use of its own resources. We can take the following measures:

i. Improve the management of on-the-job logistics operators. From the specific analysis in the example, we have found that the majority of the number of employees standing in front of the port are too many, and there are also insufficient staff in the front station. Therefore, we must do a good job in staffing, adjust the staff structure, and improve the quality of the operator through training.

ii. By reducing the logistics investment capital and operating costs of harbor-front station of the sea-rail combined transportation, we can use the data envelopment analysis to obtain the effectiveness coefficient of some ports to achieve the target in the case of excessive redundancy of logistics equipment investment and operating costs, so it can be appropriate Reduce unnecessary investment funds to improve the overall performance of the station.

6. Conclusion
The harbor-front station of sea-rail combined transportation is the key node of sea-rail combined transport and the key to improving the efficiency of sea-rail combined transport. Through data envelopment analysis for performance evaluation research, the logistics operation performance of Harbor-front Station is affected by many aspects such as logistics equipment investment funds, logistics operators, logistics operation area, and sea-rail combined operation box volume. Based on the horizontal performance evaluation results, Harbor-front Station analyzes the redundancy and deficiency of the evaluation indicators that affect the current business performance, such as equipment, funds, number of employees, yard area, operating costs, etc., so as to formulate specific improvement measures to improve their own shortcomings and seek better development.

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