

Review of Theoretical Aspects on the Studies of Port Selection Criteria

Yul-Seong Kim* · Yun-Su Yur** · Changhoon Shin†

* ,** Research fellow, Busan Development institute, Busan 601-720, Korea

† Department of Logistics System Engineering, Korea Maritime University, Busan, 606-791, Korea

Abstract : *The circumstances surrounding world ports have changed rapidly and port competition to attract cargoes has been increasing fiercely. Specifically, deploying large container vessels resulted fewer port visits and strategic alliance among liner shipping companies. Recently, many studies have worked for improving port competitiveness. However, these studies were limited to evaluation of only port competitiveness and few studies suggested strategies for reinforcing port competitiveness. Although implications of these previous studies are practically available to build policies for port, there have been very few academic studies such as identifying port competitiveness and port selection with related attributes for reasonable evaluation and analysis. Therefore, this study aims to classify the existing studies, which dealt with port selection problem, based on basic structure that was suggested by Murphy (1992). Furthermore, the conceptual definition will be carried out by comparison analysis in terms of time of study, type of data and methodology and decision factor of each study.*

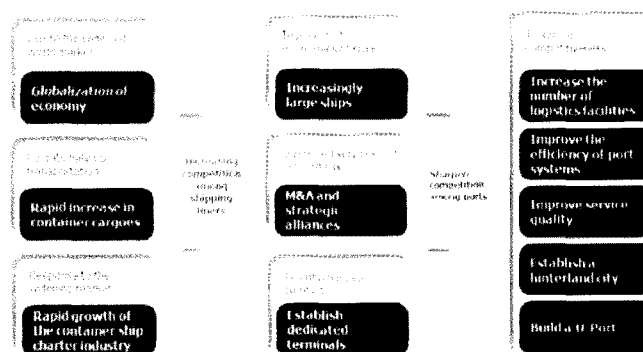
Key words : *Port Selection, Criteria, Port Competitiveness, Liner shipping companies, Decision and Respondent's Role*

1. Introduction

Globalization of the world economy has stimulated multinational companies to operate their business world widely. To do trading without borders, the global companies should raise own competitiveness to preoccupy the position in the business market, otherwise the company will die out. The same situation happens to liner shipping companies. They have to accomplish own competitiveness not to be dismissed. The way to accomplish competitiveness of liner shipping companies could be deploying large vessel, merging companies, strategic cooperation, and achieving dedicated terminals. In the meantime, ports and terminals faced following situations; firstly, deploying large vessels in order to achieve economies of scale affects shipping route that hub ports on the main trunk route are visited by large vessels and peripheral ports are visited by feeders; secondly, liner shipping companies expand their service route and increase frequency of transport service through M&A or forming strategic alliance between/among liner shipping companies. Lastly, large liner shipping companies try to accomplish the dedicated terminals in order to increase customer convenience and service competitiveness.

To respond to liner shipping companies' strategic changes, ports are needed to change themselves. As a common symptom of world ports, most of ports concentrate

on expanding port facilities and equipments, improving efficiency of port information system and service quality, reducing turnaround time, adopting discount pricing policy for port handling, entrance fee, and volume incentive. Ports are putting efforts to keep existing customers and also attract new customers, so that maintain cargo flow and their position as a hub port. In this point, port operators have to pay attention to operation pattern and decision for port call that is made by linear shipping companies.



Source : Busan Port Vision 2020(2006)

Fig. 1 Liner shipping companies and ports reaction to dynamic maritime industry environment

On the other hand, there have been a number of studies considered port problem. However, most of these studies do not consider the fact that as shipping and port industry change, port selection criteria also variously change. For

* kmaritime@bdi.re.kr, 051)860-8824

** logiyun@bdi.re.kr, 051)860-8822

† Corresponding Author: Changhoon Shin, chshin@hhu.ac.kr, 051)410-4333

instance, in 1980s the time that port development has not been yet activated, port facility was the important factor in port selection problem. In 1990s, port competition got fierce at the time, so port charge and service was considered as the important factor. However, in recent time, predominant geographical location and economy of hinterland are considered as a crucial factor. Though it has been continuously changing port selection criteria by port user, recent studies only focus on evaluation of ports' competitiveness. It means fundamental study which is a base of evaluating and analyzing port competitiveness has been overlooked. Because of this, it is hard to ensure consistency in this problem since the criteria are different in every study.

Therefore, this study aims to examine the existing port selection studies in various perspectives. Firstly, the existing studies will be examined by basic structure that was suggested by Murphy(1992). Furthermore, the existing studies will be classified in terms of the time, type of data, methodologies and scholars, and analyzed to figure out port selection criteria and its conceptual definition.

2. Trends in Maritime Industry

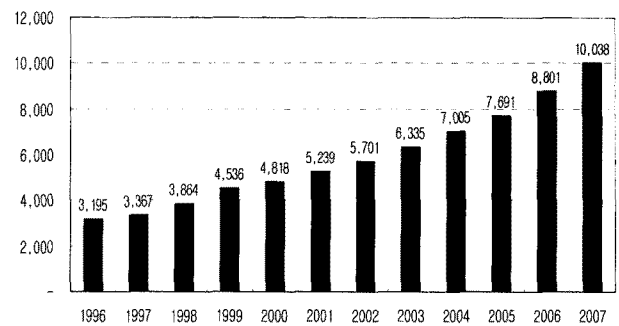
Before reviewing related studies, we will observe the environmental changes of shipping and port industry. As an environmental change of industry is dynamic, it usually affects main objective of study: for instance, since it was the time of lack of port development before 1980, studies at that time considered port facilities as a crucial factor. On the other hand, after 1990, it was the time that the competition among port got tough, hence port charge and service were considered as crucial factors for port selection problem at that time. Since the environmental changes in shipping and port industry affects port selection criteria, this chapter will investigate the trend of shipping and port industry.

2.1 Large vessel and growing capacity

Liner shipping companies have deployed large vessels in order to achieve economies of scale. It was common size of container vessel that is 3,000TEU in 1980s. But soon it was introduced 6,000 TEU vessel by Maersk Line in 1996 and 8,000 TEU in 2000. Moreover, Maersk Line operated 11,000 TEU in 2006, after that some other shipping lines placed an order of 13, 296 TEU vessel. As a container vessel size continuously increases, it affects port operation: increased sizes and numbers of port facilities, reduced number of port

visit, required high technology handling system and so on.

Specially, as world trade demand increases, the capacity of container vessel also steadily increases: as shown in Fig.2, the vessel capacity owned by liner shipping companies has been increased from 5 million TEU in 2001 to 10 million TEU in 2007 which is more than twice.



Source : Containerisation International(2008)

Fig. 2 The changes of vessel capacity of world top 100 liner shipping companies (unit: 1000 TEU)

2.2 Spreading M&A among global large liner shipping companies and their market power

Global shipping lines are expanding M&A among themselves in order to reduce the risk of new shipping route and increase market power. Also, they are building worldwide port networks by ensuring dedicated terminals. According to the data released in 2006, global shipping lines hold total 154 dedicated terminals. Moreover, they are forming port networks by cooperating with terminal operation company, and investing terminal development. These changes will affect liner shipping companies' decision to select the port.

Table 1 World top 10 container liner shipping companies (2006)

Liners	No. of Vessel	Capacity (1,000TEU)	Market Share(%)	
			Share	Accumulative Share
Maersk	518	1,600	15.6	15.6
MSC	305	937	7.4	23.0
CMA CGM	252	598	4.9	27.9
Evergreen	166	540	4.7	32.6
Hapag-Lloyd	138	449	4.2	36.8
APL	100	323	3.3	40.1
China Shipping	97	340	3.2	43.3
Cosco	125	385	3.2	46.5
Hanjin	80	328	3.0	49.5
NYK	115	313	2.7	52.2

Source : Containerisation International(2008)

2.3 Global port operation and increasing market share

Ports are improving themselves by specialized their operation business. Their market share is gradually increasing since they were grown up as global terminal operator. Especially, those world major global terminal operators, Hutchison Port Holding(HPH), Dubai Port World(DP WORLD), A. P. MOLLER Terminals(APMT's), Port Singapore Authority(PSA) and China Ocean Shipping Company(COSCO), operate total 167 terminals all over the world where their market share in 2006 reached 51% from 44% in 2004. As shipping lines are eager to ensure the dedicated terminal, and port operation companies globalize their operation business, the competition among terminals is getting fiercer and threatening small and middle size of terminals in the market.

Table 2 Market share of global terminal operators

구분	No.of terminal	2004		2005	
		Throughput (1,000TEU)	Market Share (%)	Throughput (1,000TEU)	Market Share (%)
HPH	35	478	13.3	518	13
APMT's	42	319	8.9	404	10.1
DP World	44	333	9.3	367	9.2
PSA	26	331	9.2	403	10.1
Cosco	20	130	3.7	147	3.7
소계	167	1,591	43.8	1,839	46.1

Source : Drewry Shipping Consultants(2007)

3. Literature Review

In this chapter, previous literatures are re-organized based on basic structure that was proposed by Murphy(1992). Furthermore, the characteristics of port selection criteria that proposed by prior scholars are analyzed and compared in order to identify the limitations. It will show the different port selection criteria in terms of changes of industry environment, propensity of scholar, methodology and research target. Finally, we analyze each port selection criteria by author and then, figure out port selection criteria that will use in this study.

3.1 Classification of literatures in port selection problem

Based on Murphy(1992)'s basic structure, literatures in port selection problem were classified. Suggested basic structure is consisted of "Decision" and "Respondent's Role". Based on these, there are total 4 sub-classification;

"Single Decision-Single Role", "Single Decision-Multiple Role", "Multiple Decision-Single Role" and "Multiple Decision-Multiple Role". Here, the "Decision" means type of transportation or choice of seaport/airport, while "Respondent's Role" indicates type of business of survey respondent. The result of classification is shown in <Fig.3> and the details are explained in <Table 3>. Even though it is somewhat unjustifiable to characterize each part based on <Fig.3>, it has the contribution that literatures can be simply classified like <table 3> and the research goal and result can be intuitively observed.

	Single Decision	Multiple Decision
Single Role	Brooks 1985, 1990 Murphy et al. 1988, 1991 UNCTAD 1992 TC Lrin et al. 2004	Willingale 1981 Murphy et al. 1991 Philip et al. 1996 TC Lrin et al. 2003
Multiple Roles	Slack 1985 Burdg & Daley 1985 Murphy et al. 1989(TJ, IJD) Song & Yeo 2004	Foster & Strasser 1990 Murphy et al. 1992

Fig. 3 Re-classification of literatures of port selection problem

Table 3 Summary of literatures by "Decision" and "Respondent's Role"

Study	Decision making	Type of respondent firm
Burdg & Daley(1985)	Inbound carrier selection Outbound carrier selection	U.S. shippers
Willingale(1981)	Calling water port selection	European water carriers
Slack(1985)	Water port selection	Freight forwarders, U.S. shippers
Brooks(1985, 1990)	Container shipping services	Eastern Canadian exporters
Murphy et al.(1988)	International water port selection	Worldwide water ports Worldwide water carriers
Foster & Strasser(1990)	Motor carrier selection Railroad selection	Shippers, Motor carriers, railroads
Murphy et al.(1988)	International water port selection	Large U.S. shippers
Murphy et al.(1989)	International water port selection carrier selection	International freight forwarders
UNCTAD(1992)	Water port selection	Freight forwarders
Murphy et al.(1992)	International water port selection	International water ports/water carriers/ freight forwarders, Large and Small U.S. shippers
Philip et al.(1996)	Transportation mode selection	Lager Minnesota shippers
Lirn T.C. et al.(2004)	Transshipment port selection	International water carriers
Song & Yed(2004)	Port competitiveness(selection)	Ship owners, shipping companies, shippers, terminal operators etc.

3.2 Review by period

1) Review of 1980s

The literatures that published in 1980s were reviewed. This period is a beginning of port related studies. The representative studies are Willingale(1981), Slack(1985) and Murphy(1988, 1989).

Most of studies in this time suggested port competitiveness criteria with empirical methods such as port facility and equipments, port charge, transit time, frequency of travel and damage on cargo, hinterland connectivity, potential market location and hinterland, port accessibility and so on. The analysis results chose capacity of port facilities and equipments, port service, port charge and cargo damage as major criteria.

2) Review of 1990s

On the other hand, the studies in 1990s, Peters(1990), UNCTAD(1992) and Philip et al.(1996), considered more various criteria, i.e. politic, social stability, geographical location and quantity of throughput. Specifically, Murphy(1992) concluded that handling of non-standard size cargo and handling ability for large volume are important factors where this result is different from his study in 1988. As have seen, the analysis results of 1990s' studies selected service quality, transit time, equipment ability and cargo information as major criteria.

3) Review of 2000s

The studies in 2000s are improved the procedure of drawing the port competitiveness criteria and considered the details of criteria. Also, there are a number of studies that have paid attention to port competition. The analysis results of 2000s' studies show that the factors such as geographical location and size of hinterland economy received more attentions than before, and port competitiveness criteria are

Table 4 Literature reviews about port selection by the time

Period	Author	Reserach Target	Major port selection criteria
1980s	Willingale(1981)	Carriers	Equipment availability Frequence sailing/loss/damage Service quality Costs(Handling charges)
	Slack(1985)	Customers, Forwarder	
	Murphy(1988, 1989)	Port operators, Carriers	
1990s	Murphy(1992)	All users	Service quality Transit time Equipment availability Shipment information
	UNCTAD(1992)	Customers, Forwarder	
2000s	Cullinane(2000)	Reviews	Port location Economic size(market niche/hinterland/FTZ etc.) Costs(THC/Inland/etc.)
	Lim(2003, 2004)	Specialist, Carriers	
	Song & Yeo(2004)	Specialist	

evaluated with actual port selection rather than demonstrative examination.

3.3 Review by data and methodology

The difference of port selection criteria is caused by research period and also data and methodology. Literatures can be divided in terms of their analysis methodology; i.e. statistical analysis (based on survey data) and quantitative analysis (based on collected information or numerical value). The detail comparison result is presented in <Table 4>. The studies based on quantitative data analysis dealt with distance, time and cost of shipping and inland transportation, market share, frequency and type of cargo since these categories of data are easy to collect. On the other hand, the studies based on survey data dealt with both quantitative and qualitative data such as port geographical location, service quality, hinterland connection, facilities and equipment ability and cargo loading information.

As shown, the comparison results of previous studies show that the port selection criteria can be very different in terms of type of data, time period and analysis region. Thus, this point should take into account in port selection criteria.

Table 5 Literature reviews about port selection by data types and methodology

Method	Scholars	Major port selection factors
Quantitative data analysis	Malchow & Kanafani(2001)	Transit cost, Transit time Frequence of service Distance to ports (Distance of shipper from port) Market share
	Veldman & Buckmann(2003)	
	Tiwari et al.(2003)	
Survey data analysis	Willingale(1981)	Service quality Transit time Equipment availability Shipment information
	Slack(1995)	
	Murphy et al.(1991)	
Survey + Quantitative	Lim T.C. et al.(2003)	Port location Port facility Service level Carriers' port cost
	Song & Yeo(2004)	

4. Summary and Limitation

The existing studies on port selection problem relatively well defined about port selection criteria and demonstratively analyzed with samples. Slack(1985) divided decision factors into port selection criteria and port service criteria and analyzed their priority which is important to practice to apply. Although Murphy(1987, 1988, 1991, 1992) carried out port selection criteria only empirically, the analysis procedure has been improved and the results are

carried in terms of company and characteristic. The uniqueness of French(1979) and Peters(1990) is that they classified port selection factors to port internal factors and external factors. Cullinane and Toy(2000) contributed by re-examination of transportation selection behavior through reviewing related literatures. Recent studies done by Lirn et al.(2003;2004) and Song and Yeo(2004) researched port selection criteria and structural items specifically, and evaluated actual ports by AHP analysis. However, there are limitations of existing studies.

Firstly, port selection criteria in existing studies are mostly similar, but there are many of different factors. If every study uses different criteria, it is difficult to ensure consistency. Moreover, selection of criteria has been mostly done by empirical experience without statistical process or analysis.

Secondly, existing studies seldom approached this problem from liner shipping companies' perspective. In general, major port users are shipping lines: shippers and freight forwarders are potential users. It could happen that shippers and forwarders make a special request to visit a certain port in the case of tramp, however mostly shippers

and forwarders choose shipping lines to send their cargoes, not choose port to visit. It is an essence right of shipping line to select port.

Thirdly, many of existing studies did not consider the difference of region. Most of studies targeted port users who visit the ports in author's own country. Murphy(1988) analyzed port in America and ports in other countries separately, but this study analyzed port criteria from port operator's perspective; not port users. At last, existing studies mainly focused on finding port selection criteria, or port competitiveness factors or analyzing selection criteria in terms of port users. It is hard to find such study considering the relationship of port selection criteria with the variables like purpose of port visit and preference. The frequency of port visit and preference is the factors that may give port and terminal operator an opportunity to make a profit.

5. Port Selection Criteria

In this section, previous literatures will be compared in

Table 6 Comparison of decision factors by authors

Criteria of Port Selection	Authors										
	Willingale (1982)	Brooks (1984)	Slack (1985)	Murphy et al. (1989)	Peters (1990)	Murphy et al. (1992)	UNCTAD (1992)	Philip et al. (1996)	Cullinane & Toy (2000)	TC Lim et al. (2004)	Song & Yeo (2004)
Quay length and number of berth	✓		✓		✓		✓		✓	✓	✓
Space of terminal and CFS	✓								✓	✓	✓
Equipment availability & suitability (G/C, T/C, S/C etc.)			✓	✓	✓	✓	✓	✓	✓	✓	✓
Max ship size for berthing				✓		✓		✓		✓	✓
Cost related to vessel and cargo entering	✓	✓	✓		✓		✓	✓	✓	✓	✓
Cost for cargo handling, transfer land storage	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Cost for inland transportation	✓	✓	✓				✓	✓	✓	✓	✓
Port operation and management	✓				✓		✓				✓
Stability of ship and cargo(Loss and damage etc.)		✓		✓		✓		✓	✓	✓	✓
Flexibility of cargo handling(including special cargo etc.)		✓			✓			✓	✓		✓
Reliability of berth scheduling and cargo handling		✓		✓		✓		✓	✓	✓	✓
Auxiliary service(fresh water,fuel oil and ship's stores provision)											
Frequency of ship's calling		✓	✓						✓	✓	✓
Port and waiting time(above all transit time)		✓	✓	✓		✓		✓	✓	✓	✓
Port MIS (VTS, information of ship and cargo etc)		✓		✓		✓	✓		✓		✓
Voyage and transport distance	✓										✓
Deviation from main trunk routes			✓								✓
Accessibility to port and route	✓	✓								✓	✓
Land distance and connectivity to major shippers	✓		✓		✓		✓			✓	✓
Traffic volume and throughput				✓				✓	✓	✓	✓
Economic size of local and regional market niche	✓				✓						✓
Size and activity of port hinterland or FTZ					✓					✓	✓
Bilateral/National trade volumes							✓				✓
Stability of port labor and employment					✓		✓			✓	✓
Political stability					✓		✓				✓
Change in port and social environment					✓						✓
Connectivity of Inland transport network	✓		✓				✓			✓	✓
Connectivity of hinterland/distripark/market	✓						✓				✓
Diversity of transport mode(road,rail,canal,air etc.)	✓						✓			✓	✓

terms of research time, type of data and methodology, and authors in order to figure out port selection criteria that this study will suggest. <Table 6> shows the comparison of literatures in terms of port selection criteria.

The comparison results show that proposed port selection criteria are different. Also, in recent studies, it includes not only port internal factors such as port facility, port charge, port service, but also geographical location, size of hinterland economy, hinterland connection. This fact can be explained that port external factors, those have been mentioned its concept by French(1979) and Peters(1990), receive more attentions than before. Kim et al.(2004) has concluded same result. Therefore, this study classifies various port selection factors into port internal and external factors based on study by French(1979) and Peters(1990).

Based on overall comparison results, we carried out port selection criteria as shown in <Table 6> and its conceptual definition as presented in <Table 7>.

6. Conclusion

According to the trend of large vessel, merging and strategic coalition among liners, dedicated terminal, and the competition among liners, ports competition is getting tougher. Most of studies related to port selection focused on improving competitiveness in order to overcome highly competitive situation. Also, these studies considered more on internal factors such as port facility, charge, service and marketing among port selection criteria.

Therefore, this paper studied port selection factors in terms of times, type of data and methodologies, and authors where those are basic research area but which has not been

paid attention. By reviewing literatures, each decision criteria proposed by various studies were classified into port internal decision factor and port external decision factor and the conceptual definitions of these factors were presented. Thus, port selection criteria suggested in our study can be divided to port internal decision factor and port external decision factor. Port internal decision factors are including port facility, port charge, port service and conditions of vessel access, while port external decision factors are containing geographical location, size of hinterland economy, conditions of social/political situation and hinterland connection.

Port selection factors suggested in this study are crucial factors to achieve competitiveness in the fierce competition market. These decisive factors affect shipping lines' decision to choose a port both directly and indirectly. Therefore, it is needed to analyze causal relationship of suggested port selection factors with competitiveness, productivity, preference, purpose of port call as a dependent variable. Moreover, it needs to be studied continuously because port selection criteria can be different in terms of the period.

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Table 7 Suggested port selection decision factors and definition of concept

	Factors	Criteria defined	Criteria included
Port Internal Factors	Port facilities	Quay length and number of berth, Space of terminal and CFS, Equipment availability & suitability (G/C, T/C, S/C etc.), Max ship size for berthing	1, 2, 3, 4
	Port cost	Cost related to vessel and cargo entering, Cost for cargo handling, transfer land storage, Cost for inland transportation	5, 6, 7, 8
	Port service	Port operation and management, Stability of ship and cargo(Loss and damage etc.), Flexibility of cargo handling(including special cargo etc.), Auxiliary service(fresh water,fuel oil and ship's stores provision)	9, 10, 11, 12
	Conditions of Vessel access	Frequency of ship's calling , Port and waiting time(above all transit time), Port MIS (VTS, information of ship and cargo etc)	13, 14, 15
Port External Factors	Geographical Location	Voyage and transport distance, Deviation from main trunk routes, Accessibility to port and route, Land distance and connectivity to major shippers	16, 17, 18, 19
	Size of hinterland economy	Traffic volume and throughput, Economic size of local and regional market niche, Size and activity of port hinterland or FTZ, Bilateral/National trade volumes	20, 21, 22, 23
	Conditions of social/political	Stability of port labor and employment, Political stability, Change in port and social environment	24, 25, 26
	Hinterland Connection	Connectivity of Inland transport network, Connectivity of hinterland/distripark/market, Diversity of transport mode(road, rail, canal, air etc.)	27, 28, 29

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