A Study on Port Information System and International Port Competitiveness Power

1997. 5. 10

구 자 영*

*한 국 해 양 대 학 교

A Study on Port Information System and International Port Competitiveness Power

Ja-Yeong Gu
A part-time lecturer,
Dept. of Logistics Engineering,
Korea Maritime University

1. Introduction

1.1 Background

Ports, handling the majority of external trade act as the trade gateway and highly dependent on the economic growth of a country and in essence a terminal of seaborne cargo transit area. Stiff competition among neighbouring ports also warrants the approach towards port planning and development(such as expansion of port size, increase in the number of berths, freight flow trend and restructuring of port information system) to be scrutinized. Adequate and efficient port facilities and cargo transshipment route promotes further international trade transaction. In addition, due to the separation of economic circle, competitiveness of inter-port is more serious now and accelerated the concept of open port system.

Thus, in the earlier studies, port facilities are decided by two dimensional relationship producing a less accurate freight demand forecasting. These seem to be one sided analysis causing the unbalance problem between container freight and port facilities. Comprehensive analysis between the relationship between port information(facility level, port service level) and container freight flow in the region need to be integrated.

1.2 Objectives

Taking the above factors into perspective and consolidating Korea's interest in the E/SE Asia region for containerized commodity, the objectives of this paper can be outlined as follows:

(1) To establish the relevance and importance of Korean ports, this paper compared and contrasted the ports in East and Southeast Asia region (Singapore, Hong Kong, Kaoshiung, Kobe) which are the main competitors. (Chapter 2)

(2) To obtain a more reasonable forecasting method which is very detrimental to container freight flow analysis for port development purpose, Multiple Regression Curved Surface (MRCS hereafter) is introduced. Conventional methods proves to be

inaccurate because no comprehensive analysis on the relationships between several port factors (total traffic volume) were done which are significant to the fluctuation of freight flow generated among inter-competitive hub-ports. (Chapter 3)

2. Comparative Analysis Among Major Hub-Ports

The dynamics of a port and the function it serves need to be comparatively analyze which leads to the individual port competitiveness in terms of containerization. In this analysis the ports in the region of E/SE Asia region were studied upon. The hub-ports compared are Hong Kong, Singapore, Kaoshiung, Pusan, Kobe, and Yokohama. There are many criteria for evaluating port competitiveness, but this paper selected only 2 main determinants; port facility and service level. Fig. 2.1 shows the scope of analysis performed.

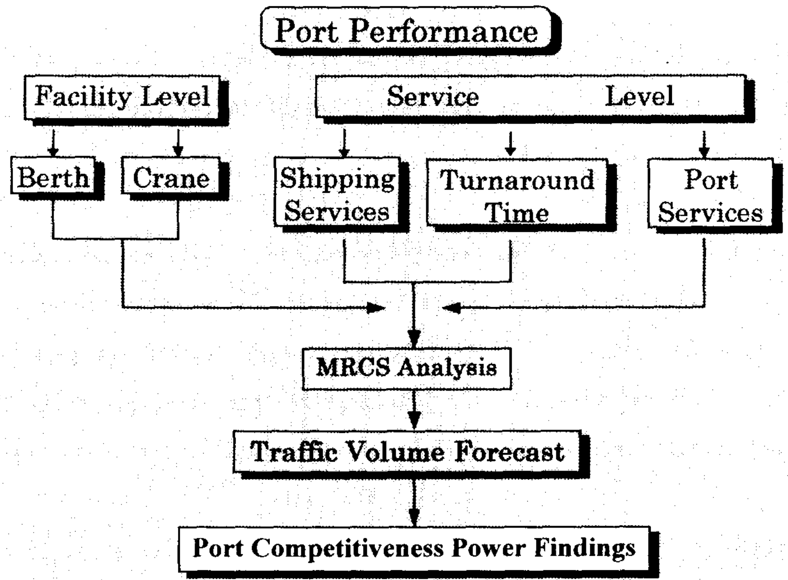

Fig. 2.1 Comparative analysis flowchart

2.1 Port Facilities

The port facilities considered here are the number of berths and gantry crane which are directly related to the cargo handling volume.

1) Berth and Crane Productivity

To analyze the productivity of the number of berth and crane by port, each port facility is compared with total transaction traffic volume as presented by Table 2.1.

Table 2.1 Productivity trend of berth and crane by port

Vol. unit:1,000TEU/year

Ports	Items	1990	1992	1994
Hong Kong	Handling Vol.	5,101	7,972	11,050
	No.of berth/crane	11/39	13/45	16/52
	Prod.berth/crane	464/131	613/177	691/213
Singapore	Handling Vol.	5,224	7,560	10399
	No.of berth/crane	14/41	19/50	20/61
	Prod.berth/crane	373/127	398/151	520/171
Kaoshiung	Handling Vol.	3,495	3,961	4,900
	No.of berth/crane	16/33	19/42	20/43
	Prod.berth/crane	218/106	209/94	245/114
Kobe	Handling Vol.	2,569	2,608	2,916
	No.of berth/crane	28/48	33/49	37/51
	Prod.berth/crane	98/54	79/53	79/57
Pusan	Handling Vol.	2,349(1,175)	2,751(1,843)	3,825(2,563)
	No.of berth/crane	4/9	7/15	7/20
	Prod.berth/crane	587(294)/ 261(131)	393(263)/ 183(123)	546(366)/ 191(128)

Source: Containerization International Yearbook 1992-1996 **Note:** ( ) of Pusan means exclusive terminal handling volumes based 67%, but 50% in 1990 only of the total traffic volume.

It can be seen that each hub-ports has different productivity output in relation to the number of berths and cranes. Productivity is higher in Hong Kong and Singapore while for Pusan port, among the hub-ports, the productivity measurement lies in the middle level.

2) Proportion of Berth to Crane and Volume Handled

Table 2.2 Volume handled trend of the gantry crane by port

Vol. unit:1,000TEU/year

Ports	Items	1990	1992	1994
Hong Kong	Handling Volume	5,101	7,972	11,050
	Crane/Berth	39/11	45/13	52/16
	Ratio(C/B)	3.5	3.5	3.3
	Handled Vol./Crane/Berth)	11.9	13.6	13.3
Singapore	Handling Volume	5,224	7,560	10,399
	Crane/Berth	41/14	50/19	61/20
	Ratio(C/B)	2.9	2.6	3.1
	Handled Vol./Crane/Berth)	9.1	8.0	8.5
Kaoshiung	Handling Volume	3,495	3,961	4,900
	Crane/Berth	33/16	42/19	43/20
	Ratio(C/B)	2.1	2.2	2.2
	Handled Vol./Crane/Berth)	6.6	5.0	5.7
Kobe	Handling Vol.	2,569	2,608	2,916
	Crane/Berth	48/28	49/33	51/37
	Ratio(C/B)	1.7	1.5	1.4
	Handled Vol./Crane/Berth)	1.9	1.6	1.5

Pusan	Handling Vol.	2,349(1,175)	2,751(1,843)	3,825(2,563)
	Crane/Berth	9/4	15/7	20/7
	Ratio (C/B)	2.3	2.1	2.9
	Handled Vol./Crane/Berth)	65.3(32.6)	26.2(17.6)	27.3(18.3)

Source: Containerization International Yearbook 1992-1996 **Note:** ( ) figures of Pusan means exclusive terminal handling volumes based 67%, but 50% in 1990 only of the total traffic volume.

The number of cranes needed (per berth or meter) at the port terminal is very important to port development. To determine the crane demand, each port handling volume per berth/crane was analyzed as in Table 2.2.

Hong Kong and Singapore reflected a higher productivity with handling volume of 13,300 TEU and 8,500 TEU respectively per berth/crane in 1994. Port of Pusan registered 18,300 TEU implying that it is ill equipped and the facility shortage level is about 3 times than Kaoshiung productivity, 2.2 less than Singapore, and 1.4 times less than that of Hong Kong.

2.2 Service Level

The service level in the container exclusive port need to be dealt with comprehensively including navigation aids, handling work, transportation, storage, delivery, information, and operating management system. Here, only liner service was considered and classified into 3 factors; 1) shipping service (consists of frequency, established route, number of ship's company), 2) turn around time of cargo handling, 3) port service (port charge-consists of handling charge and port due, free storage periods, and working hours.

1) Shipping Service

Shipping service level is related to the total transit time and when shippers or ship's company decide the route for export/import freight, the selection is based on port service level. Table 2.3 shows the shipping service by port.

Table 2.3 Shipping service level

Port	Frequency/month	Established route	Shipping company
Hong Kong	848	258	63
Singapore	849	219	61
Kaoshiung	514	128	53
Kobe	681	174	53
Pusan	568	210	54

Source: Journal of the Korea Institute of Port Research June 1993. **Note:** Frequency base on over 1000TEU ship in 1992.

The service level of Pusan port is at the middle level, behind Hong Kong and Singapore which provide a high level of service.

2) Turnaround Time

Cargo handling time depend greatly on crane efficiency of a port and also related to terminal management utility. Table 2.4 shows the crane efficiency by port. Base is set at 1.00 with Hong Kong as the reference since being the top container port in the world.

Table 2.4 Crane efficiency by port

Port	TEU/hour	Handling time(1,000TEU)	Ratio to Hong Kong
Hong Kong	73.4	13.6hrs	1.00
Singapore	65.1	15.4hrs	1.13
Kaoshiung	70.4	14.2hrs	1.04
Kobe	86.7	11.5hrs	0.85
Pusan	46.8	21.4hrs	1.57

Source: Journal of the Korea Institute of Port Research June 1992, **Note:** Pusan base on JASUNGDAE.

Crane efficiency has a great impact on the time taken for cargo handling. Pusan port takes 1.56 times more than Hong Kong for the same 1,000 TEU handling, about 2 times more compared with Kobe. In other words, Pusan port faces the most severe congestion and is affecting its competitive power.

3) Port Service

This is a major factor influencing ship companies to call at a port. Modern port provides services around the clock, 24 hours per day. To find the port utility, this section analyzed port service factors such as, free storage period, working hours (Table 2.5(a)) and port charges (Table 2.5(b)). Port charges factors consist of navigation, tonnage dues, berth hire, light dues, pilot, towage, mooring/unmooring charges and utilities. It is the main factor in the selection of a port.

Table 2.5(a) Port service condition- free storage period, working hours.

	Free storage periods(days)			
Ports	Export	Import	Transshipment	Working hours
Hong Kong	7	5	14	24
Singapore	5	3	28	24
Kaoshiung	n.a	n.a	n.a	24
Kobe	10	10	n.a	16.5
Pusan	4	5	n.a	24

Source: the same Table 2.4

In terms of port service, there is no difference in the working hours except for Kobe port which also provides a longer free storage period.

Table 2.5(b) Port charges

Cost unit: US$

Port	Handling Cost		Port Charge		Total Cost	
	20ft	40ft	20ft	40ft	20ft	40ft
Hong Kong	110	150	110	150	220	300
Singapore	110	150	110	150	220	300
Kaoshiung	140	140	214	214	354	354
Kobe	250	320	400	512	650	832
Pusan	175	220	255	321	430	541

Source: Containerization International June, Aug. 1996, Research Discussion Paper for Great Port Competitiveness Era of Civil Engineering Conference 1996 in Nagoya University. **Note:** Port charges were calculated by using the index of 1995. This index is converted to US$(100Yen/US$) value based on Kobe situation. Handling cost of Hong Kong is assumed the same as Singapore because of the similar economic environment such as GNP growth. Also port charge of 40ft were calculated by proportion of handling cost 20ft to 40ft for each port. *Ship's specification = Gross ton; 17,156, Draft;8.0m,

Pusan port total cost is 2/1.8 times for 20ft/40ft container compared to Hong Kong, and 1.2/1.8 times for 20ft/40ft container compared to Kaoshiung. In the case of Kaoshiung, the handling cost for 20ft and 40ft containers are the same.

4) Relationships between Port Charge and Handling Volume

Port charge has some impact on the traffic volume as shown in Table 2.6. Total handling cost between ports shows a vast difference. For example, in the case of full container, for a 300 TEU difference in handling volume, the charge difference is about 4,000\ (US$40)/TEU.

Table 2.6 Relationship between port charge and handling volume(Kobe Port)

unit: TEU and Yen

	Feeder Container I	Feeder Container II	Full Container I	Full Container II
Handling Volume	152	300	200	500
Pilot Charge	1,089/hr	552/hr	1,312/hr	799/hr
Tug-boat charge	3,870/1.5hrs	1,961/1.5hrs	2,941/1.5hrs	1,320/1.5hrs
Line man	278	141	440	336
Port Due	1,094	554	3,429	3,353
Handling Cost	30,834	30,079	30,575	29,648
Others	4,774	4,801	5,307	4,821
Total	41,939	38,088	44,004	40,277

Source: Research discussion of civil engineering conference '96 in Nagoya, Japan. **Note: Feeder container I**= Gross ton;3,994, Draft;5.5m, **Feeder Container II**= Gross ton; 3,994, Draft;5.5m, **Full**

container I= Gross ton; 17,156, Draft;8.0m, **Full container II**= Gross ton; 43,000, Draft;10.0m.

2.3 Findings with respect to Competitiveness Power

From the comparative analysis results obtained for the various hub-ports located in E/SE Asia in the aspect of port facility, service level and turnaround time, the findings can be outlined as below:

1) From the analysis of port facility and its productivity, handling volumes per berth/crane for Hong Kong recorded a high transaction of 691/213 TEU, while 366/128 TEU for Pusan in 1994.

2) From Tables 2.1 and 2.2, Pusan port facility is insufficient. The reason is that productivity of Pusan is 0.53 and 0.60 times per berth and crane respectively that of Hong Kong, but the handling volume for Pusan port is 1.4 times per volume/crane/berth of that of Singapore and 2.2 times that of Hong Kong.

3) Table 2.4 shows that crane efficiency is very important in the port management. For example, from the capacity per crane/hour figures, it shows that Pusan port will experience a delay about 2 times as that of Kobe and 1.6 times of Hong Kong.

4) According to the ship's size and handling volume, port charge differs as indicated in Table 2.6. From Table 2.5(b), total port charges for Pusan port is the second highest in the E/SE Asia. The table also shows that it accounts 1.2-1.8 times as compared to other competitive ports costs.

3. Analysis of Port Information Variables

3.1 Methodology

In order to estimate the volume of container freight flow within any origin/destination (called as O/D hereafter) in a transportation network, it is necessary to analyze the relationship between trade value and container freight volume of a country. The said relationship is further used in the analysis of container freight flow on sea routes followed by container volume forecasting and applying moving average method. Finally, using multiple regression curved surface(hereafter MRCS) model to ascertain the non-linear relationship between traffic volume, transportation fare, and port charges in order to analyze container among competitive ports.

3.2 Development of MRCS

1) Relationship between Transportation Fare and Distance

The reason for the MRCS model in inducing exponential function in its algorithm formulation can be explained as follows.

Table 3.1 Relationship between inland transportation fare and distance, lot size

Unit:US$

Fare	Distance(km)	Fare/km	Fare	Lot size(ton)	Fare/ton
300	15	20.0	13.9	1	13.9
205	15	13.7	15.9	2	8.0
1075	120	9.0	17.3	3	5.8
1265	180	7.0	19.0	4	4.8
1170	140	8.4	21.1	5	4.2
1410	190	7.4	23.0	6	3.8
1455	200	7.3	25.7	8	3.2
1505	207	6.8	29.3	10	2.9
1695	250	5.9	30.3	12	2.5
2100	356	5.6	34.0	14	2.4

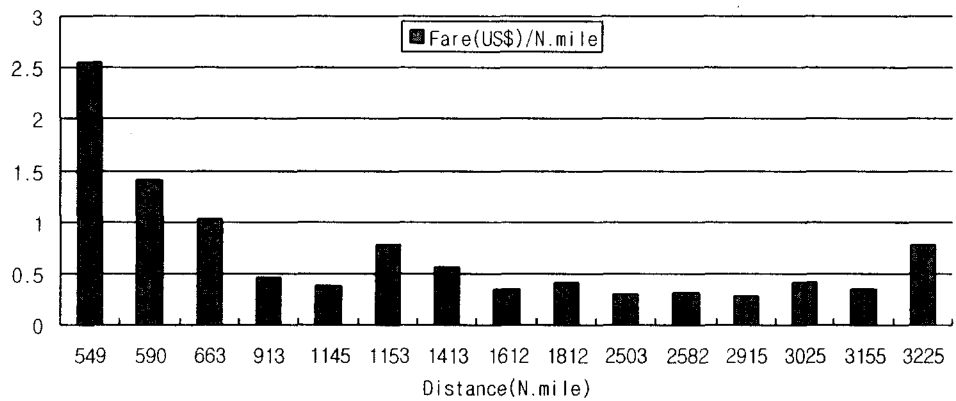

Fig.3.2(a) Relationship between sea transportation fare and distance

According to the results of the various relationship analysis between transportation fare and distance, and lot size, the relationships follow an exponential curve pattern. This is expressed by Table 3.1 and Fig. 3.2(a).

2) Traffic volume, transportation fare (involving frequency, ship size, and distance) and port charges (involving number of cranes, number of berths) are port variables selected and presented in the 3D figure as shown by Fig. 3.2(b).

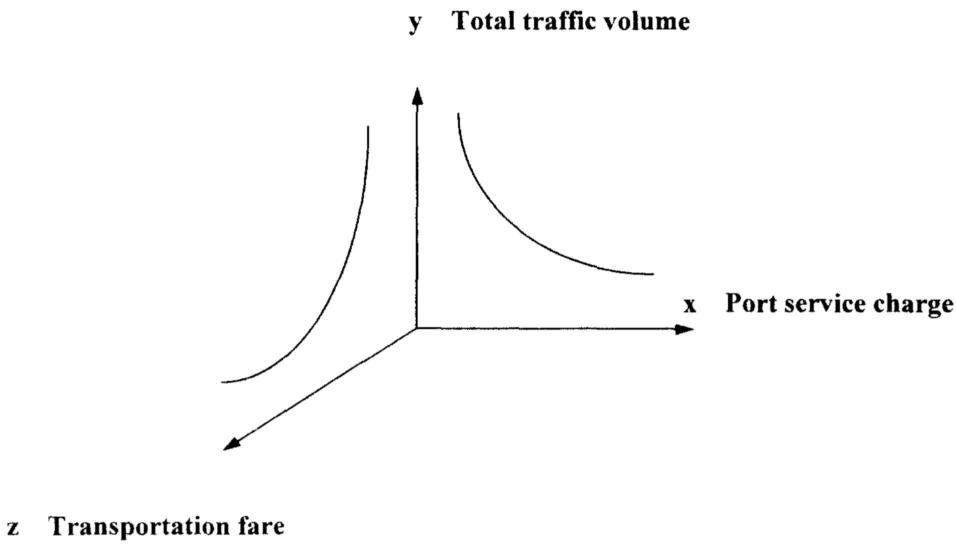

Fig. 3.2(b) Relationships between total traffic volume and port variables.

(1) Transportation Fare

It is the total fare from/to a port by route. Port handling volume depend greatly on the transportation fare (economic benefit) from/to a port which is influenced by several fluctuating factors. In this study, the route is categorized into 4 areas; Europe(Rotterdam), North America(Los Angeles), South East Asia (Singapore), and North East Asia(Shanghai). Naturally shippers and carriers route choice would be that of minimum transportation cost[10]. In the selection, however, the domestic transportation fare(truck) normally has not been considered since it is not related in measuring port total traffic volume. Inclusion of domestic transportation fare(truck) is explained in the succeeding section.

(2) Port Service Charge

Similar to (1) above, it plays an important role in deciding port handling volume. As port facilities changes, port service charge also changes. This variable determines the competitiveness power of a port and a key factor in the selection by shipper and shipping company. The curved regression lines as presented in the figure above can be expressed as in the equations below:

$$Y = f(x, z) \Rightarrow \partial f / \partial x = \alpha h(z), \partial f / \partial z = \gamma g(x) \quad \text{......(3-1)}$$

$$y = g(x) = \alpha e^{-\beta x}, y = h(z) = \gamma e^{-\delta z} \quad \text{......(3-2)}$$

where α, β, γ are parameters determined by regression analysis.

(3) Plotting the MRCS

To plot a three dimension[3)] multiple regression curved surface (MRCS), as depicted by Fig. 3.3, the three axes, x, y, and z are cut at any value by each axis, then shifted a parallel move from two to three dimensions curve of each axis matching point. In this space of three dimensions, the demand function can be drawn as the surface plane shown in the figure. The MRCS equation can be given by:

$$F = g(x) \cdot h(z) = \alpha e^{-\beta x} \cdot \gamma e^{-\delta z} \quad \text{...(3-3)}$$

and the parameters can be determined by regression analysis. The container traffic volume demand decreases with increasing transportation fare, as would be expected, and also with increasing time on the level of port service charge axis, indicating that high transportation fare have increasing disutility.

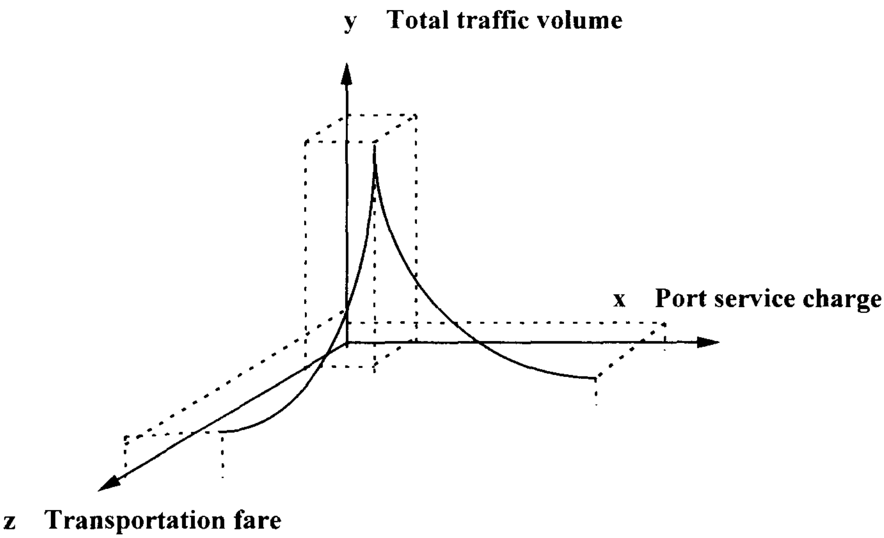

Fig. 3.3 Multiple-regression curved surface (MRCS)

The underlying choices made by the management of the facility and service charge which lead to this function are quite complex. In general, given the particular technology or production function, they will result in a unique cost and unique level of port service charge for each volume of traffic.

The MRCS carried the assumptions that the volume is the total available container with fixed volume between any O/D, and that the ship size is classified by route as given in the Table 3.2. In order to calculate total transportation fare and service charge, equations using simple algorithm are provided in the succeeding sub-chapter.

Table 3.2 Distribution of ship size by route

Unit: number of ship and TEU

RouteSize	-1000	-2000	-3000	-4000	-5000-	Average(TEU)
USWC	12	22	95	49	44	2888.6
UKCS	0	10	75	77	45	3298.3
SEAS	272	88	7	0	0	745
NEAS	8	-	-	-	-	748
KOCH	28	-	-	-	-	345
JPCH	118	-	-	-	-	405
KOJP	59	-	-	-	-	169

Data source: International Transportation Handbook 1996. **Route:** USWC-West Coast of North America, UKCS-United Kingdom, Continent and Scandinavia, SEAS-Inter Southeast Asia, NEAS-Inter Northeast Asia, KOCH-Korea and China, JPCH-Japan and China, KOJP-Korea and Japan,

3.3 Relationship Analysis of the Port Information Factors

1) Transportation Fare

The components of transportation fare can be illustrated by the Fig. 3.4(a) and represented by equation 3-4.

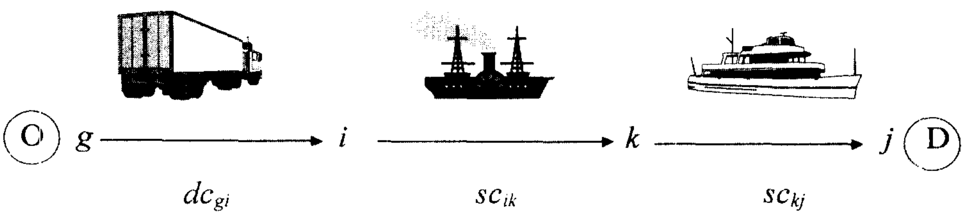

Fig. 3.4 Distinction of variables by route

$$TF_{gj} = dc_{gi} + sc_{ik} + sc_{kj} \quad \text{.......(3-4)}$$

where, TF_{gj}; total fare of container freight 1 unit from supply point g via i, k port to demand port j

dc_{gi}; fare of domestic transportation from supply point g to supply port i

sc_{ik}; tariff of freight transportation from supply port i to via port k

sc_{kj}; tariff of freight transportation from supply port k to demand port j

2) Port Service Charge at a Calling Port

Port service charges consist of ship-based charges and handling charges for container freight. The ship-based charges include tonnage dues, berth hire, pilotage, towage, mooring/unmooring charges et cetera. Fig 3.5 illustrates the variables for a given route and the port service charge is given as:

$$PC_{i,k} = (sb_i + sb_k + hc_i + hc_k) \quad \text{.......................................(3-5)}$$

where, $PC_{i,k}$; total port service charge at calling port i, k

sb_i; ship-base charge at supply port i

sb_k; ship-base charge at via port j

hc_i; fare of freight handling at supply port i

hc_k; fare of freight handling at via port k

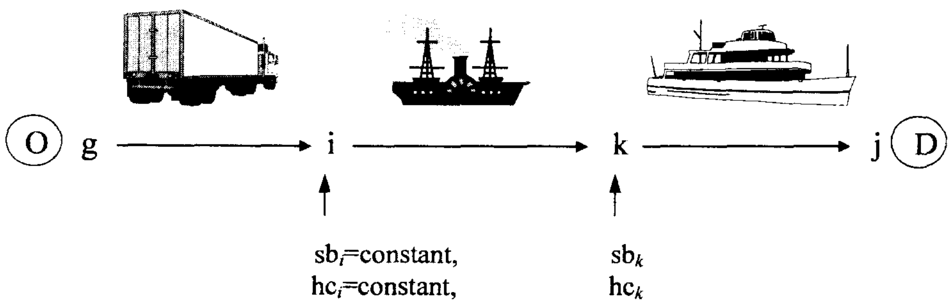

Fig. 3.5 Distinction of variables by route

In Fig. 3.5, two of the four factors are considered constant since the charges incurred are related to own port. In this case, the solution in handling cost and ship-base charges at hub-port is as follows:

$$pc_k = y_4 e^{-(\alpha_4 nb + \beta_4 nc + \gamma_4 hv + \delta_4 wr)} \quad \text{.......................................(3-6)}$$

where, pc_k: port service charge at a calling port k

nb: number of berth, nc: number of crane,

hv: total handling volume of container freight

wr: wage rate, y_4: unknown constant.

3) Relationship between Transportation Fare and Traffic Volume

The relationship between transportation fare and traffic volume is given by equation(3-7). In addition, taking account frequency as the main factor in transportation fare, the frequency at a calling port in relation to traffic volume is expressed by equation(3-8).

$$TV = y_5 e^{-\alpha_5 TF} \quad \text{.........(3-7)}$$

here, *TV*: total traffic volume,

TF: total transportation fare by route.

$$TV = y_6 e^{\alpha_6 Fq} \quad \text{.........(3-8)}$$

where, *Fq*: frequency (full container & semi-container) for a port per year

4) Relationship between Traffic Volume and Port Service Charge

Equation 3-9 and equation 3-10 expressed the relationships between traffic volume and port service charge, and between traffic volume and the number of berth and crane respectively.

$$TV = y_7 e^{-\alpha_7 PC} \quad \text{.........(3-9)}$$

where, *TV*: total traffic volume,

PC: total port service charge a port.

$$TV = y_8 e^{-\alpha_8 nb + \beta_8 nc} \quad \text{.........(3-10)}$$

where, *nb*; number of berth at a port

nc; number of crane at a port

5) Relationship between Transportation Fare and Port Service Charge

At present the analysis between the relationship of transportation fare (*frequency*), and port service charge (*nb, nc*) were done individually. By considering them simultaneously, their relationship are as follows:

$$e^{PC} = y_9 + \alpha_9 e^{TF} \quad \text{.........(3-11)}$$

where, *PC*: total port service charge,

TF: total transportation fare by route.

$$Fq = y_{10} e^{-\alpha_{10} nb + \beta_{10} nc} \quad \text{.........(3-12)}$$

where, *Fq*: frequency(full container & semi-container) of a port/year

nb: number of berth,

nc: number of crane

6) Traffic Volume, Transportation Fare and Port Service Charge

By integrating all the port variables as stated in the preceding sub-chapters, the equation formulated is given by equation 3-13.

$$TV = y_{11} e^{\alpha_{11}(TF) + \beta_{11}(PC)} \quad \text{.........(3-13)}$$

By considering equations (3-2) and (3-4), the following equation is obtained.

$$\begin{aligned} TV_k &= \alpha e^{-\beta(TF_{kj})} \\ &= \alpha e^{-\beta y_1 \{(\alpha_1 d) + (1-\beta_1 l)\} + y_2 e^{-(\alpha_2 d + \beta_2 sv)} + y_3 e^{-(\alpha_3 d + \beta_3 f_{kj})}} \end{aligned} \quad \text{.........(3-14)}$$

Also, from equations (3-2) and (3-4), port service charge can be computed as:

$$y = h(z) = \gamma e^{-\delta z} \qquad TV_k = \gamma e^{-\delta x}$$

$$TV_k = \gamma e^{-\delta(PC_{ik})} \quad \text{.........(3-15)}$$

From equation (3-3):

$$TV_k = \theta e^{-\beta TF_{kl}} \cdot e^{-\delta PC_k} \quad \text{.........(3-16)}$$

Giving:

$$TV_k = y_{12} \theta e^{u} \cdot e^{v} \quad \text{.........(3-17)}$$

$$\text{where} \quad u = -\beta y_1^{\{(\alpha_1 d) + (1-\beta_1 l)\}} + y_2 e^{-(\alpha_2 d + \beta_2 sv)} + y_3 e^{-(\alpha_3 d + \beta_3 f_{kj})}$$

$$v = y_4 e^{-(\alpha_4 nb + \beta_4 nc + \gamma_4 hv + \delta_4 wr)}$$

: unknown parameter can be determined by regression analysis

3.4 Results of Analysis

Using the derived equations and data availability using MRSC model concept, the results obtained are as follows.

1) Transportation Fare and Traffic Volume

The results for the relationship between transportation fare and total traffic volume using equation(3-7) and between transportation fare factor, frequency at a calling port, and traffic volume using equation (3-8) are given by Table 3.3 and Table 3.4 respectively.

Table 3.3 Regression results for transportation fare and traffic volume

	Partial Regr. Coefficient	Std. Partial Regr. Coefficient	t-value
TF	-0.00127	-0.923	4.16
Constant	13.00181	*	12.11
Coeff. of determination: 0.852	;	Data numbers = 5	

Note: TF means sum up sea transportation fare of 4 routes(from Hong Kong, Singapore, Kaoshiung, Kobe, Pusan to Europe route-Rotterdam, N. America route-Los Angeles, SE Asia route-Singapore, Feeder route in the NE Asia-Shanghai respectively), it is a calculated data(except Pusan, Kobe).

From the above table, it is shown that there is a high correlation between transportation fare and traffic volume and thus further analysis were carried out involving the main factor in transportation fare (frequency) and traffic volume as shown by the table below. As expected, the correlation between them are high.

Table 3.4 Regression results for transportation fare (frequency) and traffic volume

	Partial Regr. Coefficient	Std. Partial Regr. Coefficient	t-value
Fq	0.0000463	0.977	16.68
Constant	7.739	*	155.79
Coefficient of determination: 0.955	;	Data numbers = 15	

Note; Fq means frequency at a calling port per year, ship's class of full and semi-container vessel, it is a calculated data(except Korea, Hong Kong) also. The assumption is as follows; Singapore as the same HK(T/S 60%), Kaoshiung 35%, Kobe 20%, and Korea 10%.

2) Port Service Charge and Traffic volume

The relationship between port service charge and traffic volume using equation (3-9) and between port service charge factors (number of crane and number of berth) and traffic volume using equation (3-10) were analyzed and the results as shown by Table 3.5 and 3.6 respectively.

Table 3.5 Regression results for port service charge and traffic volume

	Partial Regr. Coefficient	Std. Partial Regr. Coefficient.	t-value
PC	-0.00495	-0.847	5.74
Constant	9.475	*	47.46
Coefficient of determination: 0.717	;	Data numbers = 15	

Table 3.6 Regression results for port service charge factors and traffic volume

	Partial Regr. Coefficient	Std. Partial Regr. Coefficient.	t-value
nb	-0.0588	-0.139	8.49
nc	0.0468	1.334	10.43
Constant	7.583	*	56.66
Coefficient of determination: 0.903	;	Data numbers = 15	

The above table shows a significant correlation between the two variables and thus proceeded to the analysis of the port service charge factors (nc and nb) with traffic volume as in the table below. A high correlation was observed.

3) Transportation Fare and Port Service Charge

The analysis between the relationship between transportation fare and port service charge using equation (3-11) and between transportation fare factors (frequency, number of berth, number of crane) and port service charge using equation (3-12) are the essence of the MRCS model. The results are as in Tables 3.7 and 3.8 respectively. For both cases, exponential value are used in the calculation since they are related with exponential relationship towards total traffic volume (equation 3-3).

Table 3.7 Regression results for transportation fare and port service charge

	Partial Regr. Coefficient	Std. Partial Regr. Coefficient.	t-value
e^{PC}	1.438	0.979	8.39
Constant	14.807	*	3.38
Coefficient of determination: 0.959	;	Data numbers = 5	

The above table shows a significant correlation between port service charge and traffic volume and thus justified in performing further analysis but this time taking account the port service charge factors (number of berths and crane). The results (table below) show that a high correlation exists between them.

Table 3.8 Regression results for transportation fare(frequency) and port service charge using factors

	Partial Regr. Coefficient	Std. Partial Regr. Coefficient.	t-value
nb	-0.0835	-1.049	10.63
nc	0.0708	1.374	13.92
Constant	7.583		52.51
Coefficient of determination: 0.942	;	Data numbers = 15	

4) Traffic Volume, Transportation Fare and Port Service Charge

The integration of three variables (TV, TF, PC) completes the MRCS model. Using equation (3-13) the results of the variables relationship are given in Table 3.9.

Table 3.9 Regression results for traffic volume, transportation fare, and port service charge

	Partial Regr. Coefficient	Std. Partial Regr. Coefficient.	t-value
PC	-0.00633	-0.799	3.04
TF	-0.00023	-0.202	0.77
Constant	10.76442	*	20.12
Coefficient of determination: 0.993	;	Data numbers = 5	

From the above table, the correlation between all the port variables were correlated but the value of TF was not correlated as given in the ***t*** - value.

3.5 Comparison of the Results

Table 3.10 shows the comparisons between computed results using MRCS to the actual figures for the hub-ports in the E/SE Asia.

Table 3.10 Comparison of actual data and computed figures.

Port	Computed(a)	Actual(b)	Ratio(a/b)
Pusan	4,543	4,500	1.00956
Kobe	1,315	1350	0.974
Hong Kong	13,170	12600	1.045
Kaoshiung	5,667	5,232	1.0832
Singapore	10,516	11,850	0.8874

Table 3.11 shows the comparisons done between computed results using MRCS to forecast figures as obtained from the existing Korean ports development plan.

Table 3.11 Comparison of existing plan and new MRCS value

Target Year		1995	1997	2001	2011
Existing	Berth	7	7	15	21
	Crane	20	20	38	46
Planned	Berth	*	8	6	36
	Crane		18	8	72*
Total	Berth	7	15	21	57
	Crane	20	38	46	118
Korean Forecast Vol.(a)		4,500***	6,560**	9,850	19,000
MRCS Forecast Vol.(b)		4,543	7,289	6,630	14,885
Ratio(b/a)		1.0096	1.1111	0.6731	0.7834

Note:* Crane numbers are calculated by 2crane per berth, ** The value was interpolated by the value of during the 1995-2001. ***Actual figures. Vol. unit:1,000TEU

3.6 Summary and Discussion

Comparing the MRCS results and the simple regression analysis based on the GNP growth, MRCS proves to be more reliable and because of its comprehensives with an average error ratio of 5.5% when compared to the actual data.

The real focus in this chapter is the introduction of a simple Multiple Regression Curved Surface (MRCS) model which only requires the use of simple data consisting of transportation fare and port service charge. MRCS proves to be effective in analyzing transportation policy, such as handling cost, establishment of new route (for frequency, ship size), construction of new port (for berth), and rearrangement of port equipment (for cranes). However, as with other methods proposed by previous studies, reliability is still yet to be perfected since the definition of reliability is complex because of its dependence on the behavior of shippers and carriers, transportation fare changes and improvement of service facilities within a given range.

There are certain limitations in adopting this MRCS model as mentioned above, but these are only minor problems which do not discredit the model as a whole. MRCS integrate the main port variables represented by 3D figure and thus more comprehensive and closer to the real world situation. This is truly so when compared to previous studies whereby only individual port variables are considered. Its simplicity by using non complex data is also an advantage.

4. Conclusion

According to MRCS analysis, berth development leads to port charge increase while adding crane numbers caused decreasing port charge. Thus to set the condition in the port charge aspect, minimum rate for berth per crane is 1.85cranes/berth. If a lower value than minimum rate is selected, it leads to increasing port charge. In the total traffic volume aspect, minimum rate for berth per crane is set at 1.13cranes/berth and for lower value than this minimum rate is selected, it leads to decreasing cargo traffic volume.

Both the above rates need to be considered in the port development plan and by analyzing the Korean ports development plan, the below findings are met:

1) For the year 2001, the number of berth and crane need to review if the forecast volume need to be handled smoothly.

2) For the year 2011, the forecast volume is overestimated as compared to MRCS results. In other words the port facilities is inadequate.

REFERENCE

1)Toichi Kimura(1985), "Evaluation Method of Foreign Trade Port Choice for Transportation Route and Its Application", Doctor's Thesis of Kyoto University

2)Carlos F. Daganzo(1990), "The Productivity of Multipurpose Seaport Terminals", Transportation Science vol.24, No.3, August 1990.

3)Edward K. Morlok(1978), "Introduction to Transportation Engineering and Planning", -Transportation Network Flows-, McGraw-Hill Book Company.

4)Ja-Yeong GU and Hajime Inamura(1995), "An International Freight Flow Analysis in Korea", presented in the 1st EASTS, Manila, 28-30, Sept. 1995.

5)Katsuhiko Kuroda(1994), "A planning method for International Network of hub container terminal",

Discussion paper for 9th ARSC(Applied Regional Science Conference).
6)Wayne L. Winston(1991), "Operation Research Applications and Algorithms; Queuing Theory", Second Edition, Thomson Information Publishing Group.
7)Daisuke Misima, Ieda Hitoshi(1996), "Container Flow Simulation Model of International Transport in Asia Region for Demand Estimation and Port Shipping Policy Evaluation", Master's Thesis of Tokyo University.
8)Masahiro Nakamura(1995), "A demanding forecasting model for international feeder container cargo taking account of modal choice", Master's Thesis, Tohoku Univ. in Japan.
9)Moris Hamburg et al.,(1994), "Statistical Analysis for Decision Marking; Multiple Regression and Correlation Analysis", Six Edition, The Dryden Press.
10)Terry L.Friesz(1986), "A Sequential Shipper-Carrier Network Model for Predicting Freight Flows", Transportation Science Vol.20

11)Adib Kanafani(1983), "Transportation Demand Analysis", Printed in the United States of America.
12)S.H Lee.(1992), "A study on the policy for the functional development of the Pusan Port toward Pan-Pacific International Trade center", Journal of the Korean Institute of Port Research Vol. 6, No. 1, 3-36p
13)Randolph W. Hall(1985), "Dependence between Shipment size and Mode in Freight Transportation", Transportation Science Vol. 19
14)C.Y.Lee, Y.P.Oh, and Y.T.Seo(1992), "Development of new Pusan Port and related transportation system", Journal of the Korean Institute of Port Research Vol. 6, No. 1, 49-68p
15)Calos F. Daganzo(1985), "Analyzing Trade-Offs between Transportation Inventory and Production Costs on Freight Networks", Transportation Research B.
16)S.H Moon(1994), "The challenge of the Third Generation Port and Port Competition", Journal of the Korean Institute of Port Research Vol. 18, No. 2, 92-109p
17)Patrick T. Harker and Terry L. Friesz(1986), "Prediction of Intercity Freight Flows I", Transportation Research B.
18)S.H Moon(1992), "The Economic Impact of the Korean Port Industry on the National Economy: from the Viewpoint of Macroeconomics", Journal of the Korean Institute of Port research Vol. 6, No. 2, 65-92p
19)Shigeto USUI and Hajime INAMURA(1996), "An Estimate of Operating Cost and Transportation Fare of International Container Shipment", Proceeding of Infrastructure Planning of the Japan Society of Civil Engineers,Vol.19(2) p195-198.
20)Teodor G.Crainic and Jean-Mark Rousseau(1986), "Multi-Commodity, Multi-Mode Freight Transportation : A General Modeling and Algorithmic Framework for the Service Network Design Problem", Transportation Research B.
21)J.K.Lee and K.S.Kwak (1995), "A Study on the Port Marketing Strategy for Strengthening the Competitive Power of the Container Terminal", Journal of the Korean Institute of Port research Vol. 9, No. 2, 9-24p
22)Julian Benjamin(1989), "An Analysis of Mode Choice for Shippers in a Constrained Network with Application to Just in Time Inventory", Transportation Research B.
23)Y.C. Yun and S.H Moon(1995), "A Study on the Optimal Combination of Berth and Crane in Container Terminal", Journal of the Korean Institute of Port research Vol. 9, No. 2, 39-49p
24)Hiroyuki Takemura(1995), "Development of Trade Coefficient Forecast Model for the International Trade", Master's Thesis of Tohoku University.
25)Port Development-A handbook for planners in developing countries,- United Nations Conference on Trade and Development