

## Container port selection factors: heterogeneity among major market players

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### Abstract

*This study explores the main factors considered when shippers and container shipping lines select their import/export and transshipment ports. In the present study, 38 container port selection indices were chosen from the previous research and field interviews. The scores of the 38 items were collected via survey to the three major maritime/port market players: shippers, shipping lines, and container terminal operators. In order to analyze the different priorities imposed on the port selection factors by the three market players, the ANOVA method has been employed. The empirical test shows the different perceptions about port selection attributes among service suppliers and demanders. In addition, the 38 items have been categorized into seven key factors through an exploratory factor analysis. The ANOVA technique was employed again to analyze the perspective differences for the port selection factors among the market players. The results show that there are significant differences among the players assessing the importance of the three port choice factors: liners and terminal operators give more weight to 'hinterland and terminal basic conditions' than shippers; terminal operators do not take 'line operation' as seriously as carriers and shippers; the factor of 'terminal operation' is more significantly considered by liners and terminal operators than by shippers.*

**Keywords:** *shipping line, shipper, Terminal operator, port selection, ANOVA, scheffe multiple comparison test, exploratory factor analysis*

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Submission Date: 10/04/2010

Revision Date: 10/13/2010

Acceptance Date: 10/13/2010

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## 1. Introduction

Under recent competitive maritime/port market environments, port management and operational strategies should be established and implemented with a comprehensive understanding of the key factors influencing users' port selection. For this issue, a lot of research has been undertaken and various findings and implications have been brought to light. However, little research has tried to explore the heterogeneous perspectives and priorities on port choice factors among different maritime/port market players. This paper mainly aims to identify and evaluate the key determinants of port selection and to investigate market players' different perspectives regarding port choice criteria.

In order to correspond with the research objectives proposed above, the current study adopts a questionnaire survey completed by the main market players - shipping lines, shippers and terminal operators in Korea and employs two analytic techniques, which are analysis of variance (ANOVA) and exploratory factor analysis (EFA). The remainder of this paper is structured as follows. The next section handles a literature review of port selection criteria and methodologies adopted in the existing research. Section three presents the questionnaire design and responses, while section four deals with the descriptive and statistical analysis and the results. The final section draws managerial implications and conclusions.

## 2. Literature Review

There are numerous studies on port choice issue. Determining who has more influential power in the choice of the import/export and transshipment ports between carriers and shippers has been a long and controversial argument.

Traditionally, most studies on port choice models have focused on port selection made by shippers rather than by other stake-holders such as Bird and Bland (1988), Murphy and Daley (1994), Nir *et al.* (2003) and Tiwary *et al.* (2003). For instance, Tiwary *et al.* (2003) argue that shippers possess stronger bargaining and/or influencing power against over shipping lines and liners' service design. According to them, the organization of global strategic alliances of shipping lines has redesigned liner service routes in response to economic growth and shippers' needs. The authors analyzed port and shipping line selection criteria considered by shippers, and assumed that location of the shipper, preferences for shipping line services, and facilities offered by ports are critical factors. Their empirical research applied a discrete choice model where each shipper faces a choice of 14 alternatives based on shipping line and port combinations. The empirical results indicated that the distance of the shipper from port, distance to destination (in case of exports), distance from origin (in case of imports), port congestion, and shipping line's fleet size play important roles.

In contrast, recently more research has examined port choice from the perspective of the shipping lines. D'Este and Meyrick (1992) argued that port selection shifted from the shipper to the carriers as the liners grew larger in their scale of operations. They take a similar view to that of Hayuth (1987), Hayuth and Fleming (1994), Lago *et al.* (2001), Malchow and Kanafani (2001, 2004), and Tongzon and Sawant (2007). For instance, Lago *et al.* (2001) examined the routes of vessels along the U.S. West Coast between 1993 and 1999 and found that carriers tended to choose the number of ports before specifying the ports. Malchow and Kanafani (2001) identified the factors affecting the port selection for U.S. export cargo liners using a multinomial logit model and found that oceanic and inland distances affect port selection negatively. In addition, adopting a revealed preference approach, Tongzon and Sawant (2007) presented port costs and range of port services to be the only significant factors in liner's port choice.

In the real container shipping industry, carriers seem to have more influential power to select ports; however, behind this carrier's port choice behavior, shippers exert a critical influence on liners' service route designs. As Malchow and Kanafani (2004) assumed, shipping lines directly select their calling ports considering shippers' requirements, and shippers indirectly realize their preference for a port by the choice of a line providing a service route passing through that port. Therefore, it would be a more balanced approach for ports and terminals to consider the perspectives of both carriers and shippers when they establish their development plans and marketing strategies. From this point of view, some studies have been interested to find if there are significant differences in valuation of port choice criteria among the major stakeholders.

Murphy *et al.* (1992) investigated a series of port selection criteria from the perspectives of different market players such as ports, carrier, freight forwarders, and larger and smaller shippers in U.S. They distributed a survey to those five different groups using nine port selection factors. Their empirical study indicates that port selection attributes are evaluated differently by various participants and there exist significant differences in the following five factors: large and/or odd sized freight, large volume shipments, shipment information, claims handling, and special handling. Zan (1999) built a game theoretical model to explain the interaction between port, carriers and shippers. While it was possible to explain the interaction between shippers and carriers, he was unable to explain the interaction between port and the other parties due to lack of policy data from ports.

Song and Yeo (2004) tried to identify the factors contributing to the overall competitiveness of Chinese main ports focusing on elements related to geographical location, logistics, and operational services provided by the ports. They collected 73 elements and factors for port competitiveness through a survey to 180 professionals including ship-owners, shipping company executives, shippers, terminal operators and academics and researchers. Using the analytic hierarchy process (AHP) method, the authors found that location factor plays the most significant role for a port's competitiveness. Lirn *et al.* (2004) applied the AHP

method to reveal and analyze liners' transshipment port selections. They selected 47 relevant service attributes which were categorized into 4 main service criteria (i.e. physical/technical infrastructure, geographical location, terminal cost, and management/administration) comprising 12 sub-criteria by using two rounds of delphi surveys. The results of the AHP analysis targeting 20 carriers and 20 port operators shows that both container carriers and port service providers have a similar perception about the most important service attributes for port selection; however, the weights among the sub-criteria reveal some differences between the two survey groups. The authors revealed that the five service attributes such as handling cost, proximity to main navigation routes, proximity to import/export areas, infrastructure condition, and feeder network are the most important service attributes of transshipment ports.

However, the previous studies have not provided a comprehensive understanding about heterogeneous perspectives of different market players. Some research considered very limited port choice attributes (Murphy *et al.*, 1992) or could not present clear interactions between port service providers and customers (Zan, 1999). In addition, some research only provided an aggregated perspective combining different market players (Song and Yeo, 2004) or did not include shippers' views since transshipment port choice are more oriented to carriers' network strategies (Lirn *et al.*, 2004). Considering the port choice arguments and insufficiency of previous research, it is very necessary for terminal operators to explore the perspective differences among shippers, shipping lines, and operators themselves in order to properly define their customers' needs and evaluate their capabilities to respond market demand.

### **3. Research Methodology**

The main methodology of this paper is to survey a sample of three different market players, i.e. shippers, shipping lines, and terminal operators, and analyze the survey results by analysis of variance and exploratory factor analysis.

#### **3.1. Questionnaire Survey Process**

As a first step, a draft questionnaire instrument was designed by critically referring to the various port choice factors adopted in the existing studies. In the previous studies, factors influencing the selection of ports are typically categorized into, among others, port location, port characteristics, port operations, hinterland characteristics, liners characteristics and others. The initial version of the questionnaire was pre-tested about whether expressions in the form were easy for the respondents to understand and also whether any important questions were missing or not. Through the pilot survey, respondents reported that there

were no ‘not understandable questions’ or ‘not available/applicable questions’. However, respondents recommended the deletion of seven items, which were not relevant port selection factors since some were too comprehensive (e.g., geographical location, terminal operation) and some were duplicated with other items left on the final version (e.g., nearness to import/export regions, port congestion, service pattern, and ship capacity). In addition, political stability was deleted due to its inefficacy in measuring port competitiveness. Meanwhile, seven new items were recommended to be added in order to consider liners’ fleet operation strategies (cargo balance, alliance members’ calling, competitors’ calling), to include the importance of value-added logistics (VAL) activities behind ports (port backup area, free trade zone), to compensate terminal handling charges (port productivity), and to test the usefulness of port marketing for cargo inducement.

The modified questionnaire, composed of 38 port selection attributes, includes general information about carriers, shippers and terminal operators before asking the factors (see Table 1). The questionnaire consisted of two parts. The first part was concerned with background information on the sampled company and the second part with major questions on a seven point Likert scale to decide on the important attributes in port selection. Under the Likert scale, ‘1’ designates the lowest importance while ‘7’ represents the highest priority. In addition, the measurement scales include the ‘not available/applicable’ option because potential respondents may not have all the necessary knowledge to complete all items on the questionnaire.

**Table 1.**  
Port selection factors and indices from literature review

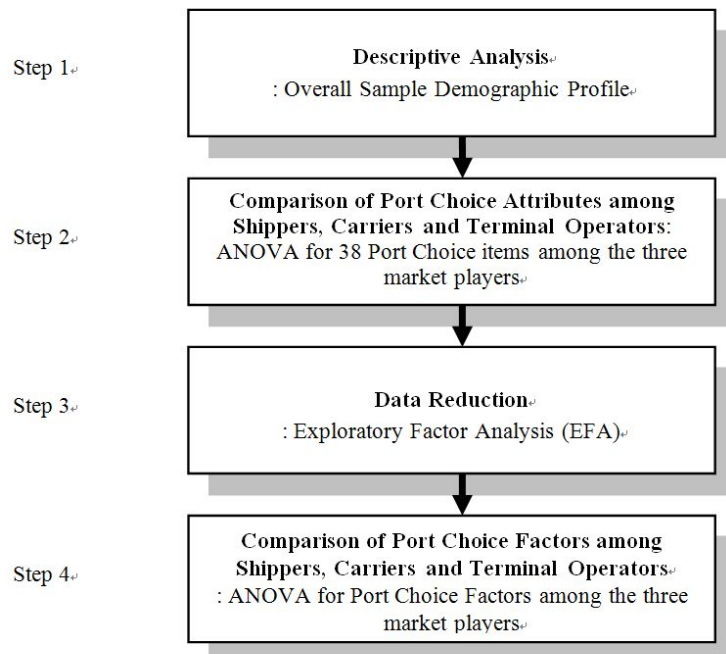
Initial Categories	Attributes	Sources
Port Location	Accessibility to port Nearness to main truck lines Ocean transportation distance Nearness to inland shippers	Slack(1985), Malchow & Kanafani (2001, 2004), Yeo et al. (2004), Lirn et al. (2004)
Port Characteristics	Port depth Port infrastructure condition Port size Port reputation Feeder network	Slack(1985), Bird and Bland (1988), Malchow & Kanafani (2001, 2004), Lirn et al. (2004)

Initial Categories	Attributes	Sources
Port Operation	Port tariff Berth availability Terminal handling charge Port productivity Service reliability Service speed Cargo handling safety Capability of operating staff Relationship with union Level of information technology	Slack(1985), Bird and Bland (1988), Murphy and Daley (1994) Nir et al. (2003), Lim et al. (2004)
Hinterland Characteristics	Market size Cargo volume Nearness to hinterland Intermodal network Efficient connectivity Cost of Intermodal transportation Port backup area Free trade zone	Slack(1985), Murphy and Daley (1994), Malchow & Kanafani (2001, 2004), Nir et al. (2003), Yeo et al. (2004), Lim et al. (2004), From interview with experts
Liners Characteristics	Cargo balance Liners' schedule reliability Liners' service frequency Variety of service routes Competitors' calling Alliance members' calling Direct calling	Malchow & Kanafani (2001, 2004), Lim et al. (2004), Yeo et al. (2004), From interview with experts
Miscellaneous	Claim handling Special requirement handling Dedicated terminal Port marketing	Lu (2000), Lim et al. (2004), Yeo et al. (2004), From interview with experts

The four-page survey was sent to the potential respondents of container shipping companies (86 staff), import/export manufacturing firms (128 staff) and container terminal operating companies (42 staff) in Korea via E-mail and/or Fax. Seven of the 78 returned questionnaires (34 from liners, 20 from shippers and 17 from terminal operators) were discarded since the respondents had put the same answers on all the seven-point Likert scale items.

### 3.2. Research Framework

After the survey data were collected, a four-step research framework was designed to analyze the data, as shown in Figure 1. First, from the aggregated survey results, the preliminary step was to extract important factors based on the information from the mean values of each item. This initial step was essential in examining how importantly market players weigh each item in their port choices. The second step was to see if there was any distinction among different market players in their port choice. This information was scrutinized by dividing the survey results into shipper, shipping line, and terminal operator groups and then by statistically testing the differences among the three groups using an analysis of variance technique. Third, in order to get a parsimonious description of data structure, an exploratory factor analysis (EFA) was adopted. This is a commonly used data reduction technique to simplify complex and diverse relationships that exist among a set of observed variables (in our case, thirty eight variables) by uncovering common dimensions or factors (Dillon and Goldstein, 1984, 53). Finally, we tried to investigate the differences in terms of port choice factors among shippers, carriers and terminal operators.



**Figure 1.**  
Research Framework

## 4. Analysis and Results of the Survey

### 4.1. Descriptive Analysis

The characteristics of respondents were analyzed by identifying their work experience in the industry/companies and their positions in the present firms. Firstly, the average lengths of work experience was 13.0 years in the three industries and 11.9 years in their current companies. Secondly, corresponding to the questions related to the respondents' job grade, a total of 73.2% marked their position between 15 and 20 on an ascending scale that ranged from '10 (clerk)' to '20 (CEO/president)', which indicates that the respondents held managerial or higher positions: the total average grades were 15.5. Considering the statistical characteristics of the respondents' positions and work experience, it was assumed that the respondents had sufficient knowledge about their firm's activities and provided accurate and reliable information.

In order to obtain company information, the respondents were asked to indicate their company age, total sales value, and number of full time employees. First, 81.7% of sampled firms had been in operation for more than 10 years and 56.3% had been operating for more than 20 years. Second, 25.4% of the firms had total sales values below 25 billion Korean Won, 46.5% of the firms recorded total sales values between 25 and 250 billion Korean Won and 28.2% firms had total sales values of over 250 billion Korean Won in 2005.<sup>2</sup> Thirdly, it was identified that 19.7% of the firms had 100 or fewer employees, 40.8% of the firms employed between 101 and 500 workers, 16.9% of the firms had 501 to 1,000 employees and 12.7% of the firms had more than 1,000 full time workers in 2006.

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<sup>2</sup> USD 1 is approximately equal to KW 1,000.



**Table 2.**  
General Profiles of Respondents and Respondents Companies

Work experience in the Industry (years)					Work experience in the Company (years)				
	Liner	Shipper	Terminal	Total		Liner	Shipper	Terminal	Total
1-3	2.9%	10.0%	0.0%	4.2%	1-3	11.8%	10.0%	0.0%	8.5%
4-6	8.8%	10.0%	0.0%	7.0%	4-6	17.6%	5.0%	11.8%	12.7%
7-9	17.6%	15.0%	23.5%	18.3%	7-9	2.9%	15.0%	11.8%	8.5%
10-12	23.5%	20.0%	17.6%	21.1%	10-12	20.6%	15.0%	23.5%	19.7%
13-15	20.6%	25.0%	11.8%	19.7%	13-15	20.6%	20.0%	11.8%	18.3%
16-18	8.8%	5.0%	29.4%	12.7%	16-18	11.8%	10.0%	35.3%	16.9%
19-21	2.9%	5.0%	11.8%	5.6%	19-21	2.9%	10.0%	0.0%	4.2%
22-24	8.8%	10.0%	0.0%	7.0%	22-24	5.9%	10.0%	0.0%	5.6%
25-27	2.9%	0.0%	0.0%	1.4%	25-27	2.9%	0.0%	0.0%	1.4%
28-30	0.0%	0.0%	5.9%	1.4%	28-30	0.0%	0.0%	0.0%	0.0%
> 31	2.9%	0.0%	0.0%	1.4%	> 31	2.9%	0.0%	0.0%	1.4%
Sum	100.0%	100.0%	100.0%	100.0%	Sum	100.0%	100.0%	100.0%	100.0%
Respondents' position					Company age (years)				
	Liner	Shipper	Terminal	Total		Liner	Shipper	Terminal	Total
10	0.0%	10.0%	5.9%	4.2%	< 5	0.0%	20.0%	0.0%	5.6%
11	2.9%	0.0%	5.9%	2.8%	5-10	8.8%	15.0%	17.6%	12.7%
12	5.9%	0.0%	5.9%	4.2%	11-15	5.9%	0.0%	29.4%	9.9%
13	8.8%	5.0%	5.9%	7.0%	16-20	2.9%	5.0%	52.9%	15.5%
14	14.7%	0.0%	5.9%	8.5%	20-25	2.9%	20.0%	0.0%	7.0%
15	29.4%	5.0%	17.6%	19.7%	> 25	79.4%	40.0%	0.0%	49.3%
16	17.6%	30.0%	0.0%	16.9%	sum	100.0%	100.0%	100.0%	100.0%
17	11.8%	20.0%	29.4%	18.3%					
18	5.9%	20.0%	11.8%	11.3%					
19	0.0%	0.0%	11.8%	2.8%					
20	2.9%	10.0%	0.0%	4.2%					
Sum	100.0%	100.0%	100.0%	100.0%					
Total sales value (100 million Korean Won)					Full time employees				
	Liner	Shipper	Terminal	Total		Liner	Shipper	Terminal	Total
< 10	0.0%	15.0%	0.0%	4.2%	< 100	17.6%	30.0%	11.8%	19.7%
10-50	5.9%	5.0%	5.9%	5.6%	101-300	32.4%	20.0%	23.5%	26.8%
51-100	11.8%	0.0%	5.9%	7.0%	301-500	29.4%	0.0%	0.0%	14.1%
101-250	2.9%	10.0%	17.6%	8.5%	501-1000	0.0%	20.0%	47.1%	16.9%
251-500	14.7%	15.0%	11.8%	14.1%	1001-2000	5.9%	10.0%	17.6%	9.9%
501-1000	0.0%	10.0%	5.9%	4.2%	> 2000	14.7%	20.0%	0.0%	12.7%
1001-2500	29.4%	5.0%	52.9%	28.2%	Sum	100.0%	100.0%	100.0%	100.0%
2501-5000	11.8%	0.0%	0.0%	5.6%					
> 5000	23.5%	40.0%	0.0%	22.5%					
Sum	100.0%	100.0%	100.0%	100.0%					

#### 4.2. Comparison of Port Choice Items among Shippers, Carriers and Terminal Operators

Table 3 presents the heterogeneous perspectives among three market players concerning the 38 port selection factors (see appendix 1 for the mean scores for all the items). Shipping lines consider ‘schedule reliability’, ‘accessibility to port’, ‘berth availability’, ‘terminal handling charge (THC)’, ‘cargo volume’, ‘infrastructure condition’, ‘liners’ service frequency’, ‘variety of service routes’, ‘direct calling’, and ‘port productivity’ as the 10 most important indices while shippers recognize ‘service speed’ ‘schedule reliability’, ‘special requirement handling’, ‘cargo handling safety’, ‘nearness to inland shippers’, ‘service reliability’, ‘accessibility to port’, ‘problem handling’, intermodal cost’ and ‘port tariff’ as critical to port choice. In addition, terminal operators impose more weights on ‘port depth’, ‘port productivity’, ‘infrastructure condition’, ‘cargo volume’, ‘berth availability’, ‘market size’, ‘nearness to main truck’, ‘accessibility to port’, ‘service speed’ and ‘THC’.

**Table 3.**  
Three Market Players’ Different Priority for the Port Selection Criteria

Ranking	Liners	Shippers	Terminal Operators
1	Liners’ schedule reliability	Service speed	Port depth
2	Accessibility to port	Liners’ schedule reliability	Port productivity
3	Berth availability	Special requirement handling	Port infrastructure condition
4	Terminal handling charge	Cargo handling safety	Cargo volume
5	Cargo volume	Nearness to inland shippers	Berth availability
6	Port infrastructure condition	Service reliability	Market size
7	Liners’ Service frequency	Accessibility to port	Nearness to main truck lines
8	Variety of service routes	Problem handling	Accessibility to port
9	Direct calling	Intermodal cost	Service speed
10	Port productivity	Port tariff	Terminal handling charge
11	Service speed	Port productivity	Port tariff
12	Feeder network	Liners’ Service frequency	Feeder network
13	Service reliability	Nearness to main truck lines	Service reliability
14	Cargo balance	Berth availability	Liners’ schedule reliability
15	Cargo handling safety	Terminal handling charge	Information technology
16	Intermodal network	Intermodal network	Liners’ Service frequency
17	Port tariff	Efficient intermodalism	Nearness to hinterland
18	Efficient intermodalism	Nearness to hinterland	Direct calling
19	Quality of staff	Port infrastructure condition	Efficient intermodalism
20	Port depth	Feeder network	Special requirement handling
22	Market size	Port backup area	Ocean distance
23	Competitor’s calling	Free trade zone	Port size

Ranking	Liners	Shippers	Terminal Operators
24	Problem handling	Competitor's calling	Nearness to inland shippers
25	Nearness to main truck lines	Variety of service routes	Problem handling
26	special requirement handling	Quality of staff	Port reputation
27	Alliance member's calling	Cargo volume	Intermodal network
28	Intermodal cost	Ocean distance	Alliance member's calling
29	Port size	Dedicated terminal	Intermodal cost
30	Port reputation	Port reputation	Variety of service routes
31	Information technology	Alliance member's calling	Quality of staff
32	Free trade zone	Market size	Competitor's calling
33	Nearness to inland shippers	Port size	Port marketing
34	Ocean distance	Cargo balance	Dedicated terminal
35	Port backup area	Information technology	Cargo balance
36	<b>Relationship with union</b>	Port depth	Port backup area
37	Port marketing	<b>Relationship with union</b>	<b>Relationship with union</b>
38	Dedicated terminal	Port marketing	Free trade zone

‘Accessibility to port’ is the only common critical port selection item. An interesting point is that ocean transportation service providers (i.e. liners and terminal operators) present similar importance on the items in the top 10 criteria, while service demanders show a different perspective for the criteria. Meanwhile, the uncritical items indicated by the three market players show somewhat different perspectives. They do not commonly consider ‘relationship with union,’ ‘port marketing’ and ‘dedicated terminal’ important factors in port choice. An interesting finding is that shippers and terminal operators point out that ‘cargo balance’ is not a considerable factor, while shipping companies recognize it as a very important factor.

**Table 4.**  
Scheffe Multiple Comparison Test for 38 items

Factor	Level of Significance			Factor	Level of Significance		
	Liners	Shippers	erminals		Liners	Shippers	erminals
Accessibility to port	Liners	0.3667	0.3424	Market size	Liners	0.0385*	0.7984
	Shippers		0.9940		Shippers		0.0213*
Nearness to truck	Liners	0.9677	0.8134	Cargo volume	Liners	0.0013*	0.8823
	Shippers		0.9371		Shippers		0.0201*
Ocean distance	Liners	0.9858	0.7846	Nearness to hinterland	Liners	0.5184	0.6193
	Shippers		0.8898		Shippers		0.9934
Nearness to shippers	Liners	0.0613	0.9511	Intermodal network	Liners	0.4081	0.0645
	Shippers		0.2142		Shippers		0.6268

Factor	Level of Significance			Factor	Level of Significance		
		Shippers	erminals			Shippers	erminals
Port depth	Liners	0.0619	0.3902	Efficient intermodalism	Liners	0.5592	0.3473
	Shippers		0.0064*		Shippers		0.9321
Port infrastructure	Liners	0.0440*	0.9846	Intermodal cost	Liners	0.5482	0.5304
	Shippers		0.1363		Shippers		0.1568
Port size	Liners	0.2564	0.9433	Cargo balance	Liners	0.0237*	0.0123*
	Shippers		0.5396		Shippers		0.9522
Port reputation	Liners	0.3954	0.8181	Port backup area	Liners	0.7352	0.5436
	Shippers		0.8442		Shippers		0.2551
Feeder network	Liners	0.1114	0.5095	Free trade zone	Liners	0.9992	0.1423
	Shippers		0.7456		Shippers		0.1963
Port tariff	Liners	0.9691	0.9196	Liner's reliability	Liners	0.8562	0.0684
	Shippers		0.9881		Shippers		0.2629
Berth availability	Liners	0.0383*	0.6867	Liner's frequency	Liners	0.5267	0.2396
	Shippers		0.3538		Shippers		0.8521
THC	Liners	0.0678	0.2667	Variety of routes	Liners	0.0425*	0.0389*
	Shippers		0.8611		Shippers		0.9934
Port productivity	Liners	0.5027	0.9825	Competitor calling	Liners	0.4085	0.2274
	Shippers		0.5042		Shippers		0.9259
Service reliability	Liners	0.9151	0.3971	Alliance calling	Liners	0.3492	0.7015
	Shippers		0.6852		Shippers		0.8813
Service speed	Liners	0.8135	0.6700	Direct calling	Liners	0.0825	0.1772
	Shippers		0.4026		Shippers		0.9541
Handling safety	Liners	0.9897	0.2068	Problem handling	Liners	0.8499	0.4299
	Shippers		0.2272		Shippers		0.2570
Quality of staff	Liners	0.1172	0.0754	Special requirement	Liners	0.3111	0.8001
	Shippers		0.9587		Shippers		0.1664
Relationship with union	Liners	0.8633	0.8282	Dedicated terminal	Liners	0.7828	0.9709
	Shippers		0.9960		Shippers		0.9257
IT	Liners	0.1512	0.9049	Port marketing	Liners	0.7983	0.7896
	Shippers		0.1212		Shippers		0.4965

\* Mean differences are significant at  $P < 0.05$

Table 3 presents different overall perspectives among shipping lines, shippers and terminal operating companies (about 38 port selection criteria). However, it only presents descriptive differences but not statistically significant heterogeneous among the players. In order to assess whether the means of the 38 factors were significantly different across the three market players, the one-way analysis of variance (ANOVA) was adopted. The results of the Scheffé multiple comparison test are shown in Table 4.

The results show statistical differences of port selection perspective among the players in the items of 'port depth,' 'port infrastructure,' 'berth availability,' 'market size,' 'cargo volume,' 'cargo balance' and 'variety of service routs'. Concerning 'port depth,' liners and terminal operators have no significant difference but shippers impose less weight compared to the terminal operators. In the cases of 'port infrastructure' and 'berth availability' liners and shippers show significant differences; compared to shippers, liners consider 'port infrastructure condition' and 'berth availability' as significant attributes for port selection. Regarding 'market size' and 'cargo volume' shipping firms and terminal operating companies have similar perspectives but possess significantly higher priorities to shippers. Meanwhile, liners place a lot of importance on 'cargo balance' and 'variety of service routes' compared to shippers and terminal operators (see Appendix 1).

#### ***4.3. Data Reduction: Exploratory Factor Analysis***

To interpret the survey results more clearly, we tried to reduce the dimensionality and burden of interpretation of the numerous variables and responses. Principal component analysis, a type of factor analysis, transforms the original set of variables into a smaller set of linear combinations that account for most of the variances of the original set. The purpose of principal component analysis is to determine factors in order to explain as much of the total variation in the data as possible with as few of these factors as possible (Dillon and Goldstein, 1984, 23-28).

Table 5 reveals several important factors or principal components. Although thirty-eight variables were specified in the questionnaire, it is shown that the dimensionality can be reduced into a smaller number of factors (principal components). Since there can be the same number of principal components as the number of variables in principal component analysis, one should decide how many components to retain. Unfortunately, there is no universally accepted method for doing so, and the decision becomes largely judgmental and a matter of taste. One commonly used method is the "root of greater than one" criterion approach, which is to retain those components whose eigen values are greater than one (Dillon and Goldstein, 1984, 23-52).

Grouping the variables into the factors should totally depend upon the value of loadings. Therefore, each variable's loading with the largest absolute value in its respective row across the factors should be grouped into the respective factors as shown as shaded italic bold-faced variables in the table. The factor solution resulted in seven factors with eigen values greater than unity, which are 'customer service capability', 'advanced port management', 'hinterland and terminal basic condition', 'shipping line operation', 'terminal operation', 'transportation distance', and 'intermodal system'. The seven factor solutions for the 38 items accounted for 75.9% of the variance. The results of a reliability test show that the derived factors are reliable.

**Table 5.**  
Exploratory Factor Analysis Result

Factor (Cronbach's Alpha)	Attributes	1	2	3	4	5	6	7
Customer service capability (0.917)	Problem handling	<b>0.788</b>	0.211	-0.046	0.244	0.066	0.002	0.327
	Cargo handling safety	<b>0.786</b>	0.261	0.161	0.211	0.114	0.181	0.032
	Service speed	<b>0.784</b>	0.038	0.152	0.215	0.206	0.214	0.135
	Service reliability	<b>0.780</b>	0.121	0.272	0.071	0.204	-0.037	0.158
	Special requirement handling	<b>0.588</b>	0.286	-0.155	0.188	0.086	0.095	0.460
	Intermodal cost	<b>0.543</b>	0.385	0.203	0.237	0.032	0.342	0.315
	Port productivity	<b>0.532</b>	0.113	0.477	0.186	0.377	0.085	-0.032
Advanced port management (0.894)	Relationship with union	0.137	<b>0.821</b>	0.196	0.046	0.100	0.037	0.116
	Port backup area	0.152	<b>0.773</b>	-0.088	0.285	0.026	0.235	0.146
	Information technology	0.127	<b>0.738</b>	0.315	0.103	0.253	-0.124	0.000
	Free trade zone	0.333	<b>0.708</b>	-0.062	0.337	0.102	-0.013	0.245
	Port reputation	0.061	<b>0.573</b>	0.071	0.178	0.491	-0.086	0.036
	Dedicated terminal	0.116	<b>0.561</b>	0.283	0.051	-0.082	0.231	0.550
	Quality of staff	0.486	<b>0.506</b>	0.235	0.117	0.332	-0.014	0.077
Hinterland and terminal basic condition (0.876)	Cargo volume	0.151	0.139	<b>0.848</b>	0.152	0.180	0.104	0.229
	Market size	0.091	0.208	<b>0.797</b>	0.126	0.082	0.084	0.175
	Port depth	-0.006	0.037	<b>0.697</b>	0.052	0.391	0.362	0.007
	Nearness to hinterland	0.314	0.171	<b>0.581</b>	0.179	0.062	0.195	0.467
	Terminal handling charge	0.295	0.272	<b>0.488</b>	0.413	0.353	0.197	-0.232
	Berth availability	0.309	0.327	<b>0.447</b>	0.302	0.447	0.133	-0.097
Shipping line operation (0.936)	Liners' schedule reliability	0.526	0.110	0.031	<b>0.727</b>	0.000	0.053	0.032
	Direct calling	0.189	0.235	0.211	<b>0.688</b>	0.191	-0.146	0.423
	Cargo balance	0.214	0.518	0.188	<b>0.640</b>	0.131	0.076	0.099
	Liners' Service frequency	0.553	0.237	0.178	<b>0.600</b>	0.205	0.095	0.167
	Alliance member's calling	0.137	0.531	0.205	<b>0.563</b>	0.161	0.071	0.232
	Competitor's calling	0.200	0.446	0.244	<b>0.511</b>	0.269	0.119	0.146
	Variety of service routes	0.502	0.331	0.243	<b>0.508</b>	0.345	-0.014	-0.019
Terminal operation (0.865)	Port tariff	0.112	0.165	0.033	0.295	<b>0.703</b>	0.357	0.049
	Port size	0.271	0.278	0.314	-0.214	<b>0.683</b>	-0.105	0.069
	Port infrastructure	0.273	0.021	0.410	0.181	<b>0.613</b>	0.005	0.300
	Feeder network	0.161	0.303	0.269	0.247	<b>0.578</b>	0.005	0.160
	Accessibility to port	0.307	-0.058	0.124	0.420	<b>0.506</b>	0.340	0.381
Transportation distance (0.783)	Ocean transportation distance	-0.157	0.123	0.065	0.041	0.220	<b>0.796</b>	0.147
	Nearness to inland shippers	0.351	-0.023	0.113	0.027	-0.219	<b>0.788</b>	0.104
	Nearness to main truck lines	0.275	-0.023	0.409	-0.012	0.138	<b>0.749</b>	-0.007
Intermodal system (0.811)	Efficient intermodalism	0.342	0.128	0.255	0.207	0.116	0.266	<b>0.587</b>
	Port marketing	0.230	0.406	0.159	0.059	0.296	-0.004	<b>0.548</b>
	Intermodal network	0.453	0.196	0.273	0.359	0.195	0.117	<b>0.506</b>

Note: Kaiser-Meyer-Olkin Measure of Sampling Adequacy is 0.775

In order to assess whether the means of the seven factors were significantly different across the three market players, the analysis of variance (ANOVA) technique was adopted again. The results of the Scheffe multiple comparison test are shown in Table 6. Appendix

2 presents the means and standard deviations of the seven port selection factors evaluated by each market player.

**Table 6.**  
Scheffe Multiple Comparison Test for Seven Port Selection Factors

Factor	Level of Significance		
		Shippers	Terminals
Customer Service Capability	Liners	0.945	0.421
	Shippers		0.340
Advanced Port Management	Liners	0.479	0.180
	Shippers		0.811
Hinterland and Terminal Basic Condition	Liners	0.003*	0.980
	Shippers		0.021*
Shipping line operation	Liners	0.061	0.030*
	Shippers		0.931
Terminal operation	Liners	0.050*	0.495
	Shippers		0.582
Transportation Distance	Liners	0.602	0.699
	Shippers		0.995
Intermodal System	Liners	0.536	0.712
	Shippers		0.977

Note: \* Mean differences are significant at  $P < 0.05$

The empirical results show significant perspective differences among maritime/port market players regarding the following three factors: ‘hinterland and terminal basic condition’, ‘shipping line operation’, and ‘terminal operation’. Regarding ‘hinterland and terminal basic condition’, shipping lines and terminal operators have a similar perspective and impose more weight compared to shippers. For ‘shipping line operation’, liners impose a significant importance while shippers and terminal operators give less weight. In addition, liners and terminal operators give more significance to ‘terminal operation’ factor than shippers.

## 5. Implication and Conclusions

The current empirical research shows that significant differences among the market players exist, especially regarding three factors: ‘hinterland and terminal basic condition’, ‘shipping liners’ operations’ and ‘terminal operations’. First, liners and terminal operators

give more weights on hinterland and terminal basic condition such as cargo volume, market size, port depth, nearness to hinterland and terminal handling charge (THC), and berth availability than shippers. Second, terminal operators do not seriously considering line operation involving the attributes of liners' schedule reliability and service frequency, variety of routes, direct calling, alliance members or competitors calling, and balanced cargo, compared to carriers and shippers. In addition, terminal operation factors such as accessibility, port size, infrastructure, feeder network, and port tariffs are more critically considered by liners and terminal operators than by shippers.

These findings indicate that liners and terminal operators place considerable importance on hinterland condition and terminal function/operations, while shippers have no specific interest in these factors. These results imply that shippers are primarily concerned with getting a shipment from its origin to its destination, paying little attention to the intermediary points through which it is moved (Malchow and Kanafani, 2001). In addition, the current study shows that shippers and liners possess similar perspectives for the importance of liners' operations in a port, which is not considered too highly by terminal operators. Therefore, it is recommended that terminal operators make more effort to reinforce their capabilities accommodating and supporting liners' operations and strategies in order to obtain and maintain their competitive advantage and position. In conclusion, ports, particularly terminal operators, should focus their attention on the factors on which shippers and liners commonly place high priority, when they formulate, implement and evaluate their terminal management policies, operating strategies and marketing plans.

The current study provides a comprehensive understanding of the different market players' heterogeneous criteria adopted when they determine calling ports and design service routes or establish port development plans and implement terminal operation strategies by utilizing critical port selection attributes and factors, and utilizing a series of rigorous statistical methods. An idea for a meaningful future study would be to test the explanation power of the port choice factors and real influences of major market players on port selection factors. For instance, it would be possible to collect the scores of various container terminals for each port selection factor and design a regression model examining the influences of these factors upon ports' market shares and/or throughputs. In addition, a structural equation modeling could be employed to explore significant direct and indirect relationships among port selection factors and port operational indices.



## Acknowledgements

This work was supported by INHA UNIVERSITY research grant.

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