An Evaluation of Container Ports in China and Korea with the Analytic Hierarchy Process

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AN EVALUATION OF CONTAINER PORTS IN CHINA AND KOREA WITH THE ANALYTIC HIERARCHY PROCESS

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Abstract: Since China adopted its liberalized economic policy, the average growth rate of Chinese economy has exceeded 10% per annum. Especially, port development and advancement in China are conspicuous in the case which refers to import and export, as China handles approximately 90% of the relevant cargo by relying upon maritime transport. Such remarkable growth in China gives an impetus to Korean ports, since both China and Korea are located at the same region in Northeast Asia, and the two lie in direct competition. In this respect, the purpose of this study is to figure out the order of competitive power of container ports, which are situated on China's east and south coasts, even including ports of Korea. The Analytic Hierarchy Process(AHP) method has been adopted as the methodology of this study, which is a method of problem solving-decision making.

Key Words: Analytic Hierarchy Process, Competition, Container Ports, China, Korea

1. INTRODUCTION

The general meaning of "port" can be defined as "an interface linking marine transportation and inland transportation". This part is an integral space that acts as a base for logistics, production, living, information production and international trade function, and a base for economic development of hinterland (Frankel, 1987). Today, nearly 90% of the world's trade volume is handled through ports. This well accounts for such infrastructure as how ports attach the great weight to the development of national economy. That is to say, a port plays a significant role in transferring the economic wealth accrued from handling enormous cargo volume and its processing to the hinterland, and conveying it to the national economy (Lee, 1998).

In spite of such importance of a port as a logistics infrastructure, the status of ports in China shows numerous difficulties in the aspects of port facilities and their operation. That is, China is now in the middle of a serious bottle-neck course, due to facility shortage, what with steeply increasing transportation traffic demand resulting from China's economic open-door policy. Also, the opportunity cost to be incurred from scarcity of infrastructures, such as railways and road systems, and inefficiency of inland inter-link transportation system, is estimated at 1% of GDP per annum (Ha, 2000).

In addition, port congestion in China has become aggravated due to the limitation of water depth in the east and south coasts of China, long since obsolete port facilities, poor hinterland facilities, delayed or late expansion of facilities that is untimely to meet increasing demand for freight traffic (Ha and Zhang, 2000). But Chinese exportation and importation are expected to increase greatly since China is now a formal member of the WTO. This expectation can be derived from the facts that China has 23% of the world's population, and a total trade volume of 473.3 billion dollars in 2000 which accounts for its being world's tenth largest trader as well as third in the marine transportation industry. Many see China as the sure-to-be world's largest trader. In order to handle the increased trade volume, China has carried out both computer hardware measures, such as large-scale port development, and computer software improvements, such as introduction of competitive system for marine transportation markets, deregulation of marine transportation, deregulatory measures for a direct call of a port, and maintenance of marine laws. Such improvements on Chinese ports have served as a stimulus to Korea's ports - which are situated nearby - and compete directly with them. Therefore, in order for Korea's ports to secure a leading position in competitiveness, port authorities have implemented government-aided programs aimed at expanding port facilities, rendering updated port services, and promoting port marketing.

Generally, when referring to competition, it usually means our strenuous efforts exerting to overtake our competitors. Ports competition refers to the development and application of differentiated strategic alternatives so as to lure more customers over other ports (Yeo and Lee, 1999). In such situation, it is essential for a competitive port to have the power to defeat other ports. This can be what is meant by the definition of port competition (Heaver, 1995).

Following are some reviews of previous studies on the port competition factors and the considering factors used when shipping lines and shippers select ports. Murphy *et al.* (1992) focused on port detention, port size, port accessibility, and calling frequency; French (1979) suggested terminal facilities, tariffs, port congestion, service level, connectivity, and port operators as internal components, while considering the economy of hinterland, the economic status of the nation, trade policy, and the world economic trend as external components. Peters (1990) put emphasis on the service level, available facility capacity, status of the facility, and port operation policy, calling them internal factors. As external factors he took the examples of international politics, change of social environment, trade market, economic factors, features of competitive ports, functional changes of transportation, and materials handling. Calling frequency, tariffs, accessibility to the port, port congestion, and inter-linked transportation network were considered affecting factors by Slack (1985).

Willingale (1981) surveyed the selection standards of port as well as the decision making process of the calling port, for the 20 liners in 1982. His study reveals that the selecting process consists of the following stages: the available port locating stage, judgment and examination stage, approach, visit and evaluation stage, preliminary discussion stage, negotiation stage, and selection stage. In the process of selecting a particular port, shipping lines consider the location factor, technical factor, operational factor, fiscal factor, and manpower factor. Kim(1993) analyzed the decision factors of port selection for Korean shippers, consignees, and liners. Distance between origin and destination, annual cargo handling volume, loading hours, average detention hours at port, goods value per tonnage, and inland trucking cost per kilometre affect exporting from higher to lower influencing order. Meanwhile, sea transportation distance, number of liners for calling-in, annual volume by import, inland transportation charges/km are the major factors for import port selection. In Jeon's study in 1993, important decision factors of port selection contained navigation facilities and equipment holding status, port productivity, price competition, and port service quality.

Examining the above previous studies on port competition, the port expansion and development strategies in China may cause severe competition among ports within China, and then induce fierce port competition among adjacent countries. In this aspect, the purpose of this paper is to figure out the integrated order of competitiveness among ports which are situated on China's East and South coasts, even including Korea's ports, which compete with China's ports for the position of mega hub-port in Northeast Asia. The subject of this study covers ports of Hongkong, Shanghai, Yantian, Qingdao, Tianjin, Xiamen, Dalian, and Shekou, which were selected for their comparative evaluation. These ports are among the world top 100 in terms of TEUs handled per annum(Containerization International Yearbook, 2001). Also, in order to compare with Korea's ports, Busan port and Incheon port were selected and evaluated with China's ports simultaneously.

The composition of this study is as follows: it examines the methodology of the Analytic Hierarchy Process(AHP) method in the second section, following the introduction. Detailed elements of port competitiveness are extracted and data by detailed elements are obtained in the third section. China's port competitiveness is compared with and analyzed by the AHP method and also made an integrated comparative evaluation which lie in competition relationships with Korea's ports in the forth section. The conclusion is drawn from the above results in the final section.

2. METHODOLOGY

The AHP is a theory of measurement for dealing with quantifiable and/or intangible criteria. The AHP has found rich applications in decision theory, conflict resolution, and in models of brain. It is based on the principle that, to make decisions, experience and knowledge of people is at least as valuable as the data the relevant people use. A useful feature of the AHP is its applicability to the measurement of intangible criteria along with the tangible, through ratio scales. In addition, by breaking a problem down into its constituent parts and relating them in a logical fashion from the large - descending in gradual steps - to the smaller and smaller, one is able to connect the small to the large through simple paired comparison judgments (Vargas, 1990).

The AHP is a tool that has found uses in a wide range of problem areas from simple and personal to complex and capital intensive decisions. Especially, application of AHP to maritime transport, a few studies can be recognized – for example, Frankel (1992) on shipping policy decision-making and Kumar (2002) on liner shipping competition policy debate. However, these two studies are limited only to the analytical discussion of AHP on the chosen policy issues. As an initiative for empirical applications of the model to maritime transport, this paper conducts a step-by-step process under the accepted framework. What follows is a brief explanation of the computation procedures – the three stages – of AHP method, which will be applied to Chinese container ports for perceived competitiveness measurement in section 4 (see Saaty and Vargas, 2001 for detailed and justified processes):

1) First stage

Problems under complex conditions must be analyzed into a hierarchy structure. But the top level of the hierarchy is the overall goal that consists of one. Here, detailed elements of each level exclusive of overall goal is 7 ± 2 that is maximum allowable weights. Alternatives will take its place on the lowest bottom level (Miller, 1956; Wilkinson, 1965).

2) Second stage

Pair-comparisons are made for detailed elements of a level (Saaty, 1980). If n is the number of comparative elements, decision-makers will make pair-comparisons as many times as $\frac{n(n-1)}{2}$. The values used as a measure for the pair-comparisons are 1/9, 1/8, … , 1/2, 1, 2, … , 9. The weights of elements at each level are computed from the pair-comparisons of each level thus obtained. At this time, since the answers to decision-makers are not expected perfect consistency, consistency index is used to measure the degree of consistency. To obtain weights of the criteria in the AHP method, see the following:

The number of criteria n is $A_1, \cdots, A_n$ and when the original weights for them are $w_1, \cdots, w_n$ the relative comparative value of the weights of A_i and A_j, a_{ij}, satisfies formula

$$a_{ij} = \frac{w_i}{w_j} \tag{1}$$

Formula (2) shows the constitution of comparison matrix (A) by use of a_{ij} mentioned above.

$$A = \begin{bmatrix} \frac{w_1}{w_1} & \frac{w_1}{w_2} & \cdots\cdots & \frac{w_1}{w_n} \\ \frac{w_2}{w_1} & \frac{w_2}{w_2} & \cdots\cdots & \frac{w_2}{w_n} \\ \vdots & \vdots & & \vdots \\ \frac{w_n}{w_1} & \frac{w_n}{w_2} & \cdots\cdots & \frac{w_{n1}}{w_n} \end{bmatrix} \tag{2}$$

When this comparison matrix A is multiplied by the vector of weights(w), vector $n \cdot w$ is obtained. That is,

$$A \cdot w = n \cdot w \tag{3}$$

To express it in detail is followed by formula (4).

$$\begin{bmatrix} \frac{w_1}{w_1} & \frac{w_1}{w_2} & \cdots\cdots & \frac{w_1}{w_n} \\ \frac{w_2}{w_1} & \frac{w_2}{w_2} & \cdots\cdots & \frac{w_2}{w_n} \\ \vdots & \vdots & & \vdots \\ \frac{w_n}{w_1} & \frac{w_n}{w_2} & \cdots\cdots & \frac{w_{n1}}{w_n} \end{bmatrix} \begin{bmatrix} w_1 \\ \\ w_2 \\ \\ w_n \end{bmatrix} = n \begin{bmatrix} w_1 \\ \\ w_2 \\ \\ w_n \end{bmatrix} \tag{4}$$

This formula is for the eigenvalue problem and can be changed into

$$(A - n \cdot I) \cdot w = 0 \tag{5}$$

Here, for $w \neq 0$, n must be A's eigenvalue, when w is A's eigenvector. Here, the eigenvalues λ_i ($i = 1, \cdots, n$) are all 0 except only one. Also, as the sum of diagonal elements is n, if the only λ_i which is not 0 is $\lambda_{\max}$, it follows as λ_i=0, $\lambda_{\max}$ = n ($\lambda \neq \lambda_{\max}$). Therefore, Weighted vector, w for $A_1, \cdots, A_n$ is normalized eigenvector ($\sum w_i = 1$) for A's principal eigenvalue, $\lambda_{\max}$.

However, in effect, when we try to solve complex problems, we have to obtain w', as w is not known. The value of w' can be obtained from computation of pair-comparison matrixes which were received from decision-makers' answering responses. Hence, the problem is then changed into $A^{'} \cdot w^{'} = \lambda^{'}_{\max} \cdot w^{'}$ ($\lambda^{'}_{\max}$ is the principal eigenvalue). In this situation, $w^{'}$ is normalized eigenvector, $\lambda^{'}_{\max}$ for which is principal eigenvalue for $A^{'}$. But in reality, the more complex the circumstances become, the more difficult it is to expect the consistent answers from decision makers. As such, $A^{'}$ is not consistent, $\lambda_{\max}$ will always remain bigger than n. This is made clear by Satty's Theorem(Satty, 1980):

$$\lambda_{\max} = n + \sum_{i=1}^{n} \sum_{j=i+1}^{n} (w^{'}_j a_{ij} - w^{2}_i)^2 / w^{'}_i w^{'}_j a_{ij} \cdot n \tag{6}$$

That is, the formula $\lambda_{\max} \geq n$ can be formed by formula (6) at any time. Equality can be complete only when there is consistency. Consistency scales are shown below in formula (7), which is called the Consistency Index(C.I.).

$$C.I. = \frac{\lambda^{'}_{\max} - n}{n - 1} \tag{7}$$

When the reciprocal pair-comparison matrix (A) has absolute consistency, C.I. value is 0. As C.I. values increase, inconsistency also increase. When the C.I. values are below 0.1, consistency is considered satisfactory.

Whereas, if the diagonal element is '1' and symmetric elements in a matrix are in a reciprocal relationship, the average M can be obtained by a series of computations of A 's C.I. after randomly being put values, 1/9, 1/8, …, 1/2, 1, …, 9.

Table 1. Random Consistency Index

n		2	3	4	5	6	7	8	9	10	11	12
M	0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49	1.51	1.53

The formula that obtaining random consistency ratio (C.R.) is done by dividing C.I. values acquired previously by M is as follows:

$$C.R. = \frac{C.I.}{M} \tag{8}$$

This C.R. value can also be used for another index showing consistency, when the C.R. value is below 0.1, the solution to weights can be considered acceptable.

3) Third stage

The evaluation value for each level's elements is obtainable through the relevant data, the final order of alternatives is set multiplying prepared values by weights.

3. DATA

3.1 Extraction of Detailed Elements of Port Competitiveness

This paper focuses on the detailed elements relevant to port competitiveness in terms of logistics services. Necessary information and data are collected through a series of surveys towards a group of experts – 350 professionals, composed of ship owners, shipping companies, shippers, terminal operators, and academic and research institutes in Korea. The survey – both face-to-face and telephone interviews – was conducted over two months between April and May 2001. Of 350 interviewers, a total of 180 respondents were successfully collected. The interviewees were requested to freely describe any intrinsic factors, which might be related with port competitiveness. Throughout the survey 73 detailed elements and/or factors for port competitive edge were extracted as listed in Table 2.

Table 2. List of Port Competitiveness Elements

- application of EDI system - average hours of port congestion - berth/terminal availability - building Port MIS - capacity of transportation connectivity - capacity/status of facilities available - cargo volume of handling transhipment - changes of social environments - changes of transport and cargo function - complete preparation of multimodal Transport - concentration of volume by export/import - customs clearance system - dredging : yes or no - easy excess to port - economy scale of hinterland - effectiveness of terminal operation - existence of cargo tracing system operation - existence of port hinterland road - existence of Terminal Operating System - existing pattern of navigation routes - extent of port EDI - financial factors of port - Free Time of container freight station - frequency of ship's calling - handling charge per TEU - handling volume of export/import cargo - inland transportation cost - inter-linked transportation network - internal politics - loading time - location factors of the port concerned - market position within the area - mutual agreement of port users - navigation distance - nearness to hinterland - nearness to main trunk	- number of liners calling at ports - personnel ability of port - port accessibility - port congestion - port facilities - port marketing - port operation - port operation by government - port operation by local autonomous entity - port operation by private - port operation strategies - port operation time - port ownership - port productivity - port service - port size - port tariff - possibility of mutual reference of electronic computation network - price competitiveness - response of port authorities concerned - road network to be fully equipped - sea transportation distance - securing deep draft - securing exclusive use of equipment - securing fairway - securing navigation facilities/equipment - securing railroad connection - status of national economy - sufficiency of berth - sufficiency of securing information equipment - technical factors of port - terminal facilities - trade market - trade/commerce policy - transportation distance - types of port operation/management - world business

It was found that there were some duplicated and correlated items in those extracted elements. In order to adjust those items, 70 members among 180 respondents were recruited. Those 70 members identified the five most important criteria to the competitiveness of port businesses. These are *cargo volume*, *port facility*, *port location*, *service level* and *port expenses* which are stemmed from KJ method(Kawakita, 1986; Tseng, 1997; Lewis, 1998; Niikura, 1999) applied to the detailed elements listed in Table 3. But, port expenses, we decided to excluded because it seemed difficult to compare them directly item by item and codes of practice were also quite different in China. The details of each item are as follows:

Cargo Volume
Handling more cargoes means a more preferable port from the viewpoint of users. Cargoes include exports, imports and transhipments.

Port Facility
The greater the capacity, the higher the competitiveness. Port facility includes both infrastructure and superstructure, such as berths, cargo equipment, and stowage capacity.

Port Location
Having a good location is deemed to render a port more competitive. Port location includes geographical aspects such as hinterland accessibility and convenience of vessel entry, and further development conditions and possibilities.

Service Level
The higher the overall quality of service provided to users in a port area, the higher competitiveness.

In order to calculate empirical values of those criteria, it is needed to define 'identifiable or representative attributes' of each criterion so that measurable or quantitative data is easily extracted. As for *cargo volume*, throughputs (either in terms of TEUs or tonnes) handled at a port provide a basis of the evaluation. The attributes for *port facility* include wharf facility, handling equipment and storage facility. Of these elements, berth length shows a representative attribute for the item since the number of berth, equipment, and storage capacity are usually dependent on the berth length. The attributes for *port location* include service frequency of liners, geographical location, hinterland economy, potential of future development. Of these detailed attributes, however, geographical location, hinterland economic condition, and future development cause a difficulty in representing quantifiable values; thus service frequency of liner operations is adopted as a representative attribute for the item port location. A representative attribute for *service level* is information system – cargo handling information, cargo tracing information, port management information system (Port-MIS) – implemented in a port since this information technology can be regarded as a key service item that port users are looking for in the current business trend. Table 3 summaries those identifiable and representative attributes to be employed in this study.

Table 3. Port Competitiveness Criteria and Representative Attributes

Criteria	Cargo Volume	Port Facilities	Port Location	Service Level
Representative Attributes	Throughputs handled	Berth length	No. of liners calling at ports	information service

Hierarchy structure based on representative attributes abstracted is as follow.

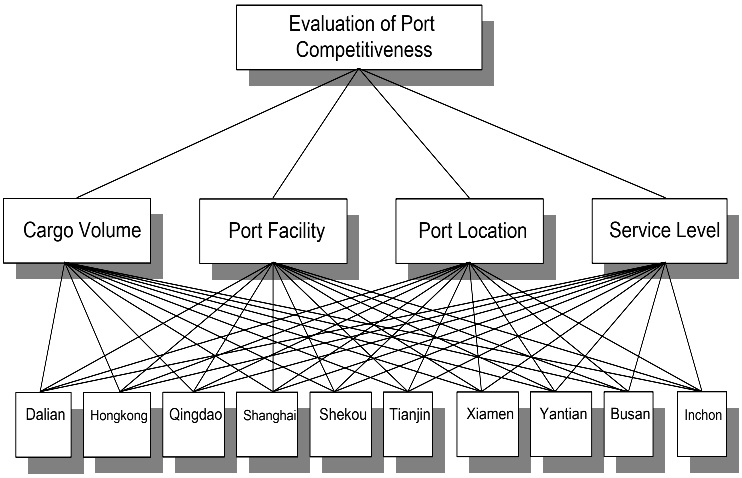

Figure 1. Decomposition of the Problem into a Hierarchy

3.2 Data of Each Ports

3.2.1 Present Status of Chinese ports

It may not be too outlandish to say that China's import/export are almost entirely dependent on seaborne transportation and ports' facilities since 90% China's total import/export has been carried on through ports. In addition, freight volume necessary to transport via steamers is constantly increasing, owing to China's growing import/export rate. In 2000, Chinese ports, as a whole, were estimated to handle up to 40 million TEU, which clearly shows that China is emerging as the world's largest marine transportation market and consignor country.

Taking a brief review of Chinese ports, Hong Kong is world's largest container terminal, enjoying an 11.6% growth rate in 2000, with its growth rate ranked 21st. But its annual increment of freights by itself amounts to 1,887 thousand TEU which was more than the sum of total freights of all competing ports treated in a whole year. Shanghai Port handled 5,612 thousand TEU, posting the world's 4th fastest growth rate. Since 1998, Shanghai has made spectacular growth with 21.7% in 1998, 37.3% in 1999 and, 33.8% in 2000. As a result, the port's influence has increased, forcing shippers or service providers to readjust their trade routes and general rescheduling within the area (Lee, 2001). Dalian Port and Qingdao Port, situated in northern China Sea, are relatively small ports, but recorded higher freight increased rates, 36.6% and 36.4% respectively. Container handling outlook for major ports in China are as follows:

Table 4. Status & Outlook for Container Handling for Major Ports in China

(Unit: Million TEU)

Port	Treated			Prospect	
	1999	2000	Growth Rate (%)	2006	2011
Hong Kong	16.2	17.8	9.8	20.08	22.119
Shanghai	4.2	5.613	31	15.813	27.384
Shenzhen	2.984	3.933	34	8.023	15.309
Qingdao	1.54	2.12	38	2.981	4.803
Tianjin	1.3	1.708	31	3.134	5.05
Xiamen	0.85	1.08	27	1.72	2.771
Dalian	0.74	1.011	35	1.653	2.799

Source : Compiled by Kwak(2001), Remark : Shenzhen includes Shekou, Yantian, Chiwan

3.2.2 China Ports data

(1) Cargo Volume(Handling Volume)

As a port's activities, such as planning and developing, focus on driving desirable revenue through maximal treatment of increased import/export freight and transit cargoes, and their maximum handling is crucial. Comparing cargo handling for the year 2000 by the Chinese ports, the research shows that Hong Kong did handle container freight volume of 18,098 thousand TEU, the largest of them all. Following are Shanghai (5,612,000 TEU), Yantian (2,147,476 TEU), Qingdao (2,116,300 TEU), Tianjin (1,708,400 TEU), Xiamen (1,080,000 TEU), Dalian (1,008,400 TEU), and Shekou (720,000 TEU).

Table 5. Handling Volume by Ports

(Unit : TEU)

Port	1993	1994	1995	1996	1997	1998	1999	2000
Dalian	526,158	305,000	370,000	420,000	426,966	475,102	740,000	1,008,400
Qingdao	264,384	430,000	600,000	810,100	1,030,000	1,214,000	1,540,000	2,116,300
Shanghai	900,256	1,130,166	1,527,000	1,971,300	2,520,000	3,000,000	4,210,000	5,612,000
Shekou	67,027	84,080	114,000	89,881	215,027	458,023	573,316	720,000
Tianjin	481,906	592,500	702,051	822,900	-	1,018,000	1,302,000	1,708,400
Xiamen	154,500	225,000	329,000	400,200	-	645,000	850,000	1,080,000
Yantian	-	73,000	106,000	353,509	638,000	1,038,074	1,588,099	2,147,476
Hongkong	9,204,236	11,050,030	12,549,746	13,460,343	14,567,231	14,582,000	16,210,792	18,098,000

Source : Containerization International Yearbook(each year)

(2) Port Facility(Berth Length)

The length of berth for container terminals in Chinese ports is depicted in table 7.

(3) Port Location(Number of Liners Calling a Ports)

A single element that gives a great effect on port's revenue is the number of liners calling ports. Examining liners number by ports, Hong Kong, with 50 liners, surpasses any other ports; Xiamen and Qingdao are relatively low.

Table 6. Berth Length by Ports

Port	Berth Length	Total
Dalian	7 Container Berths	918 m
Qingdao	Terminal 47/48/49/52/53	1,189 m
Shanghai	Boa Shan Terminal : 640 m Jun Gong Lu Terminal : 858 m Zhang Hua Bang Terminal : 783 m	2,281 m
Shekou	Berths 1 & 2	650 m
Tianjin	Berths 21	397 m
Xiamen	1 Container Berths	142 m
Yantian	5 Container Berths	2,350 m
Hongkong	Terminal 1/2/5/8 West : 3 Container Berths, 1,082 m Terminal 4/6/7 : 10 Container Berths, 3,292 m Terminal 3 : 1 Container Berths, 305 m Terminal 8 East : 2 Container Berths 640m	5,319 m

Source : Containerization International Yearbook(2001)

Table 7. Number of Liners Calling a ports

Port	Number of Liners' Direct Services
Dalian	10
Qingdao	8
Shanghai	18
Shekou	13
Tianjin	14
Xiamen	4
Yantian	28
Hongkong	20

Source : Containerization International Yearbook(2001)

(4) Service Level(Port Information Process Service)

Although ports offer various services to ships, fast delivery and provision of information about the port are paramount. Such services which offer information about the port can be classified as hardware and software.

Table 8. Status of Port Information Process by Ports

Port	Port Information Process Service (Computer Systems)
Dalian	Data Management, Vessel Movement
Qingdao	CY management
Shanghai	Software : In-house Functions : Container Yard Operation, Terminal Operations, Import/Export movement, Gate Control, CFS management, Yard tracing, Ship stowage, Statistics, Documentation, Billing, A&F, H/R
Shekou	Software : In-house, Navis SPARCs and Express, Terminal Operations Functions : Terminal Operation
Tianjin	Software : In-house Functions : Container Management, Import/Export movement, Yard tracing, stowage plan, Statistics, Documentation
Xiamen	Software : In-house Functions : Container Inventory Maintenance, Gate and Vessel Operation, Internal Movement, Graphical Yard View and Yard Status Monitoring
Yantian	Software : Ships, CWP, OMS Functions : Container Inventory Maintenance, Gate and Vessel Operation, Internal Movement, Graphical Yard View and Yard Status Monitoring, Engineering Maintenance and Repair Management, EDI
Hongkong	Software : In-house, Open VMS, DECnet, Harbinger EDI Translator, VMScluster, DEC/VAX C, Digital Unix, Solaris, All-in-1, Mantis, Supra Functions : Gate Control, Vessel Stowage, Yard and Terminal Planning, Stevedoring Operations, Spare part Booking Information, Planning and real time control system, equipment and facility maintenance, Order control and Inventory, Berth allocation, Operations Monitoring, Ship Planning, Tractor Paging/development, Tractor monitor, Depot management, Corporate applications and equipment maintenance

Source : Containerization International Yearbook(2001)

In particular, the software services consist of container terminal management system, import/export freight control system, CFS management system, gate control system, and shipment, and management system. These are currently gaining weight in today's modern ports as forming one of the great stimuli to be prompting productivity and lifting the service level for shipping companies and consignors. A quick glance over Table 8 below illustrates that ports receive high marks when provided with quality software and various programs.

4. COMPETITIVENESS EVALUATION FOR PORTS IN CHINA

4.1 Abstraction of Criteria Weights

Criteria weights are computed by pair-comparing elements. Since port logistics has some barriers to the general public in terms of expert knowledge, the surveys were catered to the understanding of the group of expertise. The group was selected from ship owners, shippers, terminal operators, national research institutes, and local government level research centres to gather the needed information. The questionnaires were conducted from June 4, 2001 to June 18, 2001, via E-mails, faxes, standard mails. 48 out of total 70 questionnaires were returned. The comparison value is indicated by numbers ranging from the lowest ‘1’ to the highest ‘9’, discarding ‘o’ and representative value for each matrix indicates geometrical average positively numbered for the whole body.

Table 9. Pair Comparison and Weights of Criteria

Criteria	Cargo volume	Port facility	Port location	Service level	Weight [$w(\cdot)$]	Priority
Cargo volume	1	7.20	0.12	0.16	0.178	3
Port facility		1	0.22	5.70	0.198	2
Port location			1	3.20	0.452	1
Service level				1	0.174	4
		Lambda=4.07,	C.I. = 0.024,	C.R. = 0.026		

Based on the survey's results, those who participated prioritized emphasis starting with location (0.452), which was followed by facility (0.198), freight volume (0.178), and service level (0.174). Also, the consistency ratio stood at 0.026. As the critical value was less than 0.1, it was confirmed that questionnaire result was effective and answering minds were consistent.

4.2 Competitiveness Evaluation for Ports in China

Table 10 shows competitiveness criteria's weight in percentage in Chinese ports. Chinese ports' competitiveness evaluation can be achieved by computing each criteria's weight, using a known percentage. The evaluation value disclosed the fact that Hong Kong was the most competitive (0.2097) with Shanghai immediately following (0.0866), then Yantian (0.0717), Qingdao (0.0449), Shekou (0.0385), Dalian (0.0348), Tianjin (0.0339), and Xiamen (0.0298).

Table 10. Competitiveness Criteria's Weight in % in Chinese Ports

(Based : Year 2000)

		Dalian	Qingdao	Shanghai	Shekou	Tianjin	Xiamen	Yantian	Hongkong
Cargo Volume	Cargo Volume (TEU)	1,008,400	2,116,300	5,612,000	720,000	1,708,400	1,080,000	2,147,476	18,098,000
	Rate	0.0310	0.0651	0.1727	0.0222	0.0526	0.0332	0.0661	0.5570
Port Facilities	Length of Berth (m)	918	1,189	2,281	650	397	142	2,350	5,319
	Rate	0.0693	0.0898	0.1722	0.0491	0.0300	0.0107	0.1774	0.4016
Port Location	Number of Liners Calling at Ports(number)	10	8	18	13	14	4	28	50
	Rate	0.0690	0.0552	0.1241	0.0897	0.0966	0.0276	0.1931	0.3448
Service Level	Port Information Service Comparative Rate (%)	50	50	70	80	60	70	80	100
	Rate	0.0893	0.0893	0.1250	0.1429	0.1071	0.1250	0.1429	0.1786

Table 11. China Ports' Competitiveness Evaluation Value

Port	Cargo Freight (0.178)	Port Facility (0.198)	Port Location (0.452)	Service Level (0.174)	Composite of Priority	
Dalian	0.0310	0.0693	0.0690	0.0893	0.0348	6
Qingdao	0.0651	0.0898	0.0552	0.0893	0.0449	4
Shanghai	0.1727	0.1722	0.1241	0.1250	0.0866	2
Shekou	0.0222	0.0491	0.0897	0.1429	0.0385	5
Tianjin	0.0526	0.0300	0.0966	0.1070	0.0339	7
Xiamen	0.0332	0.0107	0.0276	0.1250	0.0298	8
Yantian	0.0661	0.1774	0.1931	0.1429	0.0717	3
Hongkong	0.5570	0.4016	0.3448	0.1786	0.2097	1

4.3 Relative Evaluation for Important Ports in China and Korea

Ports in China and Korea in some ways supplement each other but in the years to come, they sure will be on competitive terms. The computation of evaluation value for Korean ports by criteria is as follows:

Table 12. Evaluation Value for Korea Ports by Criteria

(Based : Year 2000)

Port	Busan	Inchon
Cargo Volume	7,540,387 TEU	611,261 TEU
Port facility	Gamman Terminal : 4 Berth, 1,400m Jasungdae Terminal : 5 Berth, 1,447m Sinsundae Terminal : 4 Berth, 1,200m Uam Terminal : 2 Berth, 500m (Total : 4,457m)	Container Terminal : 2 Berth, 535m Hanjin Terminal : 3 Berth, 625m (Total : 1,160m)
Port location	42 liners	18 liners
Service level	Software : In-house, HIST automated computer operation with equipment, Computerized terminal entry and tracking system, HIT, Functions : CY and CFS operations, Equipment maintenance and repair records, Personal Management, Stevedoring, Calling schedule, Railroad operations, Invoicing, Accounting and billing, Inductive wireless radio system	Software : Solaris 2.4, Hyun-Young Systems, Dong Yang Functions : Transportation system

Source : Yearly Statistics of shipping and port by Ministry of Maritime Affairs & Fisheries, Korea (2000)

The computation of consolidated percentage of criteria for both countries' ports is depicted in Table 13; consolidated ratings applied by methodology are shown as Table 14.

Table 13. Competitiveness Criteria in Percentage for China and Korea Ports

(Based : Year 2000)

		China								Korea	
		Dalian	Qingdao	Shanghai	Shekou	Tianjin	Xiamen	Yantian	Hongkong	Busan	Inchon
Cargo Volume	Handling Volume(TEU)	1,008,400	2,116,300	5,612,000	720,000	1,708,400	1,080,000	2,147,476	18,098,000	7,540,387	611,261
	Rate	0.0248	0.0521	0.1381	0.0177	0.0420	0.0266	0.0528	0.4453	0.1855	0.0150
Port Facilities	Berth Length (m)	918	1,189	2,281	650	397	142	2,350	5,319	4,457	1,160
	Rate	0.0487	0.0630	0.1209	0.0345	0.0210	0.0075	0.1246	0.2820	0.2363	0.0615
Port Location	Number of Liners Calling Ports(Number)	10	8	18	13	14	4	28	50	42	18
	Rate	0.0488	0.0390	0.0878	0.0634	0.0683	0.0195	0.1366	0.2439	0.2049	0.0878
Service Level	Port Inf. Service Com. Rate(%)	50	50	70	80	60	70	80	100	90	50
	rate	0.0714	0.0714	0.1000	0.1143	0.0857	0.1000	0.1143	0.1429	0.1286	0.0714

Table 14. Competitiveness Evaluation Value for China and Korea Ports

Country		Cargo Volume(0.178)	Port Facility(0.198)	Port Location(0.452)	Service Level(0.174)	Composite of Priority	
China	Dalian	0.0248	0.0487	0.0488	0.0714	0.0265	**9**
	Qingdao	0.0521	0.0630	0.0390	0.0714	0.0342	**5**
	Shanghai	0.1381	0.1209	0.0878	0.1000	0.0659	**3**
	Shekou	0.0177	0.0345	0.0634	0.1143	0.0299	**6**
	Tianjin	0.0420	0.0210	0.0683	0.0857	0.0266	**8**
	Xiamen	0.0266	0.0075	0.0195	0.1000	0.0236	**10**
	Yantian	0.0528	0.1246	0.1366	0.1143	0.0540	**4**
	Hongkong	0.4453	0.2820	0.2439	0.1429	0.1600	**1**
Korea	Busan	0.1855	0.2363	0.2049	0.1286	0.1022	**2**
	Inchon	0.0150	0.0615	0.0878	0.0714	0.0273	**7**

Considering the results described above, we are really sure all the ports of China - save only Hong Kong - now lag behind Korea's Busan port with respect to competitiveness. But ports in China seem to have somewhat more competitive elements that will give China the power bypass Busan port in competitive aspect, if taking into consideration of port facility investment, colourful incentive policies for liners, uninterruptedly increasing freight traffic, increased awareness of ports, and so on.

5. CONCLUSION

After China was opened to the WTO, the average growth rate of Chinese economy has exceeded 10% per annum and continues its rapid growth. Chinese ports development and advancement in China are conspicuous in the case which refers to import and export, as China handles approximately 90% of the relevant cargo by relying upon coastal shipping and ocean-going transportation. Such remarkable growth in China gives a great effect on Korean ports, since both China and Korea are located at the same region in Northeast Asia, and the two lie in direct competition. With this in mind, the goal of our study was set to figure out competitiveness ratings of China ports stretched along the sea coast of east and south China, and then to compute consolidated ratings of those ports, including Korea. The ports chosen for our study were among the world's 100 largest container ports, measured in terms of container cargo handling.

The summarized result of the analysis confirmed that the importance of criteria's weights were placed in order: port location (0.452), port facility (0.198), cargo volume (0.178), and service level (0.174). In the order of Chinese competitiveness by ports, which was analyzed by multiplying weights by criteria, Hong Kong (0.2097) was the most competitive in China with Shanghai (0.0866) coming next, and followed by Yantian (0.0717), Qingdao (0.0449), Shekou (0.0385), Dalian (0.0348), Tianjin (0.0339), Xiamen (0.0298). Meanwhile, it proved that the competitive position of Busan port lies between Hong Kong port and Shanghai port.

From the above results, port location plays the most significant role in the evaluation of port competitiveness. However, it is impossible to move from one place to the other physically. Likewise, elements of cargo volume also have a close relationship on port location. So the two are considered fundamentally difficult elements to increase port competitiveness. But both elements of facility and service were deemed workable, when aided by government policies focused on increased investment and management efficiency. Therefore, if we were to make strenuous efforts focusing on both elements of facility and service with a hope to enjoy competitive edge over others, we assume such will greatly contribute to the betterment of port competitiveness, which brings a greater shore of freight treatment volume.

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