Check for updates

Analysis of Port Enterprise Management Construction Considering Cargo Owner Satisfaction

Jie Wang, Wenxi Wang(✉), and Dongxue Sui

Dalian Maritime University, Dalian, China
18340854420@163.com

Abstract. Based on port service data, this study examines the impact of port services on cargo owners' satisfaction. The structural equation model is used to measure the level of port-related services, revealing the impact of different types of port services on cargo owners' satisfaction. Based on the research results, the factors considered by cargo owners in port selection are explored, and ideas and opinions are provided for port construction, that is, future competitive development, and decision-making support for the port's own competition and operation.

Keywords: Port services · Port selection · Port quality of service management · Port informatization · Structural equations · AIS

1 Introduction

As the functions of ports become more perfect, cargo owners have more choices, Therefore, the port side should always pay attention to the needs of cargo owners, so as to ensure efficient docking and maintain good service that results in cooperation.

Most studies on port selection have analyzed the port selection behavior of cargo owners from multiple angles. Wanke [1] (2017) believes that cargo owners will give priority to distance factors in port selection and uses fuzzy reasoning combined with social network analysis to analyze port selection by cargo owners and shipping companies. Hu [2] (2021) established a unified performance evaluation index system for the three collection and distribution modes of container ports so as to evaluate the competitiveness of ports, starting from the four aspects of transportation capacity, collection and distribution cost, service quality, and sustainability. In order to portray the shipper's joint selection behavior of port, mode of transportation, and dry port, Jiang [3] (2018) took port cost, waiting time, liner frequency, cargo value, single volume, transportation cost, transportation and customs clearance time, shift rate, and dry port service as utility variables and constructed a nested Logit model in which port selection is located in the upper layer and transportation mode and dry port selection are located in the lower layer. Chen [4] (2021) found that, on the basis of a comprehensive consideration of the operating environment and route network inside and outside China's coastal ports, we used two methods, entropy-weighted TOPSIS analysis and complex network analysis,

N. Akhtar et al. (Eds.): PMIS 2023, AHIS 8, pp. 806–813, 2023.
https://doi.org/10.2991/978-94-6463-200-2_83

to reflect the competitiveness of each port more comprehensively. Liu [5] (2021) constructed the Bohai Rim cruise port competitiveness evaluation index system from six aspects, including economic conditions, transportation conditions, tourism conditions, port conditions, service level, and development potential. Kim [6] (2022) stated that port competitiveness could be improved by consolidating terminals, reducing vessel wait times, and balancing port terminal utilization. Cabral [7] (2014) uses cluster analysis to evaluate the competitiveness of Brazilian ports. Lu [8] (2020) organically combine mutation theory and game theory to analyze and predict the strategic choices of Bohai Rim ports in competition and cooperation, using the TEI@I methodology as the basic theoretical framework and guiding ideology.

Although the above research can reflect the factors of port competition and the concerns of cargo owners on port selection to a certain extent, there are few studies on port competition from the perspective of port selection by cargo owners. Based on this, this paper uses the data of 24 ports above the coastal scale in China from 2011 to 2019 and uses the structural equation model to explore the impact of port service stability, cargo owner convenience, and cargo owner participation on cargo owner satisfaction.

2 Port Service Satisfaction Index Measurement

2.1 Stability of Basic Port Services

Port service stability represents the adaptability of the port's infrastructure to the cargo requirements of cargo owners and is an assessment of the port's operational capacity. A series of indicators directly or indirectly affect the operating time of the ship and affect the cost. This paper regards service time and waiting time as important considerations for cargo owners when choosing a port and as important factors in determining the basic service quality of the port.

2.2 Shipper Convenience

Through the establishment of a management information system, shortens the time when ships stop in port, and reduces quality accidents and energy consumption through equipment operation monitoring and management, which brings huge economic benefits. Through the information platform, ports can obtain the latest cargo source and market information, improve their reputation, popularity, and market competitiveness, and accelerate the pace of moving towards an international, modern, and comprehensive port.

2.3 Shipper Engagement

In the process of port service, the service progress should be visually displayed to the cargo owner, attention should be paid to the personalized and diversified transportation needs of the cargo owner, actively guide the cargo owner to participate in the port service process, encourage them to participate in the port operation supervision, and trust should be enhanced.

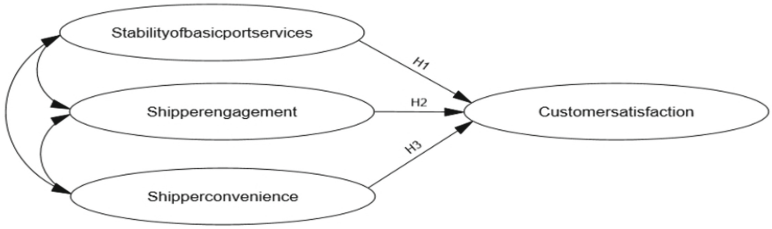

Fig. 1. Theoretical framework of shipper satisfaction research

3 Research Hypotheses

Based on the above facts and principles, this paper puts forward the following assumptions:

H1: port service stability has a positive impact on cargo owner satisfaction.
H2: cargo owner participation has a positive impact on cargo owner satisfaction.
H3: the convenience of cargo owners has a positive impact on cargo owner satisfaction.

4 Model Design

This model can be regarded as a port satisfaction model, which examines multiple aspects of port services: exploring the promotion and inhibition relationship between four latent variables of port service stability: customer engagement, port information, and cargo owner satisfaction. Because each latent variable is measured by multiple metrics, this part of the analysis is performed in two stages: first, the measurement model is tested, including estimating the parameters between the latent and indicator variables; and then, hypotheses are tested for the paths in the structural equation while keeping the measurement model unchanged. A path analysis model can be defined as: $y_i = \alpha + By_i + \Gamma x_i + \zeta_i$, $\mathrm{Var}(\zeta i) = \Psi$ Represented as a matrix is $\begin{bmatrix} y_{1i} \\ y_{2i} \end{bmatrix} = \begin{bmatrix} \alpha_1 \\ \alpha_2 \end{bmatrix} + \begin{bmatrix} 0 & 0 \\ \beta_1 & 0 \end{bmatrix}\begin{bmatrix} y_{1i} \\ y_{2i} \end{bmatrix} + \begin{bmatrix} \gamma_{11} & \gamma_{12} \\ \gamma_{21} & 0 \end{bmatrix}\begin{bmatrix} x_{1i} \\ x_{2i} \end{bmatrix} + \begin{bmatrix} \zeta_{1i} \\ \zeta_{2i} \end{bmatrix}$. Bring in the equation to get $\begin{bmatrix} y_{1i} \\ y_{2i} \end{bmatrix} = \begin{bmatrix} \alpha_1 + \gamma_{11}x_{1i} + \gamma_{12}x_{2i} + \zeta_{1i} \\ \alpha_2 + \gamma_{21}x_{1i} + \gamma_{21}x_{2i} + \zeta_{2i} \end{bmatrix}$. The implied mean vector is $\Sigma(\theta)$ and the covariance matrix is $\mu(\theta)$. $\sum(\theta) = \begin{bmatrix} (1-B)^{-1}(\Gamma \sum_{xx} \Gamma' + \Psi)(1-B)^{-1'} \\ \sum_{xx} \Gamma'(1-B)^{-1'}) & \sum_{xx} \end{bmatrix}$, $\mu(\theta) = \begin{bmatrix} \frac{(1-B)^{-1}(\alpha + \Gamma\mu_x)}{\mu_x} \end{bmatrix}$. They represent values at population level. All estimates of structural equation models in this paper were done using AMOS 26.0 software. The port service satisfaction pathway is shown in Fig. 1.

5 Case Studies

From September 2011 to 2019, this paper takes 24 ports above the coastal scale in China as the research object, and the data are derived from the China Statistical Yearbook, the Statistical Yearbooks of various cities, and the China Port Network, and some of the data are calculated twice through ship AIS data. The Port service observation variables is shown in Table 1. Some of the indicators are shown in Table 2.

Data is processed using SPSS 26.0 and Amos 26.0 software. The internal consistency index of each variable, the Kronbach coefficient, was greater than 0.5, indicating that the scale had good construction reliability. The factor load of all variables was greater than 0.5, the AVE was greater than the square of the correlation coefficient, the T value reached a significant level, and the KMO was greater than 0.9, indicating that the scale had good construction validity. The fitting test results of the model show that the chi-square value is 314.826, the degree of freedom is 146, the GFI and AGFI are greater than 0.6, the NFI, IFI, and CFI are greater than 0.9, and the RMSEA is about equal to 0.1, and the fitting results are ideal, as shown in Table 3. From the analysis, it can be seen that the influence coefficients of service stability, cargo owner participation, and cargo owner convenience on cargo owner satisfaction are 0.38 ($p < 0.001$), 0.25 ($p < 0.01$), and 0.33 (p), respectively, and that the H1, H2, and H3 hypotheses were confirmed. It

Table 1. Port service observation variables

Latent variables	Observed variables
Stability of basic port services	WD1 Collection and transportation capacity [9]
	WD2 Fixed asset inputs
	WD3 Barge vessel operating rate
	WD4 Berth utilization compliance rate
	WD5 The average usage compliance rate of warehouse yard
	WD6 Efficiency of dry bulk loading and unloading operations
	WD7 Container stand-alone operation efficiency
	WD8 Waiting time/service time [10]
	WD9 On-time service completion rate
	WD10 Port safety operation rate
Shipper convenience	XX1 Traffic management system
	XX2 Production management system
	XX3 Comprehensive information sharing platform
Shipper engagement	CY1 General choice for cargo owners
	CY2 Quality of service feedback
	CY3 Customer management system
Customer satisfaction	MY1 Monthly cargo throughput at the port
	MY2 Monthly container throughput at the port
	MY3 The monthly output value of the port

Table 2. The indicators of Port service

	WD1	WD2	WD3	WD4	WD5	WD6
2011.9	595.65	8122.12	89.91%	81.57%	82.65%	1557.87
2011.10	536.42	7936.51	87.79%	81.49%	85.12%	1566.13
2011.11	535.3	8114.99	85.91%	82.22%	84.74%	1586.84
2011.12	578.55	8270.41	80.38%	81.84%	84.94%	1585.52
2012.1	588.63	8240.8	89.49%	81.51%	81.32%	1552.83
2012.2	585.62	8172.6	83.33%	82.28%	82.80%	1588.38
2012.3	626.84	7812.74	82.92%	84.60%	81.21%	1670.23
2012.4	612.1	8225.32	86.21%	85.61%	85.90%	1604.22
2012.5	643.38	8090.72	82.40%	85.19%	86.40%	1658.78
2012.6	632.04	8090.79	81.19%	85.31%	91.50%	1654.58
2012.7	578.97	7899.06	85.51%	82.15%	82.98%	1573.59
2012.8	585.08	8245.57	80.66%	82.69%	81.20%	1571.56
2012.9	598.36	8104.21	79.50%	81.95%	83.12%	1595.17
2012.10	629.55	8231.25	82.94%	84.73%	84.53%	1670.29
2012.11	570.35	8236.75	82.75%	82.19%	83.10%	1572.99
2012.12	587.51	8138.69	86.47%	81.89%	84.64%	1561.5
2013.1	573.87	8186.39	84.99%	82.06%	85.20%	1600
2013.2	544.42	8215.75	82.51%	81.35%	82.82%	1576.54
2013.3	623.24	7833.07	86.26%	84.61%	82.04%	1659.45
2013.4	586.84	7881.65	81.02%	81.47%	85.68%	1552.78

can be seen that a higher level of service stability can improve the satisfaction of cargo owners, and the port's collection and distribution capacity, berth utilization, loading and unloading operation efficiency, and vessel waiting time are also very important for the port to maintain good stability. The structural equation model and standardized path are shown in Fig. 2.

Table 3. Model fit index

Chi-square	GFI	AGFI	NFI	IFI	CFI	RMSEA
314.826	0.763	0.692	0.875	0.929	0.928	0.108

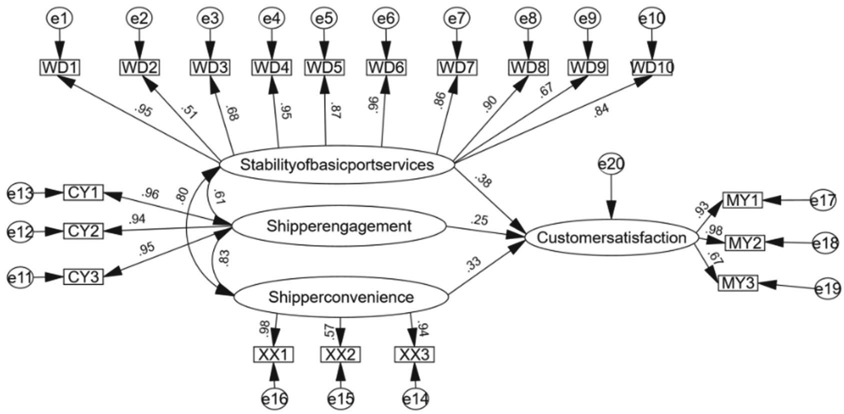

Fig. 2. Structural models and standardized path diagrams

6 Conclusion

In this study, the structural equation model of port service and cargo owner satisfaction was constructed, and the following conclusions were drawn: First, service stability, cargo owner participation and cargo owner convenience all had significant positive effects on cargo owner satisfaction, among which service stability had the greatest impact on satisfaction, and port collection and distribution capacity, loading and unloading efficiency, and service waiting time had the greatest impact on service stability. The port selection behavior of cargo owners tends to achieve the least risk, the most convenient and the most economical logistics system. Minimizing the risk of the logistics system requires the port to provide more stable services on the basis of functional integrity, complete functions, and the ability to resist exogenous and endogenous risks such as port congestion, so that cargo owners can receive stable services. Therefore, in the future port construction, we should focus on improving the efficiency of infrastructure operations and the relevant indicators of port queuing. At the same time, in the behavior of port selection, the initiative of cargo owners cannot be ignored. The general choice of cargo owners represents the reputation of the port, represents the general preference of cargo owners when choosing ports, and gives certain reference significance to the port selection behavior of other cargo owners. When providing logistics services, the port establishes a complete information interaction platform, quickly responds to customer needs, cooperates with the supervision of cargo owners, and completes shipping tasks; Cargo owners are encouraged to put forward opinions on services and jointly participate in port construction. The convenience of the port is also an important factor in improving the satisfaction of cargo owners. Ports should vigorously realize the interconnection of information among internal departments through information means, improve the synergy between internal departments, optimize the operation process, strengthen the timeliness of information exchange and real-time data collection, improve the level of port production management, and improve production and operation efficiency. In the future, ports should pay attention to the construction of port service stability, focus on improving infrastructure service levels, reduce port waiting times, reduce port congestion, improve cargo owner satisfaction from the aspect of service level construction, and enhance their own competitiveness.

References

1. Peter, W., Bernardo, B.F. (2017) Cargo allocation in Brazilian ports: An analysis through fuzzy logic and social networks. Journal of Transport Geography., 60:33-46. https://doi.org/10.1016/j.jtrangeo.2017.02.006
2. Hu, Y., Wang, Y. (2021) Performance evaluation of container port collection and distribution based on comprehensive integrated empowerment method. Journal of Ningbo University (Science and Engineering Edition)., 34(03):84-90. https://kns.cnki.net/kcms2/article/abstract?v=3uoqIhG8C44YLTlOAiTRKibYlV5Vjs7iy_Rpms2pqwbFRRUtoUImHXpZ24NTJL4Jh8Hp3bpN4sTmLM5Pmkqy9Xljwjl8NJcS&uniplatform=NZKPT
3. Jiang, X., Fan, H., Zhang, Y., Chen, Z. (2018) Nested Logit model of port and transportation mode and dry port joint selection. J. Transportation System Engineering and Information., 18(05):32-37. DOI: https://doi.org/10.16097/j.cnki.1009-6744.2018.05.006.
4. Chen, F., Zhang, J. (2021) Evaluation and comparative study of the competitiveness of China's coastal ports under the "One Belt One Road" strategy. J. Industrial Engineering and Management., 26(03):1-7. DOI: https://doi.org/10.19495/j.cnki.1007-5429.2021.03.001.
5. Liu, C., Zhuang, H., Zhang, Q. (2021) Evaluation of Bohai Rim Cruise Port Competitiveness Based on Entropy Weight-Cloud Model. Journal of Chongqing Jiaotong University (Natural Science Edition)., 40(07):8-15. https://kns.cnki.net/kcms2/article/abstract?v=3uoqIhG8C44YLTlOAiTRKibYlV5Vjs7iy_Rpms2pqwbFRRUtoUImHTk6VJA9vw3Jnrq9AH_HxZeudFpRAkGaJij1VCwtWzRZ&uniplatform=NZKPT
6. Kim, G., EunSu, L. Bok C. K. (2021) Strategic port management by consolidating container terminals. The Asian Journal of Shipping and Logistics., 38(1):19-24. https://doi.org/10.1016/j.ajsl.2021.11.003
7. Cabral, M. R., Alexandra, Ramos, F. d. S., (2014) Cluster analysis of the competitiveness of container ports in Brazil. Transportation Research Part A: Policy and Practice., 69: 423-431. https://doi.org/10.1016/j.tra.2014.09.005.
8. Lu, B., Wen, Y., Xing, J., Song, D. (2020) Research on Competitive Cooperation Strategy of Bohai Rim Port Based on TEI@I Methodology. J. Management Review., 32(07): 246-257. DOI: https://doi.org/10.14120/j.cnki.cn11-5057/f.2020.07.022.
9. Sun, J., Yang, X. (2022) Research on logistics efficiency of ports above designated size in China. Journal of Dalian Maritime University (Social Science Edition)., 21(05):47-56. DOI: https://doi.org/10.2991/aebmr.k.220603.020.
10. Chen, W., Zhao, N. Zhang, J., Song, B. (2022) Research on the application of AIS data in container port service efficiency. Journal of Geo-Information Science., 24(01):153-164. https://doi.org/10.1016/j.tranpol.2022.09.010