Study on Development of Taipei Port in Terms of Efficiency of Container Transport in Taiwan

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Abstract

The situation for the port is upset about a setting of the intense container competition in East Asia ports recently. For example, Port of Singapore was run after in an upper Port of Shanghai from 2010 where container throughput comes first to a regular customer so far (Container Yearbooks 2012). It is thought issue that the weak ports with low container throughput is how to subsist in this severe situation. Some of the reference point about new constructed ports that container yard is limited out and hard to extend like Port of Taipei. It is thought the narrow container yard is hard to attract import/export and also influence container throughput. To improve the issue of the narrow container yard, smooth container transportation system plan between port's container yard and hinterland is necessary.The aim of this research is clarify requirements to succeed as an international containerized cargo ports after having clarified the characteristic of the main port and association with the container throughput in Asia.

In this research, use Data Efficiency Analysis from the side of the port's facilities and Bath of the harbor, the depth of the water, total area, storage ability, port's facilities with an injection element and analyze the efficiency of each harbor as a production element with container throughput in 2010. Furthermore, the port with low container throughput suggests a solution to have efficiency from the aspect of the port's facilities and evaluates the effect.

Keywords:DEA, Port competitionof container, Port of Taipei

1. Introduction

1.1Situation of the Port calls in Taiwan recently

According to Takeuchi (2013), in addition to the Port of Keelung which located in the northern part of Taiwan, the development of Taipei Port is progressing, and port of call number of container ships to the northern port which combines both port has increased, it is possible to build a efficient container transport system efficient in Taiwan.

However, the comparison of Port of Taipei,which is maintain in underway, to other ports in Asia,there is some problem that space such as a bonded area and the container yard is narrowed, the limit will occur in the receiving container ships at this rate. It is though that in order to solve this problem, it is necessary to compensate for the space to build a transport system between inland and smooth materials handling efficient insufficient.

1.2 The DEA approach

Data Envelopment Analysis (DEA) is a technique for measuring the relative efficiencies of decision-making units (DMUs) that use similar inputs to produce similar outputs where the

multiple inputs and outputs are incommensurate in nature. DEA has been one of the fastest growing areas of Operations Research and Management Science in the past two decades.

The DEA technique is a useful measurement of port efficiency because the calculations are non-parametric, they can handle more than one output and they do not require an explicit a priori determination of relationships between output and inputs, as is required for conventional estimations of efficiency using production functions.

In this study, first, in order to analyze in terms of efficiency and relevance of the container cargo volume and characteristics of major ports of Asia, to succeed as an international container cargo port, in addition berth of the port, the water depth, it is shown that total area, container storage capacity, port facilities are required.Then, it shows the problem of Taipei port, it is intended to propose measures for the realization of the transport system An Efficient hinterland as the improvement measures, and evaluate the effect.

The remainder of this paper is structured as follows, Section 2, presents the Literature review of DEA. Section 3 presents the Measuring Asia's port efficiency with DEA. Section 4 presents the outcomes in this research. Conclusions are given in section 5.

2.Literature review

2.1 Literature review of DEA

The selected ports in 20 locations, apply the DEA analysis as an element handling capacity, services, labor mainly, Y.ROLL (1993) conducted a efficiency rating of cargo handling. As a result, assessment of cargo handling was able to grasp, but that there is no (Benchmark) index that can evaluate the port of inefficiency has been pointed out as an issue.

Ito (2000), using the input-output table of China in 1997, 1987, 1992, was analyzed for port efficiency in the time series. However, it is though for input / factor is small, and there is a possibility that shift reliability of the analysis results have pointed out the need for analysis and consideration of the detailed input / factor.

3.Measuring Asia's port efficiency with DEA

In this research, create a Benchmark by the DEA analysis, we carried out the analysis that takes into account a more detailed input / production factor as compared to the existing research. More specifically, in helping with capacity of Asian port, facilities and cargo handling machinery, we found an association with the container handling capacity, to clarify the requirements for a successful container cargo port International, to be a reference for improvement of the Port of Taipei.

3.1 Number example data

The first step towards conducting a relative efficiency analysis is to define the characteristics that best describe port performance. In this research, one output factor and ten input factors by Containerization Yearbook 2013 were chosen, as follows:

3.1.1 Output

The output we utilized is container throughput in 2010, which is the total number of containers loaded and unloaded in 20-foot equivalent units (TEUs).

3.1.2 Input

To produce the above outputs and to facilitate port operations, varieties of inputs are required. Based on the production framework, port inputs can be generalized as land, labor and capital. In this research, we are going to focus on land and capital. The major capital input in port operations are the berths and cranes. About the berth, we utilized the number of berth, total length of berth, reeferpoint, quay crane, yard gantries, yard chassis/trailer, yard container work mobile to measure efficiency. And the land weutilized is total area of the container terminal to measure efficiency. As follow:

Table 1. The output/input for DEA

Output
2010 container throughput
Input
Number of berth
Total length of berth
The mean value of berth
Total area
Storage
Reefer point
Quay crane
Yard gantries
Yard chassis/trailer
Yard container work mobile

The values of these outputs and inputs are define as follows and detailed in Table 2:

Table2. Values of output/input

country	DMU	PORT	Output 2010	Input1 berth	Input2 length(m)	Input3 depth(m)	Input4 total area(1000㎡)	Input5 storage(TEU)	Input6 reefer point(electric)	Input7 Quay crane	Input8 Yard gantries	Input9 Yard container work mobile	Input10 Yard chassis/trailer	PORT	DMU	country
China	1	SHANGHAI	29,069,000	32	9,142	12	8,570,197	350,084	6,510	112	372	608	0	SHANGHAI	1	China
	2	HONGKONG	23,699,242	81	11,409	13	3,438,500	300,238	7,080	125	321	216	341	HONGKONG	2	
	3	SHENZHEN	22,509,700	10	3,465	14	1,485,800	117,473	1,398	27	89	38	55	SHENZHEN	3	
	4	NINGBO	13,144,000	9	3,748	10	757,000	0	992	16	22	62	0	NINGBO	4	
	5	GUANGZHOU	12,550,000	20	5,370	10	4,604,600	281,871	2,374	54	149	198	49	GUANGZHOU	5	
	6	QINGDAO	12,012,000	14	5,449	13	1,322,800	144,872	6,072	46	116	64	0	QINGDAO	6	
	7	TIANJIN	10,080,000	16	4,674	11	1,859,400	107,362	1,950	33	94	135	0	TIANJIN	7	
	8	XIAMEN	5,820,000	9	2,483	13	480,000	15,000	240	10	20	26	20	XIAMEN	8	
	9	DALIAN	5,242,000	33	10,032	11	3,570,579	224,712	4,834	92	231	221	234	DALIAN	9	
	10	LIAN YUNG GANG	3,870,000	23	2,421	9	441,000	13,200	218	18	11	111	71	LIAN YUNG GANG	10	
	11	YINGKOU	3,338,000	21	8,743	13	2,282,000	116,000	2,578	47	74	181	192	YINGKOU	11	
	12	FUZHOU	1,318,958	10	2,336	13	1,813,000	60,228	1,124	16	30	6	0	FUZHOU	12	
	13	NANJING	1,058,500	9	1,600	12	600,000	18,500	244	11	12	118	104	NANJING	13	
	14	QUANZHOU	1,050,700	8	2,217	11	360,000	3,000	0	5	8	8	4	QUANZHOU	14	
	15	ZHANGJIANGANG	889,500	3	722	10	40,000	0	0	6	18	9	0	ZHANGJIANGANG	15	
	16	GAOLAN	430,731	40	1,662	13	3,000,000	186,000	256	113	264	198	62	GAOLAN	16	
Taiwan	17	KAOHSIUNG	9,181,211	22	6713	13.2	1416374	70584	2479	21	47	120	28	KAOHSIUNG	17	Taiwan
	18	KEELUNG	1,962,896	30	3920	12.7	396900	16049	300	29	0	38	0	KEELUNG	18	
	19	TAICHUNG	1,356,952	6	1800	14	935269	46200	547	0	0	0	0	TAICHUNG	19	
	20	TAIPEI	434,744	2	740	14	948843	0	0	10	33	0	0	TAIPEI	20	
Japan	21	TOKYO	4,284,944	16	4669	14.3	1521547	201958	4195	43	72	129	153	TOKYO	21	Japan
	22	YOKOHAMA	3,280,191	21	5390	13.4	2094922	107186	5572	37	53	144	82	YOKOHAMA	22	
	23	KOBE	2,556,291	27	7625	12.9	1889497	80904	3199	44	65	230	231	KOBE	23	
	24	NAGOYA	2,548,851	12	3670	13.6	1405549	77430	975	27	41	84	0	NAGOYA	24	
	25	OSAKA	1,264,000	15	4435	13.4	1303767	55675	2192	22	30	100	50	OSAKA	25	
	26	HAKATA	748,580	4	1280	14	451600	21148	540	9	13	18	0	HAKATA	26	
	27	KITAKYUSHU	480,228	9	2215	11.8	710000	32738	550	14	7	33	0	KITAKYUSHU	27	
	28	SHIMIZU	475,084	6	2510	13	307102	26163	431	7	19	17	0	SHIMIZU	28	
	29	NAHA	441,768	2	600	14.5	208000	7000	60	2	0	12	0	NAHA	29	
	30	TOMAKOMAI	322,126	4	1080	12.3	322000	18622	400	4	9	11	0	TOMAKOMAI	30	
	31	SENDAI-SHIOGAMA	216,142	2	600	13	215900	250000	105	4	0	11	0	SENDAI-SHIOGAMA	31	
	32	HIROSHIMA	210,048	4	740	10.75	152360	6422	46	6	4	0	0	HIROSHIMA	32	
	33	YOKKAICHI	208,415	2	550	12.5	203546	12396	152	4	0	41	0	YOKKAICHI	33	
	34	MIZUSHIMA	174,300	9	1400	8.8	121466	3200	40	3	3	4	6	MIZUSHIMA	34	
	35	NIIGATA	168,809	3	665	9.8	34000	2700		3	0	6	3	NIIGATA	35	
	36	CHIBA	88,041	1	240	12	80000	2616	52	2	0	0	0	CHIBA	36	
	37	HACHINOHE	45,430	1	260	13	41516	1865	62	2	0	0	0	HACHINOHE	37	
	38	OITA	40,329	3	730	12	300000	8630	304	0	0	0	0	OITA	38	
Singapore	39	SINGAPORE(PSA)	28,431,100	40	12800	15.3	5000000	0	0	148	0	0	0	SINGAPORE(PSA)	39	Singapore
	40	JURONG	747,400	28	5896	12.5	35000	0	360	14	36	7	0	JURONG	40	
Korea	41	Busan	14,194,334	58	14610	13.9	4277778	325155	8214	80	253	524	854	Busan	41	Korea
	42	GWANGYANG	2,084,892	9	2550	15	7797319	103523	2732	16	45	101	211	GWANGYANG	42	
	43	INCHEON	1,887,000	6	2335	12.5	500000	6600	120	8	17	200	702	INCHEON	43	
	44	PYONGTAEK	447,612	3	720	12	122570	0	0	0	0	0	0	PYONGTAEK	44	
	45	ULSAN	333,589	1	240	12	102507	11700	56	3	3	14	0	ULSAN	45	
Malaysia	46	PORT KLANG	8,870,000	24	7570	14.4	1824300	75026	2288	63	148	794	360	PORT KLANG	46	Malaysia
	47	TANJUNG PELEPAS	6,530,000	12	4320	17	1800000	189000	4161	44	122	0	0	TANJUNG PELEPAS	47	
	48	PENANG	1,106,098	4	900	12	670000	5916	360	16	34	73	127	PENANG	48	
	49	PASIR CUDANG	876,268	3	700	14	250000	25000	144	7	19	54	0	PASIR CUDANG	49	
	50	BINTULU	251,296	2	450	14	91450	362564	84	2	7	53	12	BINTULU	50	
	51	KUCHING	190,642	11	1248	9.8	933000	5137	288	0	0	14	21	KUCHING	51	
	52	KUANTAN	142,080	19	0	11.2	1600000	1750	168	4	4	0	0	KUANTAN	52	
	53	SIBU	80,333	10	1297	17.4	73471	1168	34	4	0	57	6	SIBU	53	
Indonesia	54	TANJUNG PRIOK	4,714,857	14	3192	11	1,656,000	40,980	396	26	102	46	158	TANJUNG PRIOK	54	Indonesia
	55	TANJUNG PERAK	3,030,000	11	2370	9.75	1,100,000	13192	359	16	47	205	265	TANJUNG PERAK	55	
	56	SEMARANG	384,522	8	1700	30	259727	6546	108	10	11	47	53	SEMARANG	56	
Vietnem	57	HO CHI MINH	3,856,000	33	5434	11	2589000	45500	1531	46	70	180	106	HO CHI MINH	57	Vietnem
	58	HAIPHONG	953,646	6	1169	8.2	177300	20000	300	7	44	66	0	HAIPHONG	58	
	59	CAI MEP	511,900	4	1080	16.5	825000	26000	1152	14	25	26	20	CAI MEP	59	
	60	VUNG TAU	293,912	2	600	14.5	540000	0	0	6	0	20	0	VUNG TAU	60	
	61	DANANG	89,199	8	1493	9.5	299256	125000	60	4	25	64	0	DANANG	61	
	62	QUI NHON	72,224	6	835	10.2	357239	7000	0	21	1	18	10	QUI NHON	62	
Philippines	63	DAVAO	524,498	10	1093	10.6	167500	320000	264	0	0	17	0	DAVAO	63	Philippines
	64	CEBU	492,776	6	1141	8.6	100000	8060	36	3	10	40	26	CEBU	64	
	65	CAGAYAN DE ORO	163,831	2	300	12	240000	6882	262	2	4	1	0	CAGAYAN DE ORO	65	
	66	GENERAL SANTOS	140,023	18	1591	103	151000	2682	204	0	1	22	11	GENERAL SANTOS	66	
	67	MANILA	125,042	69	7232	7	1098258	54746	1402	17	109	440	274	MANILA	67	
	68	ILOILO	91,998	2	2100	9.5	52000	2000	36	0	6	35	0	ILOILO	68	
	69	ZAMBOANGA	67,251	2	492	9.5	157000	2286	0	0	2	8	9	ZAMBOANGA	69	
Thailand	70	LAEM CHABANG	5,068,076	30	10300	14.6	4313800	109172	3826	75	122	401	230	LAEM CHABANG	70	Thailand
	71	BANGKOK	1,356,952	22	4154	8.6	887810	25000	754	7	74	534	269	BANGKOK	71	
COUNTRY	DMU	PORT	2010	berth	length(m)	depth(m)	total area(1000㎡)	storage(TEU)	reefer point(electric)	Quay crane	Yard gantries	Yard container work mobile	Yard chassis/trailer	PORT	DMU	COUNTRY
			Output	Input1	Input2	Input3	Input4	Input5	Input6	Input7	Input8	Input9	Input10			

4. Outcomes and their analysis

To measure DEA in this research, we utilized a computer program called DEAP, which is made from Centre for Efficiency and Productivity Analysis in University of New England. The result of the efficiency in this research as follow:

Table 3. Result of the efficiency in Asia's ports

No.	Port	Efficiency	No.	Port	Efficiency
1	SHANGHAI	1	37	OITA	0.081
2	HONGKONG	0.442	38	SINGAPORE(PSA)	1
3	SHENZHEN	1	39	JURONG	0.96
4	NINGBO	1	40	Busan	0.636
5	GUANGZHOU	0.447	41	GWANGYANG	0.168
6	QINGDAO	0.791	42	INCHEON	0.552
7	TIANJIN	0.647	43	PYONGTAEK	1
8	XIAMEN	1	44	ULSAN	0.414
9	DALIAN	0.095	45	PORT KLANG	0.519
10	LIAN YUNG GANG	1	46	TANJUNG PELEPAS	0.77
11	YINGKOU	0.107	47	PENANG	0.301
12	FUZHOU	0.287	48	PASIR GUDANG	0.389
13	NANJING	0.219	49	BINTULU	0.179
14	QUANZHOU	0.754	50	KUCHING	0.416
15	ZHANGJIANGANG	1	51	KUANTAN	1
16	GAOLAN	0.067	52	SIBU	0.192
17	KAOHSIUNG	0.703	53	TANJUNG PRIOK	0.471
18	KEELUNG	0.87	54	TANJUNG PERAK	0.473
19	TAICHUNG	1	55	Semarang	0.129
20	TOKYO	0.268	56	HO CHI MINH	0.268
21	YOKOHAMA	0.211	57	HAIPHONG	0.362
22	KOBE	0.161	58	CAI MEP	0.084
23	NAGOYA	0.314	59	VUNG TAU	0.244
24	OSAKA	0.117	60	DANANG	0.055
25	HAKATA	0.176	61	QUI NHON	0.039
26	KITAKYUSHU	0.093	62	DAVAO	1
27	SHIMIZU	0.115	63	CEBU	0.424
28	NAHA	1	64	CAGAYAN DE ORO	0.267
29	TOMAKOMAI	0.116	65	GENERAL SANTOS	0.292
30	SENDAI-SHIOGAMA	0.231	66	MANILA	0.015
31	HIROSHIMA	1	67	ILOILO	0.484
32	YOKKAICHI	0.229	68	ZAMBOANGA	0.225
33	MIZUSHIMA	0.268	69	LAEM CHABANG	0.233
34	NIIGATA	0.873	70	BANGKOK	0.233
35	CHIBA	0.206	71	TAIPEI	0.306
36	HACHINOHE	0.192			

4.1 Percentage of the efficient port in

As the result, 13 places ports efficiency value reaches to one, accounting for 18% of the total. It has resulted in the port of nine has been referred to as the benchmark further.

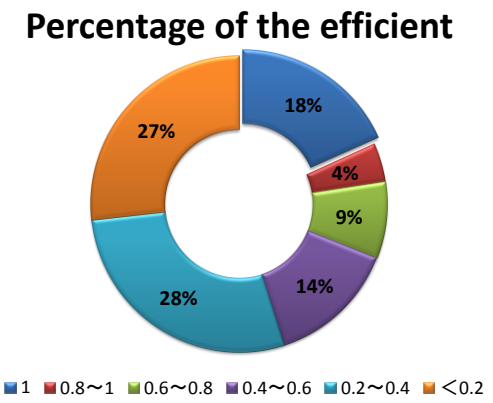

Fig. 1 Percentage of the efficient

4.2 Count of comparison of the benchmark

As the result, we can also know that efficiency port which is compared and would be the benchmark in this research. The table 4. Is showing the port that is the benchmark and their count of comparison.

Table 4. Count of comparison of the benchmark

Benchmark	Count
SHANGHAI	10
SHENZHEN	38
NINGBO	39
XIAMEN	7
ZHANGJIANGANG	5
TAICHUNG	11
SINGAPORE(PSA)	47
PYONGTAEK	18
KUANTAN	2

4.3 Compare with the port of Taipei and port of Singapore

Port of Taipei performs efficiency evaluated as the reference object Port of Singapore(PSA), it becomes 0.306, which is inefficient relative shows the results. Furthermore, the results of Singapore and Taipei port, that the input element Length of Taipei Port, Depth, Total area, Quay crane, Yard gantriesbecome negative, input factors are not enough has been shown. Especially the Total area has become a negative element in particular. It can be considered as the reason, that container yard is very narrow and has influence. Therefore, in order to increase the transport efficiency, it is necessary to construct a transport system smooth inland between Taipei harbor space is insufficient.

Results for firm: Singapore(PSA)
Technical efficiency = 1.000
PROJECTION SUMMARY:

variable		original value	radial movement	slack movement	projected value	
output	1	28431100.000	0.000	0.000	28431100.000	---(2010 Container throughput)
input	1	40.000	0.000	0.000	40.000	---(Berth)
input	2	12800.000	0.000	0.000	12800.000	---(Length)
input	3	15.300	0.000	0.000	15.300	---(Depth)
input	4	5000000.000	0.000	0.000	5000000.000	---(Total area)
input	5	0.001	0.000	0.000	0.001	---(Storage)
input	6	0.001	0.000	0.000	0.001	---(Reefer point)
input	7	148.000	0.000	0.000	148.000	---(Quay crane)
input	8	0.001	0.000	0.000	0.001	---(Yard grantry)
input	9	0.001	0.000	0.000	0.001	---(Yard chassis/trailer)
input	10	0.001	0.000	0.000	0.001	---(Yard container work mobile)

LISTING OF PEERS:

peer	lambda weight
38	1.000

Results for firm: TAIPEI
Technical efficiency = 0.306
PROJECTION SUMMARY:

variable		original value	radial movement	slack movement	projected value	
output	1	434744.000	986817.509	0.000	1421561.509	---(2010Container throughput)
input	1	2.000	0.000	0.000	2.000	---(Berth)
input	2	740.000	0.000	-99.999	640.001	---(Length)
input	3	14.000	0.000	-13.235	0.765	---(Depth)
input	4	948843.000	0.000	-698843.346	249999.654	---(Total area)
input	5	0.001	0.000	0.000	0.001	---(Storage)
input	6	0.001	0.000	0.000	0.001	---(Reefer point)
input	7	10.000	0.000	-2.600	7.400	---(Quay crane)
input	8	33.000	0.000	-33.000	0.000	---(Yard grantry)
input	9	0.001	0.000	-0.001	0.000	---(Yard chassis/trailer)
input	10	0.001	0.000	-0.001	0.000	---(Yard container work mobile)

LISTING OF PEERS:

peer	lambda weight
38	0.050

Fig. 2 The example of the figure in this paper

5. Conclusion

As the result, we can find port's efficiency situation in Asia, and Port of Taipei also in the inefficiency situation by the measure result. Thus, after the above of identify issues to be evaluated by the port DEA analysis, there are no studies on the improvement measures for the realization of the transport system efficient in the hinterland. But it is though improvement plan to make efficiency up on Port of Taipei. In the future work, we are going to do deeply discuss the transportation's construction of the port between the port of Taipei and port of Singapore. It is though that may find out the hint which is the key to rising up the efficiency of the port of the Taipei. For hypothesis, Port of Taipei isonly No.64 fast road expressway leading to the city center and Taipei port.In the future, container cargo volume would increase gradually, freight car utilization of No.64 expressway may also increase, then it is though traffic congestion occurs is possibly considered. It is though solve the congestion on the No.64 expressway and make a smooth transport plan were rise the efficiency in Port of Taipei. But how to prove the hypothesis rise the efficiency in the port competition in this research is the issue we are going to discuss.

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