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THE STRATEGY OF BUSAN PORT IN ANALYSIS OF WORLD'S MAJOR CONTAINER PORTS

The world economy has become multipolarized from developed G7 countries to emerging BRIC, NEXT-11 and MIKT. As economic exchange in northeast Asia region including China becomes active, international logistic demand has been increasing respectively in this region. Korea, located in the center of the biggest Asian market, has the role as bridge between Asian continent and the Pacific. Along with geographical advantage, Korea can have a role of the economic and logistic center, as the Netherlands is the gateway for Europe. In addition, world top 10 ports except for Rotterdam are all in Asia, making the region the center of world economy. This study compares and analyzes the efficiency of 20 ports: 13 in northeast Asia, 4 in Europe, and 3 in North America. Managerial efficiency of the ports has been evaluated by the non-parametric DEA method which is used for objective and logical measurement and evaluation of the ports.

Keywords: *Asian container ports; data envelopment analysis; efficiency analysis; Kruskal Wallis test.*

М'янг Бае Лі, Санг Ок Лі

СТРАТЕГІЯ ПОРТА м. ПУСАН У МЕЖАХ АНАЛІЗУ РОБОТИ ПРОВІДНИХ КОНТЕЙНЕРНИХ ПОРТІВ СВІТУ

В статті обґрунтовано, що полюсами розвитку сучасної світової економіки, крім країн "великої сімки", стали країни БРІК, N 11 та МІКТ. З прискоренням економічного обміну у Північно-Східній Азії зростають і логістичні потреби регіону. Роль П. Кореї як центру азійського ринку — бути мостом, що з'єднує Азію та Тихоокеанський регіон. Завдяки своїм географічним перевагам П. Корея може стати економічним та логістичним центром Азії, як Нідерланди у Європі. Крім того, з 10 провідних портів світу всі, крім Роттердаму, знаходяться в Азії, що робить даний регіон центром світової економіки. Порівняно та проаналізовано ефективність роботи 20 портів: 13 у Північно-Східній Азії, 4 в Європі, 3 у Північній Америці. Ефективність управління портами оцінено методом непараметричного аналізу.

Ключові слова: *контейнерні порти Азії; аналіз середи функціонування; аналіз ефективності; критерій Крускала-Уолліса.*

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СТРАТЕГИЯ ПОРТА г. ПУСАН В РАМКАХ АНАЛИЗА РАБОТЫ ВЕДУЩИХ КОНТЕЙНЕРНЫХ ПОРТОВ МИРА

В статье обосновано, что полюсами развития современной мировой экономики, кроме стран "большой семерки", стали страны БРИК, N 11 и МИКТ. С ускорением экономического обмена в Северо-Восточной Азии растут и логистические потребности региона. Роль Ю. Кореи как центра азиатского рынка — быть мостом между Азией и Тихоокеанским регионом. Благодаря своим географическим преимуществам Ю. Корея может стать экономическим и логистическим центром Азии, как Нидерланды в Европе. Кроме того, из 10 ведущих портов мира все, кроме Роттердама, находятся в Азии, что делает данный регион центром мировой экономики. Сравнена и проанализирована

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эффективность работы 20 портов: 13 в Северо-Восточной Азии, 4 в Европе, 3 в Северной Америке. Эффективность управления портами оценена методом непараметрического анализа.

Ключевые слова: *контейнерные порты Азии; анализ среды функционирования; анализ эффективности; критерий Крускала-Уоллиса.*

1. Introduction. As the world economy has become multipolarized from developed G7 countries to emerging BRIC, NEXT-11 and MIKT dynamic economic activity in northeast Asia region including China.

Respectively, international logistic demand has been increasing in the region resulting in expansion of logistic networks and infrastructure; countries are striving to build themselves as the logistic hub. Korea is one of a this countries, willing to become northeast or Asia's logistic hub country with Busan port.

Geographically, Korea is located in the center of the biggest Asian market where China, Japan, and ASEAN are, having a role of bridge between Asian continent and the Pacific. With strong geographical advantage, Korea can have a role of the economic and logistic center as the Netherlands is the gateway for Europe. Moreover, world top 10 ports except Rotterdam are all in Asia, making the region the center of world economy.

Korea has a strong potential to be northeast or whole Asia's center of economy, being a logistic hub for the region.

With road network built across the whole Korean peninsula, Korea can acquire even stronger geographical benefit which is to connect to Europe through TSR and TCR. Moreover, Korea has strong political ties with ASEAN+3 countries, which is another strong advantage of the country.

Respectively, this study compares efficiency of major ports in northeast Asia, Europe, and north America taking the most of world container traffic, and suggests barriers for Busan port to become Asian hub basing on the analysis of influencing factors.

It is complicated to objectively evaluate the efficiency of ports of different size. Therefore, non-parametric DEA method is used for objective, logical measurement, and evaluation of managerial efficiency of northeast Asian, European, and American ports.

Regression analysis based on variables of TEU throughput and efficiency results from DEA are used to analyze how relevant factors influence the efficiency.

This study can contribute to port development by understanding how input and output factors influence. This study compares the efficiency of 20 ports: 13 in northeast Asia, 4 in Europe, and 3 in North America, taken from Containerisation International Yearbook (2010).

The study consists of 5 sections: Section 2 is Review of Literature, Section 3 is Current Status of World Major Ports, Section 4 is Empirical Analysis, and Section 5 presents Conclusion.

2. Review of Literature. Analysis on container port efficiency and competitiveness has been studied basing on key decision, input, and output factors. DEA analysis is non-parametric, efficiency measurement tool, measuring parametric on the assumption of detailed function format in advance. Using this non-parametric DEA analysis tool which draws efficiency figures from objective method of using multiple input and output factors, Charnes et al. (1978) overcome previous measurement tools.

Willingale (1981) uses statistical analysis tool on data gathering and surveys from relevant parties and port customers as ship, cargo owners and forwarders. Slack (1985) states cost of shipping and service level are important factors in port selection. Ahn et al. (1988) suggest two guidelines for DMU selection. Firstly, DMU needs to be self controlling, economic unit which can allocate resources of input and output elements in a changeable business environment. Secondly, DMU figure is to be high enough to allow flexibility for maximum credibility of efficiency figures; and flexibility depends on relative DMU size of sum, output and input elements.

Al-Eraqi et al. (2008) state the core of DEA analysis is to find the benchmark with the most efficient frontier for efficiency improvement of inefficient DMU, as there are input oriented model and output-oriented model. Input oriented model seeks to minimize the input element level while maintaining current output element level, as output oriented model is used to minimize the output element level while maintaining the current input level. Although Roll Y. et al. (1993) use for the first time, DEA for efficiency measurement of port performance, they only theoretically show DEA can be applicable for efficiency measurement with 20 virtual port resources. They use CCR model which consists of 3 input elements as labor, capital and homogeneity of facility/cargo, and 4 output elements as cargo throughput, service level, customer satisfaction, and number of ship entry.

Itoh, H (2002) introduces DEA-window analysis supplementing the weak points of cross-sectional analysis that measures efficiency based on input and output in a specific period. DEA-window analysis is used to supplement dynamics of efficiency along with environmental changes.

In addition, Athanassopoulos (1995, 1996) develops the model which simultaneously reduces inputs and increase outputs for making each inefficient DMU efficient. In shipping and port industry, most of studies are to assess efficiency of container port terminal.

Tongzon (2001) implements CCR analysis which uses 'shipping work rate' measuring figure of container transport through efficiency analysis of 16 major container ports. CCR analysis model shows Melbourne, Rotterdam, Yokohama, and Osaka Ports are inefficient in port management.

Valentine et al. (2002) analyzes efficiency of container port for 31 ports, selecting CY area, Dock CFS, number of crane as input elements, and container transport volume as the output element.

Wang et al. (2003) studies privatization of ports, and competitiveness and commercialization from deregulation, comparing the efficiency of English and Korean container ports.

Moreover, the study compares and analyzes efficiency of 28 container ports using DEA and FDH analysis tool. The results suggest 'port and terminal' decision makers to consider the results of both DEA and FDH analysis. The study shows that higher participation of private side results in higher production efficiency from deregulation.

Cullinane et al. (2006) analyzes world top 30 ports using DEA-CCR/BCC model. Output-oriented model is used for the specifics of container industry, as DEA model is compared to SFA for precise analysis of efficiency measurement. In terms of container terminal, size, dynamics, and correlation between geographical influence and efficiency are also studied.

Dragovic et al. (2006) implement simulation experiment of Busan East Container Terminal and performance evaluation of 'ship-berth link' based on waiting theory. Using usage portion of total ship, average number of waiting ship, average waiting time, operation hours per ship, total average duration, average productivity of quay crane, and number of quay crane per ship, managerial efficiency and 'ship-berth link' process are analyzed.

Lin et al. (2007) analyze efficiency of Asia's major 10 container terminals utilizing DEA CCR, BCC, A&P, SCE, and D&G models.

De Koster et al. (2009) compare the inefficiency results between the benchmark and previous study, further scrutinizing background of difference. The study emphasizes the importance of difference on terminal's size and format, precision of input and output data, and additional information, when applying DEA method for comparison of container terminal efficiency.

Panayides et al. (2009) review DEA method application for ports' efficiency measurement, and discuss the issues and limitations in decision of parameters, extent of samples, and selection of DEA application method in order to propose a new method.

Yan et al. (2009) analyze production efficiency of world major container ports during 1997-2004 using SFA method. Considering level of technology and change, efficiency of each port, change in efficiency, and sustainability of efficiency are measured using Bayesian approach technique through Markov Chain Monte Carlo simulation experiment.

As average efficiency of container companies is on the optimal range of 70~90%, results can vary if technology difference factor is not considered.

Hung et al. (2010) study managerial efficiency, efficiency target based on size, and variability in DEA efficiency estimation of Asian container ports. Concept of optimal productivity based on size, approach technique on economy size, and bootstrap method are used to evaluate management performance, and establish efficiency target based on size. Accordingly, efficiency of Asian container ports is ranked.

Wu et al. (2010) analyze efficiency of container ports in BRIC, Next-11, and G7 using DEA method based on container traffic in 2005. The result states ports of developed countries are not to be used as a model, suggesting new perspective for port efficiency in emerging economies.

Cullinane et al. (2010) analyze mid to long term port efficiency using panel data of 25 ports. The study shows a substantial loss in container port productivity and competitiveness of ports, and provides platform to find the optimal benchmark and factors of inefficiency.

Cheon et al. (2010) state change in port structure has positive influence on productivity increase of container transport through port efficiency change analysis on port ownership structure and form; and more optimal port management is achievable for bigger sized ports.

3. Analysis and Results

1. Linear programming model

A basic assumption of DEA Model includes following four (Charnes et al, 1996).

First, Convexity assumption: if more than two points of production (X_i, Y_i) are within possible production set, their Convex Combination also belongs to possible set. Second, Inefficiency assumption: when given production point (X_i, Y_i) falls within possible production set, points with same output but with more input, and points with same input but less output include within possible production set.

Third, Ray unboundness assumption: when given production point (X_i, Y_i) falls within possible production set, multiple by K also falls within possible production set.

Fourth, Minimum Extrapolation assumption: considered possible production set is intersection of all 3 assumptions set.

Most frequently used DEA models are CCR model by Charnes, Cooper, and Rhodes (1978), and BCC model by Cooper (1984). Upon its focus on factors, it classifies into input-oriented or output-oriented model.

Input-oriented model maintains its output level and calculates technological efficiency with proportional decline of input factor usage. Output factor model maintains its input level and calculates technological efficiency with proportional incline of output production.

Both models have the same value under CRS (Constant returns to scale) but different value under VRS (Variable returns to scale) assumption. Selection of input-oriented model or output-oriented model does not affect econometric assumption. According to many precedent studies input-oriented model is selected often because input selection refers to decision making variable for corporations.

Industries with limited resources are better off using output-oriented model to increase the output. Selection of a model depends on the factors available to control and administrate between input oriented and output-oriented model.

2. Efficiency Analysis

1) Selection of data and input/output factors

Analysis object DMU in this study is selected on the world's major 20 container ports by their container traffic. Dubai port is excluded from the analysis because of private content and Tokyo port is included because of its geographical location in Asia.

Table 1. **Input and output factors**

				Outputs	Inputs				
	Rank 2008	Port	Country	2008 TEU	Number of berths	Length of berths (m)	Dept of berths(m)	Terminal area (1,000m²)	Number of cranes
1	1	Singapore	Singapore	29,918,200	45	12,014	14.8	3,390	140
2	2	Shanghai	China	27,980,000	23	7,071	12.0	3,256	46
3	3	Hong Kong	China	24,494,229	24	7,694	14.8	2,788	84
4	4	Shenzhen	China	21,413,888	15	4,270	14.2	1,823	31
5	5	Busan	Korea	13,452,786	24	7,173	14.1	3,927	70
6	7	Ningbo	China	11,226,000	4	2,138	14.3	757	18
7	8	Guangzhou	China	11,001,300	16	4,579	12.6	4,260	28
8	9	Rotterdam	Netherlands	10,800,000	18	11,790	11.4	4,950	70
9	10	Qingdao	China	10,320,000	8	3,367	13.8	1.136	22
10	11	Hamburg	Germany	9,737,000	30	8.223	14.0	4.067	64
11	12	Kaohsiung	Taiwan	9,676,554	19	5,122	13.3	1,907	49
12	13	Antwerp	Belgium	8,663,736	44	10,014	14.0	4,937	90
13	14	Tianjin	China	8,500,000	8	2,450	13.6	1,005	15
14	15	Port Klang	Malaysia	7,970,000	19	4,913	14.8	1,256	50
15	16	Los Angeles	USA	7,849,985	32	8,116	13.6	3,264	64
16	17	Long Beach	USA	6,487,816	36	7,608	14.0	3,961	58
17	18	Tanjung Pelepas	Malaysia	5,600,000	6	2,160	15.0	1,200	24
18	19	Bremen/ Bremerhaven	Germany	5,500,709	15	4,040	13.2	2,265	32

The End of *Table 1*

				Outputs	Inputs				
	Rank 2008	Port	Country	2008 TEU	Number of berths	Length of berths (m)	Dept of berths(m)	Terminal area (1,000m²)	Number of cranes
19	20	New York/New Jersey	USA	5,265,053	42	8,569	12.0	5,680	53
20	24	Tokyo	Japan	5,133,930	14	4,016	13.1	1,021	26

Source: Containerisation International Yearbook 2010. Korea Container Terminal Authority (www.kca.or.kr).

Input factors of this study are number of berth, length of berth, depth of water, extent of terminal, and cranes. Output factor is at container throughput of 1 TEU.

When there are many piers for a port, average is calculated for the depth of water. Container throughput (TEU) includes full TEU and empty TEU which has already loaded or unloaded.

Number of DMU (20) is more than three times of input factor and output factor sum.

Data used in this study is from Containerization International Yearbook (2010) and Korea Container Terminal Authority.

Table 2. **Output-oriented efficiency analysis**

No	Port	Output-oriented CCR efficiency scores	Output-oriented BCC efficiency scores	Reference group	Return to scale
1	Singapore	0.9681	0.9681	2,4	Decreasing
2	Shanghai	1	1	2	Constant
3	Hong Kong	0.8928	0.8928	2,4	Decreasing
4	Shenzhen	1	1	4	Constant
5	Busan	0.4539	0.4539	2,4	Increasing
6	Ningbo	1	1	6	Constant
7	Guangzhou	0.5716	0.5716	2,4	Increasing
8	Rotterdam	0.4707	0.4707	2,6	Increasing
9	Qingdao	0.7108	0.7108	4,6	Increasing
10	Hamburg	0.299	0.299	2,4	Increasing
11	Kaohsiung	0.4563	0.4563	2,4	Increasing
12	Antwerp	0.2654	0.2654	2	Increasing
13	Tianjin	0.8203	0.8203	4	Increasing
14	Port Klang	0.4936	0.4936	4,6	Increasing
15	Los Angeles	0.2683	0.2683	2,4	Increasing
16	Long Beach	0.2106	0.2106	2,4	Increasing
17	Tanjung Pelepas	0.4938	0.4938	6	Increasing
18	Bremen	0.2736	0.2736	2,4	Increasing
19	New York	0.1882	0.1882	2	Increasing
20	Tokyo	0.3825	0.3825	4,6	Increasing

Shanghai, Shenzhen, Ningbo ports are shown to be efficient. For the ports with decreasing returns to scale, efficiency improvement should be achieved by establishing sufficient measure. And for the ports with increasing returns to scale, efficiency improvement should be achieved by increasing their port scale.

Thus Singapore and Hong Kong ports should improve their port management efficiency. The rest of the ports (but of Shanghai, Shenzhen and Ningbo) should increase their port scale to raise efficiency.

Analysis shows that Shanghai, Hong Kong, Busan, Guangzhou, Hamburg, Kaohsiung, Los Angeles, Long Beach, and Bremen ports should model after Shenzhen port.

3. Kruskal-Wallis test

Table 3. **Descriptive statistics 1**

	N	M	SD	Min.	Max.	Percentile		
						25	50 (median)	75
TEU	20	12049559.30	7617572.537	5133930	29918200	6828358.25	9706777.00	12896089.50
Number of berths	20	22.10	12.536	4	45	14.25	19.00	31.50
Length of berths	20	5855.61	3278.982	8	12014	3529.25	5017.50	8010.50
Dept of berths	20	13.630	1.0090	11.4	15.0	13.125	13.900	14.275
Terminal area	20	2582.61	1705.307	1	5680	1065.75	2526.50	3952.50
Number of cranes	20	51.70	30.378	15	140	26.50	49.50	68.50
Efficiency	20	2.65	.671	1	3	2.25	3.00	3.00

Table 4. **Descriptive statistics 2**

		N	M	SD
TEU	Decreasing	2	27206214.50	3835326.675
	Constant	3	20206629.33	8441992.307
	Increasing	15	8397257.93	2480283.242
	Sum	20	12049559.30	7617572.537
Number of berths	Decreasing	2	34.50	14.849
	Constant	3	14.00	9.539
	Increasing	15	22.07	12.186
	Sum	20	22.10	12.536
Length of berths	Decreasing	2	9854.00	3054.701
	Constant	3	4493.00	2474.049
	Increasing	15	5595.01	3208.767
	Sum	20	5855.61	3278.982
Dept of berths	Decreasing	2	14.800	.0000
	Constant	3	13.500	1.3000
	Increasing	15	13.500	.9607
	Sum	20	13.630	1.0090
Terminal area	Decreasing	2	3089.00	425.678
	Constant	3	1945.33	1253.983
	Increasing	15	2642.55	1892.506
	Sum	20	2582.61	1705.307
Number of cranes	Decreasing	2	112.00	39.598
	Constant	3	31.67	14.012
	Increasing	15	47.67	22.125
	Sum	20	51.70	30.378

Table 5. **Ranks**

	Efficiency	N	Mean rank
TEU	Decreasing	2	19.00
	Constant	3	17.00
	Increasing	15	8.07
	Sum	20	

The End of *Table 5*

	Efficiency	N	Mean rank
Number of berths	Decreasing	2	16.75
	Constant	3	6.50
	Increasing	15	10.47
	Sum	20	
Length of berths	Decreasing	2	17.50
	Constant	3	7.33
	Increasing	15	10.20
	Sum	20	
Dept of berths	Decreasing	2	18.00
	Constant	3	11.17
	Increasing	15	9.37
	Sum	20	
Terminal area	Decreasing	2	12.50
	Constant	3	7.67
	Increasing	15	10.80
	Sum	20	
Number of cranes	Decreasing	2	19.00
	Constant	3	6.00
	Increasing	15	10.27
	Sum	20	

Table 6. **Test statistics**

	TEU	Number of berths	Length of berths	Dept of berths	Terminal area	Number of cranes
x^2	10.288	3.615	3.698	3.832	.955	5.896
df	2	2	2	2	2	2
Asymp. Sig.	.006**	.164	.157	.147	.620	.050*
Kruskal Wallis Test						
Grouping variable: efficiency						

**p<.01, *p<.05

Depending on efficiency, there is statistically significant difference in TEU at (x^2=10.288, p<.01). Thus, ports with increasing returns to scale have less TEU than the others.

Depending on efficiency, there is statistically significant difference in cranes at (x^2 =5.896, p<.05). Thus ports with constant returns to scale have more cranes than the others.

4. Regression analysis and Correlation Analysis between variables

Correlation Analysis is used to measure the association between variables. It is normally implemented before the regression analysis to predict hypothesis verification, which is a very significant reference.

To verify association between variables, Pearson correlation coefficient is used to analyze correlation.

Pearson correlation coefficient has value between -1 to 1, correlation coefficient sign represents directivity. Absolute value of correlation coefficient shows size of correlation. There are strong correlations between variables when absolute value gets high.

Normally value of Pearson correlation coefficient between $\pm$0.7 – $\pm$1.0 means there is very high correlation, between $\pm$0.4 – $\pm$0.7 means relatively high correlation, between $\pm$0.2 – $\pm$0.4 – normal correlation, and between 0 – 0.2 – there is very low level of correlation.

Table 7. **Correlation analysis of the sample**

	TEU	Number of berths	Length of berths	Dept of berths	Terminal area	Number of cranes	Efficiency
TEU	1						
Number of berths	.201	1					
Length of berths	.355	.680***	1				
Dept of berths	.132	-.034	-.259	1			
Terminal area	.100	.643**	.820***	-.466*	1		
Number of cranes	.495*	.809***	.758***	.182	.490*	1	
Efficiency	.769***	-.362	-.076	.218	-.299	-.035	1

***p<.001, **p<.01, *p<.05

A correlation analysis of the sample shows there is statistically significant positive correlation between TEU to cranes at (r=.495, p<.05) and efficiency at (r=.769, p<.001).

There are statistically significant positive correlation between number of the berth to length of the berth at (r=.680, p<.001), area at (r=.643, p<.01), and cranes at (r=.809, p<.001).

There is statistically significant positive correlation between length of the berth to area at (r=.820, p<.001), and crane at (r=.758, p<.001).

There is statistically significant negative correlation between depth of water and area at (r=-.446, p<.05).

There is statistically significant positive correlation between area and cranes at (r=.490, p<.05). As depth of water increases, area of the port decrease. But other variables are proportionally increasing.

Table 8. **Hierarchical regression analysis on input factors and efficiency (N=20)**

Model		Unstandardized Coefficients		Standardized Coefficients	t	p	Statistics
		B	SER	β			
1	(Constant)	.372	1.200		.310	.761	R^2 =.345
	Number of berths	-.019	.011	-.801	-1.752	.102	Adjusted =.110
	Length of berths	3.293	.000	.372	.615	.548	F=1.472
	Dept of berths	.022	.086	.077	.259	.799	
	Terminal area	-4.665	.000	-.274	-.542	.596	
	Number of cranes	.004	.006	.451	.757	.461	
2	(Constant)	.681	.132		5.163	.000	R^2 =.341
	Number of berths	-.019	.010	-.813	-1.845	.085	Adjusted =.166
	Length of berths	2.947	.000	.333	.587	.566	F=1.472
	Terminal area	-5.169	.000	-.304	-.637	.534	
	Number of cranes	.005	.005	.519	1.001	.333	
3	(Constant)	.695	.127		5.466	.000	R^2 =.326
	Number of berths	-.021	.009	-.912	-2.288	.036	Adjusted =.200
	Terminal area	-1.274	.000	-.075	-.278	.784	F=2.582
	Number of cranes	.007	.003	.739	2.112	.051	
4	(Constant)	.686	.120		5.729	.000	R^2 =.323
	Number of berths	-.022	.008	-.965	-2.842	.011*	Adjusted =.243
	Number of cranes	.007	.003	.746	2.197	.042*	F=4.055*

*p<.05

Hierarchical regression analysis on input factors and its efficiency shows, on model 1 all variables are input but fail to produce statistically significant result. Statistically significant result is in model 4. Coefficient of determination shows statistically significant at R2=.323, and value of F at 4.055. Regression analysis shows number of berth has statistically significant negative correlation with efficiency.

Table 9. **Correlation analysis of increasing returns to scale ports**

	TEU	Number of berths	Length of berths	Dept of berths	Terminal area	Number of cranes	Efficiency
TEU	1						
Number of berths	-.078	1					
Length of berths	.123	.561*	1				
Dept of berths	-.063	-.120	-.481	1			
Terminal area	.088	.630*	.862***	-.532*	1		
Number of cranes	.304	.799***	.669**	-.060	.571*	1	
Efficiency	.418	-.783***	-.394	.103	-.465	-.610*	1

***p<.001, **p<.01, *p<.05

Correlation analysis of increasing returns to scaleports shows statistically significant positive correlation between number of berth and length of the berth at (r=.561, p<.05), area at (r=.630, p<.05) and cranes at (r=.799, p<.001), but showing statistically significant negative correlation with efficiency at (r=.-783, p<.001). There is positive correlation from berth length to area at (r=.862, p<.001), cranes at (r=.669, p<.01).

Statistically significant negative correlation exists between depth of berths to area at (r=-.532, p<.05).

Statistically significant positive correlation exists between area and cranes at (r=.571, p<.05) but negative correlation exists between crane and efficiency at (r=-.610, p<.05). Positive correlation exists between number of berth and length of berth, between length of berth and area, and between cranes and area. Negative correlation is shown between number of berth and efficiency, between depth of berth and efficiency, and between cranes and efficiency.

Table 10. **Hierarchical regression analysis on input factors and efficiency (N=15)**

Model		Unstandardized Coefficients		Standardized Coefficients	t	p	Statistics
		B	SER	β			
1	(Constant)	.524	.707		.742	.477	R^2 =.618 Adjusted=.406 F=2.918
	Number of berths	-.012	.006	-.817	-2.065	.069	
	Length of berths	6.042	.000	.106	.215	.834	
	Dept of berths	.011	.051	.057	.212	.837	
	Terminal area	3.074	.000	.003	.007	.995	
	Number of cranes	.000	.004	-.026	-.062	.952	
2	(Constant)	.525	.649		.809	.437	R^2=.618 Adjusted=.446 F=4.052*
	Number of berths	-.012	.005	-.816	-2.491	.032*	
	Length of berths	6.175	.000	.109	.333	.746	
	Dept of berths	.011	.046	.056	.230	.823	
	Number of cranes	.000	.003	-.027	-.070	.946	
3	(Constant)	.540	.587		.919	.378	R^2=.618 Adjusted=.514 F=5.939*
	Number of berths	-.012	.003	-.831	-3.614	.004**	
	Length of berths	5.462	.000	.096	.369	.719	
	Dept of berths	.009	.041	.050	.230	.822	

The End of *Table 10*

Model		Unstandardized Coefficients		Standa-rdized Coeffici-ents	t	p	Statistics
		B	SER	β			
4	(Constant)	.674	.073		9.256	.000	R^2=..616 Adjusted=.553 F=9.643
	Number of berths	-.012	.003	-.820	-3.798	.003**	
	Length of berths	3.748	.000	.066	.305	.765	
5	(Constant)	.683	.065		10.577	.000	R^2=..613 Adjusted=.584 F=20.631***
	Number of berths	-.012	.003	-.783	-4.542	.001***	

***p<.001, **p<.01, *p<.05

Hierarchical regression analysis on input factors and efficiency shows statistically significant result from model 2. But on models 2, 3, 4, and 5 only for length of berth result is statistically significant.

Result on model 5 shows significance at coefficient of determination of =.613, and value of F at 20.631 on significance probability of 0.001.

Regression analysis shows number of berth effect negative correlation to efficiency.

4. Conclusion. Global competitiveness of a port comes from its geographical location, port facility, and service level. Also, effectiveness and efficiency of port management, cost of handling cargo, reliability, shipper preferences, depth of water, adaptability to marine market, accessibility to its distripark, and differentiated service can raise the competitiveness.

Port efficiency analysis shows efficiency of Shanghai, Shenzhen, and Ningbo ports are 1.0 and Busan port at 0.4539. Shanghai and Shenzhen ports are selected as reference group to Busan port. They are evaluated as increasing returns to scale ports and correlation analysis on increasing returns to scale ports shows statistically significant positive correlation from number of berth to length of berth at (r=.561, p<.05), area at (r=.630, p<.05), and cranes at (r=.799, p<.001). Therefore, improving efficiency measure through expanding port scale is needed.

The strategy of Busan port as Asia hub port are as follows.

First, to raise its competitiveness to global level of productivity, construct distripark, establish SCM network, and advancement of labor union. To raise its productivity to global level, development of port cluster networking industries and institutions is required.

Second, establishment of innovative transshipment system with aggressive marketing strategy to attract mega container vessel is required.

Third, raise of effectiveness of port facility and its management, lower the cost of port service, and flexibility of labor market is needed. Furthermore, to survive in the fierce competition between the ports, raising its productivity and adopting high technology is required to move ahead of the competition. Shipper preference comes from cost of the service. To raise port competitiveness cost down and enhance customer service is required.

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