

Performance Evaluation of Asian Port Distriparks Using Factor Analysis

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Abstract : Business environment in which a port carries out its management and operations is increasingly reflected by intra- and inter-port competition in the regional and global scale and thus by port concentration and deconcentration. Due to the changes in the port industry, most countries are making great effort to secure their ports as a hub by investing enormous funds on port facilities and by improving efficiency in port operations and management. To advance their competitiveness, the port authorities in the region have implemented various strategies, such as building logistic centres, expanding port back-up areas, cooperation between port authorities in the same areas and advancing IT systems. Especially, the port authorities have built the distriparks, such as logistic centers and off-dock container yards, in periphery of port to cope with growing rival ports quickly. The distriparks have advanced their port competitiveness and increased their profit through improving port productivity. Having the aforementioned in mind, purposes of this paper are to investigate the port performance related to its distriparks and to suggest the appropriate ways to design

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and plan its distriparks against Asian cases, where competition is highly severe and container cargoes are quickly increasing. In addition, it will suggest the points of difference between hub ports and regional ports and/ or among the ports in terms of the performance related to distriparks.

Key Words : Performance, Competition, Distripark, Asian Container Port, Factor Analysis

I . Introduction

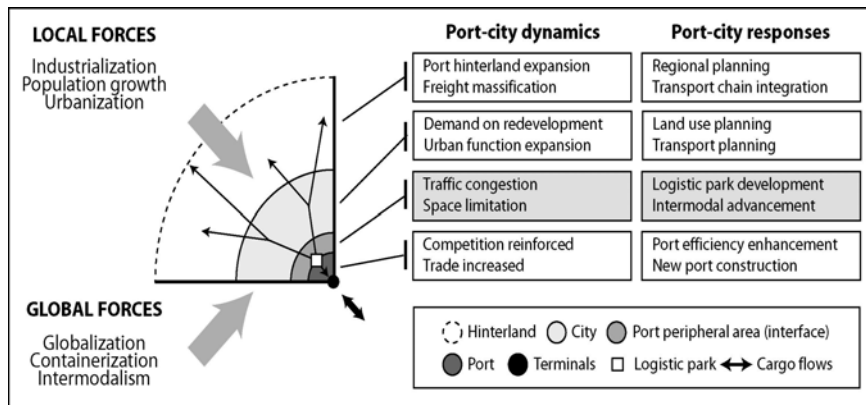
Over the last decades, globalisation has become a general trend in many countries, especially in the Asian countries. One of the major engines to this trend is China's opening of its industries through the Economic Reforms in 1978. Due to the fact, a lot of multinational corporations (MNCs) have been concentrated at the Asian region, especially at China as their prime focus. As a result of the globalisation, business environment in which a port carries out its management and operations is increasingly reflected by intra- and inter-port competition in the regional and global scale and thus by port concentration and deconcentration.

Such series of transitions have intensely happened in Asian ports. Due to the changes in the port industry, most Asian countries are making great efforts to secure their ports as a hub by investing enormous funds on port facilities and by improving efficiency in port operations and management. Asian countries have experienced remarkable economic growth over the past three decades. Since their international trade is carried predominantly by sea transport, their ports play a pivotal role in national and regional economic development (Song and Han, 2004).

Under these circumstances, many port authorities have tried to improve their facilities and systems. However, due to the quick increasing container cargoes, they still suffer from "... diseconomies of scale in some load centres emerge in a lack of space for expansion and limited foreland or hinterland accessibility" as mentioned by Notteboom (1997, p. 100). Thus, the efficient management of peripheral port areas is important for such port cities. <Figure-1> illustrates the relational mechanism between port and city, and also

the potential role of their common interface.

〈Figure-1〉 Relational Mechanism between Port and City



Source: Modified from Lee (2005)

To deal appropriately with these problems and to advance their competitiveness, the port authorities in the region have launched various strategies, such as building logistic centres, expanding port distriparks, cooperation between port authorities in the same areas and advancing Information Technology (IT) systems.

Among the factors yielding on a port's competitiveness, performance or efficiency is considered as one of the most influential elements (Tongzon 1995 & 2001; Song et al, 2001; Song & Han, 2005). The impact of a port's performance is not only confined to its competitiveness, but also goes beyond the industry to effect on a country's overall competitiveness. Port's performance, especially related to container handling capacity, is the most important factor to maintain and to advance port competitiveness. In this respect, the port authorities have built the distriparks such as logistic centres and off-dock container yards, in periphery of port to cope with quickly growing rival ports. The port logistics activity zones have advanced

their port competitiveness and increased their profit through improving port productivity.

Geographically, this study covers the ten ports (Hong Kong, Singapore, Yantian and Busan as a major port; Dalian, Tianjin, Gwangyang, Port of Tanjung Pelepas, Tokyo, and Yokohama as a regional port) in Asia. The major ports are located in the centre of the region. These ports are also ranked in the world top 10 in terms of container throughputs. On the other hand, the regional port is not located on the main interregional trunk line and it is smaller than their peripheral ports. These ports mentioned above are newly born or modernized port compared with the major ports. Regional ports are not ranked in the world top 10 in terms of container throughputs.

Therefore, the target ports may be given to an eminent differential between hub ports and regional ports. It is easy to draw a distinction between hub ports and region ports in terms of port performance related to its distriparks. The 10 ports are chosen to be analyzed because of the similarities and disparities in backgrounds.

Having the aforementioned in mind, purposes of this paper are to investigate the port performance related to its backup areas and to suggest the appropriate ways to design and plan its distriparks against Asian case, where competition is highly severe and container cargoes are quickly increasing. In addition, it will suggest the points of difference between hub ports and regional ports and/or among the ports in terms of the performance related to port backup areas.

II. Concept of Port Distriparks

Distriparks, in general, the provision of advanced logistic services

for handling maritime freight trigger a progressive increase in customer loyalty in the short term and generate new demand in the medium and long term. This commercial effect is becoming progressively more pronounced in the port service markets that are undergoing a process of growing competition, where shore-based transport systems (rail and road) are gradually encroaching upon hitherto captive hinterlands.

In this context, port support and logistic services have ceased to be a novelty and have become a necessity, an option that port customers are beginning to demand. Consequently, distriparks are becoming a key tool for the integral development of ports, notably container terminals, representing as they do areas of integrated logistics activity of the highest quality.

Generally, due to carrying out many functions for port as described above, distripark is hard to define conceptually. However, for the purpose of this research, distripark is defined as an area where industrial or economic activity takes place, kept spatially separated from and functionally connect with the main port areas, and universally devoted to the logistics of sea-based cargoes.

Distriparks consist of three areas such as logistic areas, intermodal areas and service centres as shown in <Table-1>. The scope of distripark is quite wide for evaluating the function and role related to port. In addition, this research is focused on container terminal in terms of port competitiveness compared with rival ports. Therefore, in this study, the scope of distripark is limited to Off-Dock Container Yard (ODCY), Distribution Centre (DC), Logistic Centre (LC) and Free Trade Zone (FTZ), notably carrying out commercial functions and having the location closed to main container terminal.

〈Table-1〉 **Type of Port Distripark**

Category	A Single Transport Mode	Multi Transport Mode
Type	Transport (Service) Centre Logistic Centre Distribution Park Off-Dock Container Yard Inland Container Depot	Free Trade Zone Port Logistic Activity Zones
Function	Storage, Distribution, Custom Services, Delivery	Consolidation, Processing, Assembly, Manufacturing, Storage, Distribution, Custom Services, Commercial, Trade, Business

Source: modified from IAPH & Spanish Ports Agency (2003); Lee (2005)

Distripark belongs to narrow backup area part in terms of such spatial classification. As defined in the above, it can be regarded as a logistics space, which interacts mutually as keeping direct relationship with terminal within the terminal or in the right rear. Such a logistics space comprises a single transport mode and multi transport mode as mentioned in the 〈Table-1〉. Therefore, with such a classification, data collection necessary for analysing a distripark will be available.

III. Port Performance as Indicator of Port Competitiveness

1. Concept of Port Performance

Even though the concept of port performance has been used widely, the concept is still unclear because it includes overall concepts such

as port *productivity*, *port efficiency*, *port effectiveness*, and *economy* of a port.

Port performance is used as a joint definition of effectiveness and efficiency. In this study, performance is addressed to throughputs in container terminal. The performance of container terminal is able to produce a maximum output (in TEU) for given inputs (terminal infrastructure including the distriparks located in outside of a port), or use minimal inputs for the production of a given level of output.

Ports need to know how to compare with their rivals and advance their competitiveness for holding dominant market position. Measurement of *port performance* is a crucial way in checking the competitiveness of a port, comparing with rival ports. In order to measure port performance, many operational and functional variables; such as depth of berths, stacking area of container yards, number of terminal ground slots, ownership of container terminals, etc, have been selected within the territory of container terminal itself until the middle of 1990's. However, these days, modern container terminals have to harmonize with cities where the container terminals located because the relationship between container terminals and cities has become the key factor of having competitiveness among rival ports. Therefore, the measurement variables of port performance have been changed from operational and functional factors of container terminal itself to spatial and functional relation factors between container terminals and cities (Notteboom and Rodrigue, 2005). Especially, space limitation of a port itself becomes the main obstacle factor functionally and spatially in Asian ports such as Hong Kong and Singapore. In addition, space limitation of a port itself and within the city where the port located caused high traffic congestion; therefore, the harmonising between functions of ports and urban functions become importance more and more (Lee & Song, 2005).

In order to increase the degree of harmonising, port authorities and port operators have started to develop the distriparks, such as logistic centre within the territory of ports and off-dock container yard within the outside of ports with compact designing (Lee, 2005; Lee & Song, 2005). Distriparks become more important factor to make up port performance under the fierce competitive areas and time. Therefore, in order to measure port performance related to its distriparks, the concept of port performance and the measurement variables of port performance have to be defined and highlighted by reviewing previous literature.

2. Measurement Variables of Port Performance

There are various methods to evaluate the performance in the econometrics and the variables agreeable to the concerned methods are also various. The selection of variables depends on the research method, the evaluation techniques, the constraint conditions and the characteristics of research (Zhu, 2003).

<Table-2> is about the variables of researches on the measurement of container terminals' performance, productivity, and efficiency have been recently conducted. As it is difficult to obtain the direct data in these studies, the performance or productivity has been tried to presume the indirect variables.

In most studies, container throughputs, service level, and user satisfaction are mainly adopted as dependent (output according to methodology). In case of independent variables, labor costs, capital, depreciation cost, level of computerisation, number of berth, number of crane, dwelling time, size of CY, number of personnel and characteristics of cargo are mainly used in the DEA methodology.

〈Table-2〉 Variables (Input & Output) of Efficiency Analysis on the Existing Ports

Researcher	Research Method	Variables	
		Input	Output
Dowd & Leschine (1990)	Literature Survey	<ul style="list-style-type: none"> * Yard throughput * Crane productivity * Berth utilisation * Gate throughput * Labour productivity 	
Hayuth and Roll (1993)	DEA	<ul style="list-style-type: none"> * Labour cost * Capital * Characteristics of cargo 	<ul style="list-style-type: none"> * Total cargo volume * Service level * User satisfaction * Number of ships
Martinez-Bu dria et al (1999)	DEA	<ul style="list-style-type: none"> * Labour cost * Depreciation 	<ul style="list-style-type: none"> * Total cargo volume * Earnings from rent
Notteboom et al. (2000)	Baysian Stochastic Frontier Model	<ul style="list-style-type: none"> * Length of quaywall * Size of terminal * Number of G/C 	<ul style="list-style-type: none"> * Container throughput (TEU)
Tongzon, J. (2001)	DEA	<ul style="list-style-type: none"> * Number of berth * Number of crane * Number of tugboat * Size of CY * Waiting time * Number of personnel 	<ul style="list-style-type: none"> * Container throughput (TEU) * Working rate of vessel
Song, et.al. (2002)	Stochastic Frontier Model	<ul style="list-style-type: none"> * Length of quaywall * Size of terminal * Number of cargo handling equipment 	<ul style="list-style-type: none"> * Container throughput (TEU)
Wiegman et.al. (2004)	DEA	<ul style="list-style-type: none"> * Size of terminal * Number of gate * Number of reachstacker * Length of loading tracks 	<ul style="list-style-type: none"> * Container throughput (TEU)
Song & Han (2004)	Regression	<ul style="list-style-type: none"> * Terminal berth * Ratio of container * Terminal equipment * Size of CY 	<ul style="list-style-type: none"> * Container throughput (TEU)

Source: modified from various literatures

Length of quaywall, size of terminal and number of stevedoring equipment were mainly used in the stochastic frontier model while berth occupancy rate, size of terminal, berth utilisation, and geographic location are mainly used in the regression model.

Most of previous studies have used container throughput (in TEU) as a dependent variable. Besides the dependent variable, there are a bunch of independent variables such as labor costs, depreciation, length of quay wall, size of terminal, number of gantry cranes, number of berth, number of tugboat, waiting time, characteristics of cargo, and so on depending on the research purpose of the researcher and the intention.

These studies did rarely concern about the spatial expansion of ports because most of researchers have thought that a port is an isolated facility from the function of a city. Thus, the studies have just measured performance, effectiveness, and efficiency of a port within the territory of the port. They just used inner factors of a container terminal, such as labour costs, depreciation costs of facilities and container handling equipments, length of quay wall, size of terminal, number of gantry cranes, etc, as independent variables as described above.

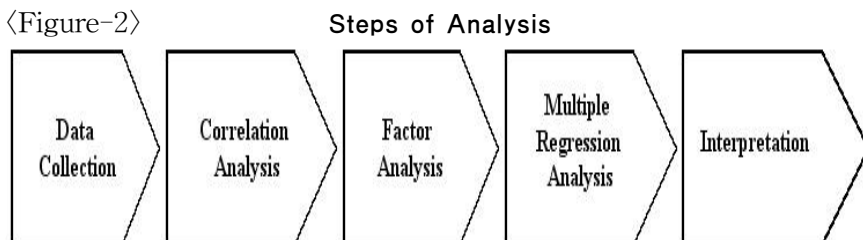
However, recent studies have started to concern about the spatial expansion of ports into cities because the researchers have started to be aware that a port is no longer an isolated facility in the function of city resulting from the functional changes of ports. Especially owing to the limitation to the expansion of container terminal, it is necessary to take Off-Dock Container Yard, Distripark, Logistic Centre, and Inland Depot into consideration at backup facilities. They have greatly influenced the performance of port. In addition, recent researches have shown the trend to move the scope and focus of research owing to the geographic characteristics of port, like location,

size of hinterland, and the network with hinterland (Notterboom & Rodrigue, 2005; Slack & Wang, 2003; Lee and Song, 2005). For instance, according to the work of Song and Han (2004), the accessibility of hinterland, size of hinterland, global locations of port have been suggested to exert great influence on the performance of port. In addition, port's privatization level and the application of IT system at the operation of terminal have begun to be dealt as main independent variables.

IV. Methodology

The analysis of this study is to be carried out by the five steps such as data collection, correlation analysis, factor analysis, multiple regression analysis and interpretation. After defining many variables into container terminal factor and backup area (distripark) factor, which we wish to know the influence through factor analysis, we catch the degree of the influence on the port performance by regression analysis through these factors. Particularly, the clarification of relationship between PLAZ and port performance is the key issue of this study on the basis of the influence of the distripark.

〈Figure-2〉



1. Variables of Port Performance

From the previous studies, one dependent variable and 22 independent variables are selected as a dataset in order to carry out this research. Data set is primarily created on the basis of 22 factors drawn from the previous studies through the direct interview survey on the ports of 10 regions. First of all, a dependent variable is the container throughput in 2003 of the target ports. Besides the selecting of the dependent variable, this study divides the independent variables into two groups, Container Terminal Factors and Port Backup (distripark) Factors in terms of spatial view.

Container terminal factors are only dealing with inner factors of container terminals and they are also divided into three subgroups, Forward Factors, Berth Factors, and Terminal Factors, according to the functional locations of container terminals. Namely, forward factors cannot be directly controlled by port authorities or terminal operators, but they can be treated as same kinds of the results of port performance (Song & Cullinane, 1999). They are Number of Direct Callings (NDC)¹⁾ and Average Anchorage Time/Vessel (AATV)²⁾ (Hayuth & Roll, 1993). Berth factors indicate the berth performance in terms of Number of Quay Cranes (NQC), Net Crane Product (NCP),³⁾ Rate of Berth Occupancy (RBO),⁴⁾ and Terminal Working Hour (TWH). Lastly, terminal factors have three variables, Average

1) *Number of Direct Callings* is consisted with two categories, containerships over 5,000TEU in capacity and less 5,000 TEU.

2) *Average Anchorage Time* is the total time for anchoring from the boundary line of the port to the berthing; therefore, it includes pilot time and tugging time.

3) *Net Crane Product* is calculated by
$$\frac{TEUsHandledPerWorkingDay}{No.ofCRane \times NetWorkingHoursPerDay}$$
.

4) Total anchorage time of all calling ships in a year is divided by total berthing time for all berth of container terminal is *Rate of Berth Occupancy*.

Stacking Story (ASS), Terminal Ground Slots (TGS), and yes or no of EDI System (EDI) (Song and Han, 2004).

In the meantime, Port Backup Factors are divided into two subgroups, General Backup Area factors and Detailed Backup Area Factors. These factors are for defining the relationship between the inside and outside of container terminals. General backup area factors consist of four items, Number of Gate (NoG), Number of Gate Lanes (NoGL), yes or no of Train System (TS), and Floor Size (FS)⁵⁾ of port back area. In addition, in detailed backup area factors, there are five items such as Average Number of Floors (ANF), Distance from the Main Container Terminal (DMCT), yes or no of IT Operating System (IT), Total Number of Operators (TNO), and Ownership (Public or Private). Appendix 1 shows the overall dataset of this study.

2. Factor Analysis

Factor analysis is concerned with which the co-variances or correlations between a set of observed variables can be “explained” in terms of a smaller number of unobservable latent variables or common factors. Explanation here means that the correlation between each pair of measured (manifest) variables caused by their mutual association with the common factors. Consequently, the partial correlations between any pair of observed variables, given the values of the common factors, should be approximately zero. At this time, new variables are called factors and each factor is indicated as the linear combination of the original variables. Also, the volume of information each factor holds is measured by the variance of it (each

5) Unit of size is m².

factor). Due to such reasons, factors are numerated by the order of variance size. The largest factor, which holds the largest information volume, becomes the first factor while the smallest factor, which holds the least information volume, becomes the last factor. Analysts prefer to analyse through the reduction of level. The number of variables is easy to make confusion resulting from co-relationship. Accordingly, it is more desirable to analyse simply through a few factors that are not correlated with each other instead of the analysis of the variables, which have complicated co-relationship.

Once the extraction of primary factors is conducted, the factor score of individual observation is obtained. The calculation of factor score is necessary for two reasons. First, the location of individual observation may be reviewed in the factor space. Second, the factor score of individual observation can be used as new variable in the following multiple regression, etc. The factor score is obtained by the linear combination of the standardised factor score coefficient and the value of standardised variable.

The formal model linking manifest and latent variables is essentially that of multiple regressions. In detail:

$$\begin{aligned}x_1 &= \lambda_{11}f_1 + \lambda_{12}f_2 + \cdots + \lambda_{1k}f_k + u_1 \\x_2 &= \lambda_{21}f_1 + \lambda_{22}f_2 + \cdots + \lambda_{2k}f_k + u_2 \\x_p &= \lambda_{p1}f_1 + \lambda_{p2}f_2 + \cdots + \lambda_{pk}f_k + u_p \quad \dots\dots\dots (3.1)\end{aligned}$$

where f_1, f_2, \dots, f_k are the latent variables (common factors) and $k < p$.

V. Results and Interpretations

On the basis of the above-mentioned analysis method, the performance of distripark is expressed in the model as follows:

$$\ln TEU = \alpha_0 + \alpha_1 F_1 + \alpha_2 F_2 + \cdots + \alpha_n F_n + \varepsilon$$

where n follows the number of obtained factor.

First of all, dependent variable was standardised to get rid of the unit difference between independent variable and dependent variable. In case of the other independent variable, special transformation was not conducted as the difference between the measurement units of variables was standardised by using the correlation matrix in factor analysis.

Henceforth, the variable of low relationship was excluded through the correlation analysis of dependent variable. Although there are various methods to select the variable, the variable was excluded by using the Pearson's correlation analysis without using the other method in view of the characteristics of this research's data. The correlation coefficient between the standardised dependent variable in Throughput and variables is judged to be mutually high more than 0.5 of absolute value on the basis of the observed result.

As a result, the 6 variables were drawn through Pearson correlation analysis of 22 mutual significance which were into factor 1 (container terminal factor) and factor 2 (backup area factor), which have similar characteristics based on the factor analysis of 6 variables to raise the accuracy of analysis by protecting mutual disturbances and conflicts of 6 variables drawn from correlation analysis. Port backup area

factors have significantly influenced the port performance in terms of the factor analysis.

〈Table-3〉 **Result of Factor Analysis (Factor Matrix)**

Variable	Factor 1	Factor 2
No. of Quay Crane (QC)	0.871	–
Rate of Berth Occupancy (BO)	0.839	–
TGS	0.918	–
No. of Gate x No. of Gate Lanes (GL)	0.700	–
Size of Port-back up Area (PA)	–	0.967
Average No. of Floors (AF)	–	0.967

As a result of factor analysis, each of the variables was classified into two factors. In case of Factor 1, the variables such as number of Quay Crane, Rate of Berth Occupancy, TGS and No. of Gate x No. of Gate Lanes give positive(+) effects. In case of Factor 2, all the variables such as Size of Port-backup Area and Average No. of Floors gave positive(+) effects.

The multiple regression analysis model is created to grasp the impact degree which affects on port throughput through the statistical method, on the basis of factor score drawn through the factor analysis. The analysis model is as follows:

$$\hat{F}_1 = 0.312QC + 0.300BO + 0.328TGS + 0.250GL \quad \cdots \text{Factor score 1}$$

$$\hat{F}_2 = 0.517PA + 0.517AF \quad \cdots \text{Factor score 2}$$

$$\hat{y} = 15.251 + 0.524 \hat{F}_1 + 0.323 \hat{F}_2 \quad \cdots \text{Regression Model}$$

where y is throughput (in TEU).

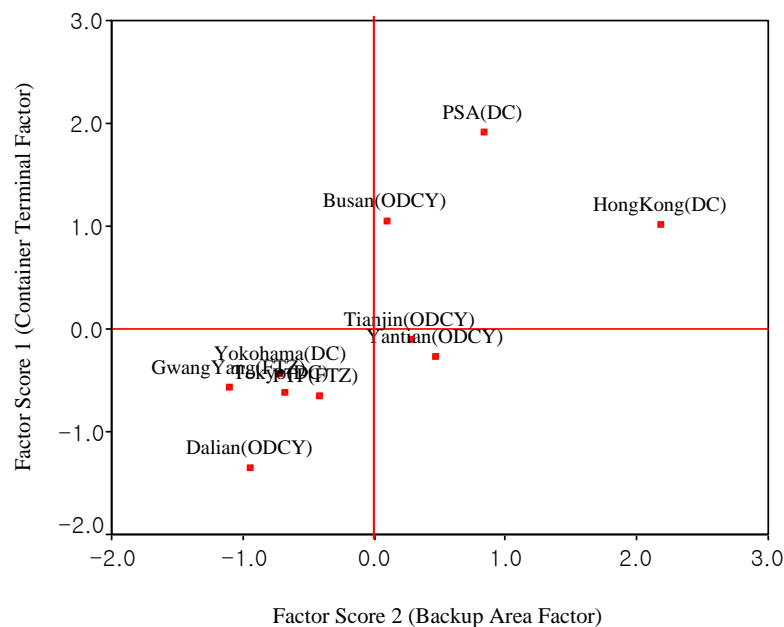
〈Table-4〉 Estimation Results of Port Performance Determinants

Dependent Variable	ln TEU	
Variable	Coefficient	t-value (p-value)
Constant	15.251	154.605 (0.000)
Factor Score 1	0.524	3.390 (0.012)
Factor Score 2	0.323	2.086 (0.075)
R ²	0.893	
Adjusted R ²	0.862	
Durbin-Watson Test	2.502	
ANOVA (F-value(p-value))	29.116 (0.000)	
Collinearity Statistics (Tolerance)	0.452	

As a result, the both container terminal factor and backup area factor indicated the influence on the port performance. As same with the results of previous studies the container terminal factor indicated the great influence on the port performance as having significance level of 0.5. In the other hand, port backup area factor indicated comparatively low influence compared to the container terminal factor. However, comparative significance was shown in significance level of 0.5, distripark indicated the influence to some degree on the port performance. The impact degree indicates differently according to the port as shown in <Figure-3>. In factor analysis, interest is usually centred on the absolute size of parameters in the factor model. However, the estimated values of the common factors, which called factor scores, may also be required. These quantities are often used for diagnostic purposes, as well as inputs to a subsequent analysis (Multiple regression model etc.). The scores for Factor 1 are then formed by summing the (standardised) observed values of the variables in the group, combined according to the sign of the loadings.

The factor scores for Factor 2 are the sums of the standardised observations corresponding to variables with high loadings on factor 2, and so forth. Data reduction is accomplished by replacing the standardised data with these simple factor scores.

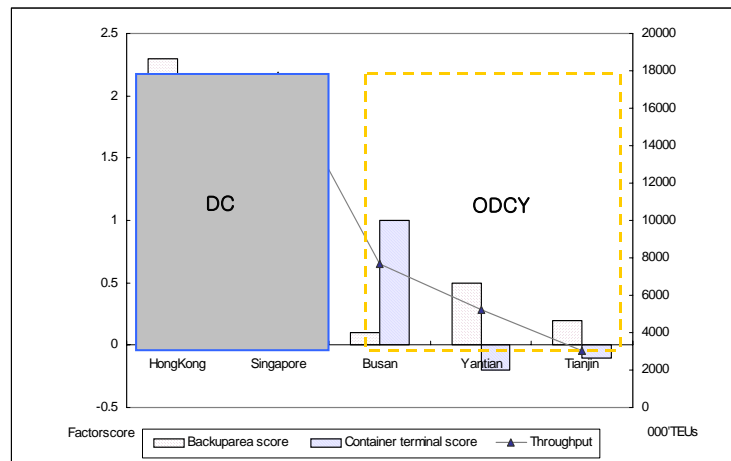
〈Figure-3〉 **Scatter Plot of Factor Scores**



When the locations of each item in Factor 1 and Factor 2 are studied as shown in 〈Figure-3〉, reportedly, Dalian, Gwangyang, PTP, Tokyo and Yokohama, the container terminal factor and backup area factor make negative (-) influence on port performance. This is why the linkage between port facilities and port cargo traffic volume seems very small in view of the newness of investigated ports and the isolation from the main trunk line. In case of Yantian and Tianjin container terminal, factors indicate

somewhat negative (-) while backup area factor indicates somewhat positive (+). This can be interpreted as the process in which the cargo traffic volume was drastically increased due to activation of port backup area of China's mega ports under rapidly changing international economy. In case of Busan port, backup area factor indicates little influence while container terminal factor indicates a great influence. The backup area factor indicated relatively low influence due to the failure to secure ample port backup areas caused by the narrow backup area and conflicts of port and urban function. On the other hand, container terminal factor indicates very high influence because of good geographical and physical location and high efficiency of port facilities. In case of Hong Kong, both of container terminal factor and backup area factor indicates a very high influence. Particularly, the influence of backup area factor in Hong Kong shows the highest influence among 10 ports. The large size logistics centre and ODCY which Hong Kong indicated the positive influences on the port cargo traffic volume. In case of Singapore (PSA), the both container terminal factor and backup area factors indicate a very high influence. In comparison with Busan, Singapore (PSA), and Hong Kong, container terminal factor of Singapore (PSA) is the highest while backup area factor of Hong Kong is the highest. The container terminal factor of Singapore (PSA) is the highest among 10 ports. This figure is consistent with the results of the past studies in terms of efficiency of Singapore (PSA) (i.e., Tongzon, 2001). In addition, regional port rather than major port were greatly influenced by both of the container terminal factor and backup area factor. The reason why is in line with the findings of Weigmans et. al., (2004) who studied the efficiency of container terminal toward the European ports.

〈Figure-4〉 Relationships between Factor Score and Throughput



In view of the distripark in <Figure-4>, the impact degree of DC (Districentre) typed Hong Kong and Singapore is higher than that of ODCY (Off-Dock Container Yard) typed Busan, Tianjin, Yantian, and Dalian or FTZ (Free Trade Zone) typed PTP. This is due to the well-connected linkage between port facilities and distripark in the DC-typed port. From this result, it is shown that the distripark of relevant ports makes a high influence on the port performance in DC typed ports. On the other hand, port facilities and distripark cannot be linked systematically in view of spatial structure of ODCY typed port since distripark indicates comparatively low influence on the port performance. In case of FTZ typed PTP, the impact degree of port performance is indicated as low because the construction of port facilities is under way and there are some factors excluding facilities. In addition, the influence of backup area factor is indicated as significant in the ports of which cargo traffic volume is more than about 5 million TEUs. After a certain level, port cargo volume is strongly affected by backup area factor. The certain level of port

cargo volume is a critical index to design and plan for distripark.

VI. Conclusions

The world port industry environments are rapidly changing due to the globalisation, transportation revolutions and local constraint, and the speed of change in Asia, centred on China is faster and more varied than that of many other regions. The 20 Asian ports ranked in the world top 30 container ports are concentrated in the Asian region and the 25% of the total trade volume is occurring in this region. The growth and change of shipping port markets in Asia has stirred the sever port competition and ports are doing theirs best to survive in the competition.

Under these circumstances, port operators put their multi-faceted efforts such as restructuring of port facilities, strengthening of marketing strategies, enhancement of IT systems and alliance between ports enlargement of hinterland and expansion of supporting traffic network. Recently, a lot of researchers have tried to evaluate the level of competitive power among the ports from the aspect of enhancing the competitive edges by analysing the indexes such as productivity, performance, and efficiency of ports. However, such approach could not fully reflect the change such as consolidation or advancement into logistics markets by shipping lines, logistics hub arising from intermodalism, the enhancement of value-added logistics industry, and enlargement of port space arising from the enlargement of container. Particularly, Hong Kong and Singapore, the first and second busiest ports of the world maximized the efficiency and performance of the port facilities by constructing large-size logistics

centres right beside the port (Zhu, et.al., 2002). The previous studies did not reflect such factors in the corresponding analysis. Therefore, this study is aimed to grasp the existence of influencing effects on the distripark (backup area factor) by analysing the influencing effects of backup area factor, together with existing container terminal factor on the 10 large container ports in Asia.

The following results are drawn from the analysis of container terminal factor and backup area factor related to port performance.

First, the influences of container terminal factor and backup area factor are indicated as significant in the ports of which cargo traffic volume is more than about 5 million TEU. After a certain level, major ports compared to regional ports are strongly affected by container terminal factor and backup area factor. In case of backup area factor, the size of cargo volume gives more impact than container terminal factor.

Second, correlationship of backup area factor indicates high figure in high value-added creating ports, such as Hong Kong and Singapore. Hong Kong and Singapore puts various efforts for the creation of value-added, attraction of cargoes and maintenance in addition to already holding container terminal factor.

Third, the container terminal factor on Hong Kong, Singapore (PSA) and Busan is indicated high while backup area factor on Busan is indicated as meagre. This seems to be attributable to the limited urban space and the shortage of distriparks due to narrow port space of Busan.

Fourth, the other ports excluding the abovementioned three ports have not high correlationship comparatively on container terminal factor and backup area factor. This seems to be attributable to the fact that cargo volume is not sufficient compared to port facilities and the construction of port facilities are under way.

Fifth, the effect of DC (Distribution Centre) indicates bigger effects than that of ODCY (Off-Dock Container Yard) and FTZ (Free Trade

Zone) among backup area factors.

On the other hand, Japan's two ports where influence is indicated low in spite of having DC, do not seem to have correlation because of over-development of facilities and logistics structure centred on imported cargoes.

On the basis of this analysis result, ports located in the main artery routes should make great efforts on the development of backup area factor as well as container terminal factor and on the functional enhancement in view of severe port competition in the future. In addition to this, the pattern of port backup area suitable for the port should be grasped and ensured in view of consideration on port characteristics and circumstances.

This study has difficulty in collecting data because of low recognition about distripark on the part of interviews during the interview for data collection. In addition, there are some problems on some statistical credibility toward population group by trying to collect data on the limited region in the limited period instead of building more than 15 mother groups to secure statistical significance. Particularly, due to shortage of mother group, the analysis has the limit. For better result, the same method on the 20 representative ports in Asia seems to be required. And for more elaborate analysis, the distinction between port backup area within the terminal and port backup area outside of the terminal is needed. Distripark within the terminal and distripark outside of the terminal seems to impact differently on port performance, but the approach is not available due to the limit of data collection in this study. If further collection of data is possible, the certain level of port cargo volume when backup area factor strongly influence port performance, can be found significantly. This research will provide port authorities with an interesting insight into a distripark plan for port performance.

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APPENDIX

Interview Questionnaire

The purpose of this interview questionnaire is to get information on container terminals, ODCYs, DCs, and ICDs of your side. The following questions are designed to obtain some background information on your side's container terminals, ODCYs, DCs, and ICDs. The information you answered will be used only for statistical analysis. This information will be kept strictly confidential.

Limitations:

Container Terminal : the number one Container Terminal in annual container throughput on your side.

ODCYs (Off Dock Container Yards), DCs (Distribution Centres or Logistic Centres or Free Trade Zone closed to port) and ICDs (Inland Container Depots) : ranked in the top five by annual container throughput related to the Container Terminal.

1. Frequency (in 2003)

Container Terminal	No. of Direct Caling		Average Anchorage Time/vessel
	Over 5,000TEU	Less 5,000TEU	

Note 1. *Number of Direct Calling* is divided into two categories. First category is for the number of direct calling of containerhips over 5,000TEU(as its capacity) per week. Second categoryis for the number of direct calling of containerhips less 5,000TEU(as its capacity) per week.

Note 2. The definition of *Average Anchorage Time* is the average time for anchoring from the boundary line of the port to the berth per a containerhip. This time is including pilot time and tugging time.

2. Berth (2003)

Container Terminal	No. of Quay Crane	NCP	Rate of Berth Occupancy	Terminal Working Hour

Note 1. *NCP* stems from Net Crane Product and it is calculated by the following equation.

$$NCP = (\text{TEUs Handled Per Working Day}) / (\text{No. of Crane} \times \text{Net Working Hours Per Day})$$

Note 2. Total anchorage time of all calling ships in a year is divided by total possible berthing time for all berth of container terminal is *Rate of BerthOccupancy*.

Note 3. *Terminal Working Day* is the total operation day a year.

3. Terminal (in 2003)

Container Terminal	Average Stacking Story	TGS	CFS Floor Size	EDI System (Y/N)

Note 1. *TGS* stems from Total Ground Slots in the main container terminal.

Note 2. The Unit for CFS (*Container Freight Station*) *Floor Size* is square meters.

Note 3. If the container terminal has an EDI system for the operation, please answer "yes," or not.

4. Backward Factors I (in 2003)

Container Terminal	No. of Gate	No. of Gate Lanes	Train System (Y/N)

Note 1. If there is any train systems in the container terminal, please answer "yes," or not.

5. Backward (related to port back-up areas) Factors II (in 2003)

(Unit : square meters)

	DC Floor Size	ODCY Floor Size	ICD Floor Size
# 1			
# 2			
# 3			
# 4			
# 5			

Note 1. If there is CFS area in DC, please include the floor size of CFS in DC floor Size. If CFSs are separated from DC area, please answer the following question number 6.

6. Backward Factors III (in 2003)

(Unit : square meters)

	CFS Floor Size
# 1	
# 2	
# 3	
# 4	
# 5	

Note 1. If there is CFS area in DC, please include the floor size of CFS in DC floor Size.

7. Detailed Backward Factors (in 2003)

(1) For DCs

	DCs				
	# 1	# 2	# 3	# 4	# 5
Average No. of Floors					
Distance from the main Container Terminal					
(Y/N) of IT Operating System					
Total Number of Operators					
Ownership (Public or Private)					

(2) For ODCYs

	ODCYs				
	# 1	# 2	# 3	# 4	# 5
Average No. of Floors					
Distance from the main Container Terminal					
(Y/N) of IT Operating System					
Total Number of Operators					
Ownership (Public or Private)					

(3) For ICDs

	ICDs				
	# 1	# 2	# 3	# 4	# 5
Average No. of Floors					
Distance from the main Container Terminal					
(Y/N) of IT Operating System					
Total Number of Operators					
Ownership (Public or Private)					

8. Connectivity (in 2003)

[illegible]