EFFECT OF LARGE SCALE CONTAINER TERMINAL IMPROVEMENT TO THE REGIONAL/NATIONAL ECONOMIC DEVELOPMENT

NAOHISA OKAMOTO
Institute for Transport Policy Studies
3-18-19, Toranomon, Minato-ku, TOKYO, JAPAN

TAKAO SATO
Ministry of Transport
2nd District Port Construction Bureau,
Kashima Port Construction Office,
2254 Aou, Kashima-City, IBARAGI, JAPAN

Abstract

In this study, the methodology for evaluation of port improvement is constructed considering various factors. This evaluation methodology is applied not only to assess the effects for agency concerned with the port but also the effects to regional and national economies. The methodologies for evaluation of the port improvement is introduced in considering the many factors, such as port fare, land transport cost, production price and etc. The benefit incident matrix is applied to the evaluation. Especially the influence of port improvement is analyzed as benefits and costs for each related body, such as port authority, transport companies, manufacturing companies, residents and communities.

BACKGROUND AND PURPOSE OF THIS RESEARCH

In recent years, the need for improvement of international container ports has become an important issue in Japan. This is because of certain changes in the situation of Japanese international ports, which happened during these past several years.

- the relative drop in quantity of international cargo handling (Figure 1)
- the increase in share of big ships called Over-Panamax which can transport cargo of more than 5000TEU with respect to the total commissioned ships (Figure 2)
- the emergence of international trunk route by-passing Japan

99.8% in quantity of the overall volume of the import/export cargo of Japan (80% of the financial share) has been carried by marine transportation. It is clear that port activity greatly influences the economy of a city situated in the hinterland of that port. Moreover, it also greatly influences the economy of the nation. However, there are several studies which analyzed the economic benefits of container port development. In this paper, the effects of improvement of container ports are shown from the viewpoint of the regional economy and the national economy in addition to the corporations/agencies concerned with port use.

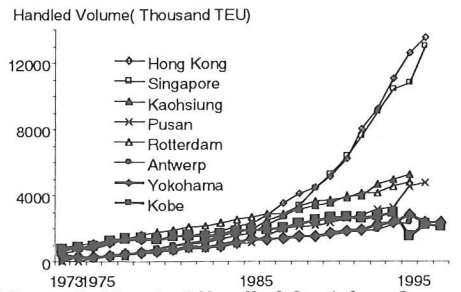

Figure 1 - Trend of Handled Container Cargo Volume

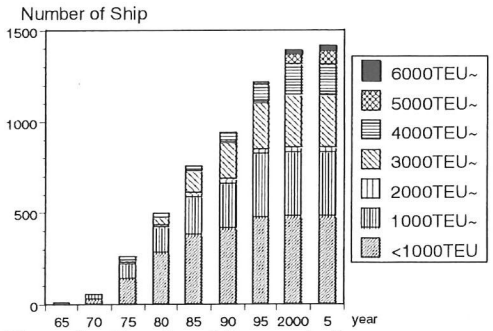

Figure 2 - Trend and Forecast of commission of container ship

EVALUATION METHOD OF PORT IMPROVEMENT

Evaluation by Benefit Incidence Matrix

In this study, the benefit incidence matrix is applied as an evaluation method for comparison and examination of the impact of port improvement. The several sectors should bear costs and get benefits in the case of transport improvement project. And these costs and benefits will be spread to another sectors. Therefore, it is necessary to analyze the distribution process and the final return of benefit. A technique for this purpose is the benefit incidence matrix. The benefit incidence matrix can express quantitatively the process of cost and benefit distribution to the various sectors passing through economy cycle. In this matrix, benefits are distributed among the different sectors and benefits remaining in the sectors are defined. Using this matrix, each item of benefit that should be added up and the value of each benefit are clearly shown. In this paper, the benefit incidence matrix is used to express the effects that container port improvement brings to several related sectors which include port authority, transport enterprises as port user, hinterland communities and the whole nation.

Impact of Port Improvement

To construct the benefit incidence matrix, the influence of port improvement must first be considered. Figure 3 shows the impact of port improvement. It also shows what kind of impact brings about each factor. For example, when port improvements, such as harbor deepening and rationalization of port services, is carried out, and improvement of transportation efficiency is achieved. Competition between sectors is reflected by the decrease in transportation costs leading to a decrease in consumer prices. Finally, the increase of consumer's surplus is represented. Based on influence flow shown in Figure 3, benefit and cost for each sector are measured.

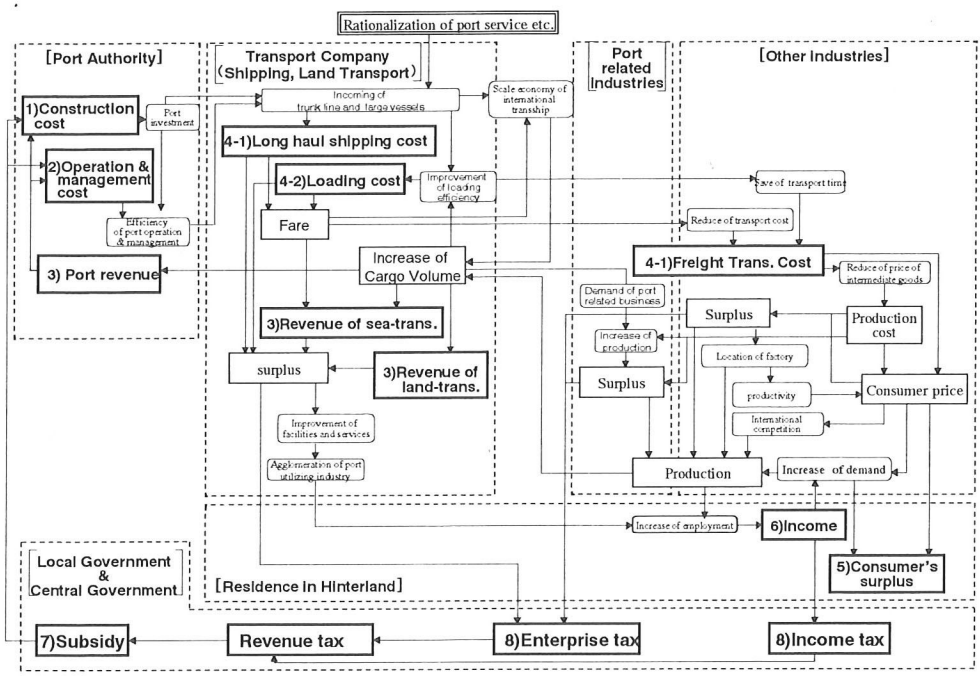

Figure 3 - Impact of Port Improvement

Related Sectors and Evaluation Factors

Related Sectors

The following sectors related to port improvement and operation are considered. The sectors are divided into 4 groups: 1) port authority as the construction and management sector, 2) sectors that utilize the port directly, such as transportation enterprises, 3) business and people located in the hinterland of a port, 4) areas except the hinterland, meaning the rest of country.

1) port authority
2) transport enterprises
   a) shipping companies
   b) harbor transport companies
   c) land transport companies
3) hinterland area
   a) port-related industries
   b) other industries
   c) residents c1) consumers
      c2) workers
   d) local government
4) country
   a) enterprise
   b) people b1) consumers
      b2) workers
   c) central government

Factors of Cost and Benefit

The factors of cost and benefit of port improvement are as follows:

1) Construction costs
2) Operation costs
3) Revenue
4) Transportation costs
   -Sea-Transport cost
   -Loading cost
5) Prices
6) Income
7) Subsidies
8) Taxes

1) Construction costs: The sectors concerned with construction are the port authorities and the public port corporations. All costs concerned with container terminal construction are appropriated to these sectors. But construction costs are converted into the amount of payment annually as capital costs, and it is necessary that the benefit incidence matrix shown in this study is in terms of evaluation of a single year.

2) Operation and management costs: General management costs of personnel expenses and others are classified as operation costs. The maintenance costs of anchorage and terminals are considered as operation costs of the public port corporation, and the maintenance cost of the waterway is considered as the operation cost for the port authority.

3) Revenues: The rates between sectors related to cargo handling and transportation are appropriated for revenues of the receiving sectors. Conversely, these rates are appropriated for the transportation costs for the paying sectors. Table 1 shows items of these rates.

Table 1 - Rates and Sectors

Rates	Receiving Sector	Paying Sector
Port Due	Port Authorities	Shipping Companies
Terminal Rent	Port Public Corporation	Terminal Operator
Sea transport Fare	Shipping Company	Port-related Industries, Other Industries, Enterprises
Yard Usage Fee Wharfage Crane Usage Fee	Terminal Operator	Shipping Companies
Line Handling Charge Tuggage Pilot Charges Agency Commissions	Harbor Transport Companies	Shipping Companies
Loading LaborCharges	Harbor Transport Companies	Terminal Operator
Land Transport Fare	Land Transport Company	Port-related Industries, Other Industries, Enterprises

4) Transportation Efficiency

4-1) Sea Transport Cost: Shipping companies transport cost include shipping costs, line-handling charge, tuggage charge, pilot fee (bay and harbor), and agency commissions.

4-2) Loading Cost: The yard usage fee, wharfage and crane usage fee are the main components of the loading cost paid by the shipping company. Loading labor charges are appropriated by the harbor transport companies.

The money flow relation of factors of cost and revenues items 1), 2), 3) and 4) between transport sectors is shown in Table 2.

5) Consumer Prices and Surplus: As transportation efficiency is improved, shipping companies expenses decrease. This is reflected by the decrease in transport cost. This cost decrease reduces the payments for industrial transportation costs. Reduction of transportation costs decreases the cost of production. The decrease in cost of production results of the increase of consumer surplus.

6) Income: Increase in consumption and production leads to an increase in industrial employment opportunities. This is classified as income effect.

7) Subsidy: In case of public corporations implementing berth improvements, there exist several kinds of subsidy and investment. In this study, the following subsidies and investments are considered:

Table 2 - Money flow between sectors concerned with port transport

	Port authority		Shipping company		Port mover company	Land transport company	Port related industries/ other industries/ Enterprise
		Public port corporation		Terminal operator			
1) Construction cost	Area of the sea institution (route)	Berth, yard, Area of the sea institution (anchorage), Gantry crane					
2)Operation cost	General management, Route maintenance	General management, Maintenance (terminal and anchorage)					
3)Revenues	Port due	Yard rent	Sea transport fare	The yard and crane usage fee, Wharfage	Line handling charge, Tuggage, Pilot charges, Agency commission, Loading work charges	Land transport fare	
4)Transport cost							
4-1)Sea-Transport Cost			Sea transport costs, Port due, Line handling charge, Taggage, Pilot charges	The yard rent			Land transport fare, Sea transport fare
4-2) Loading cost			The yard and crane usage fee, Wharfage	Loading work charges			

- Subsidies for construction costs from local government and the central government to the Port Authority
- Interest-free loans from the government to the public port corporation
- Loans from the private sector to public corporations
- Investment from shipping companies to public port corporation

8) Tax: Five kinds of tax are considered in this study:
- Tonnage which is a tax paid by the shipping company to the central government for every port arrival. 20/36 of tonnage tax returns to local government as special donation tax.
- Corporate tax is paid to the government by the harbor transport companies, land transport companies, port connecting industries and other industries.
- Consumption taxes are paid by consumers to the central government
- Residence tax is the tax paid by the consumer to the local government
- Income tax paid by workers to the central government.

Measurement method of port development effects

1) Construction costs and 2) Operation and management cost
Construction, operation and management costs which are necessary for the improvement of each port are to be allocated in the benefit incidence matrix. Construction cost is converted into the amount of payment as social capital costs in the year when the interest rate is 5 %, and it is evaluated for a single year.

3) Revenues
Among the variable charges/costs in port activities, only the rent is paid every year, and the other charges are paid for every arrival in port. There are charges that are dependent and others that are independent of handled volume by each arrival in port. The annual rent, which a terminal operator pays to a public port corporation, is around 1200 million -1500 million yen per berth. The port due depends on the model of ship, and it is fixed at 2.7 yen × G/T. Line handling charges, tuggage and pilot charges differ according to the model of ship, but there is no clear proportional relation. These charges contribute to the increase in income by the increase in the number of arriving ships, but the handled cargo volume is not directly related. For every 1 TEU, loading work charges are approximately 2,700 yen. As the handled cargo volume increases, and revenue of port mover companies increases. According to the present tariff, the sea transport fare and land transport fare are calculated taking into consideration the unit price rate for every OD cargo volume. Sea

transport fare reflects the increase and decrease of transport costs described in the next section. The sea transport fare of cargo varies according to the type of handling at port which is depended on cargo volume.

4) Transportation Cost

The various charges described in 3) are costs for the port user. Figure 4 and 5 show the change in the transportation costs per 1 TEU divided into loading cost and cost of arrival in port. The cost of loading includes loading work charges and the terminal rent, while the cost of arrival in port include port dues, line handling charges, tuggage and pilot charges. When the handled volume per ship arrival is fixed and the handled volume between years increases, it is shown that the transport cost for 1 TEU decreases. The annual rent revenue remains constant, because it does not depend on the handled volume. On the other hand, Figure 5 shows a decrease in transportation costs with the increase of the handled volume per ship. Here, the arrival cost is divided by the handled volume. In this way, unit fixed cost per unit will decrease for every arrival in port and loading with the increase of handled volume.

The calculation of function of the sea transport costs of some ship models is shown in Table 3. Using this function, the sea transport cost of each route is determined.

Sea transport cost and loading cost depend greatly on the handled cargo volume and model of ship. It is assumed that the change of handled cargo volume, model of a ship and frequency of ship arrival, associated with port improvement are major factors that effect transport costs and fare. In other words, the new fare is calculated by following equation:

[present fare + (the increase/decrease of sea transport costs + cargo loading costs)].

5) Prices (consumer's surplus) and 6) Income

Increase of handled cargo volume and improvement of the transportation efficiency by port calls of

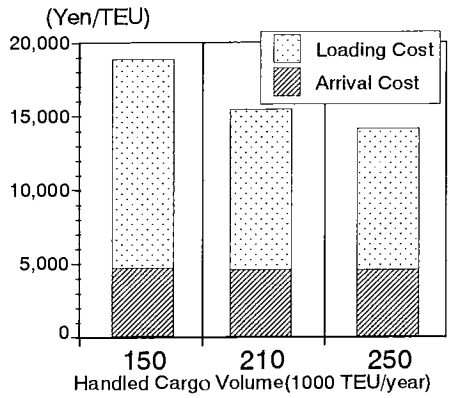

Figure 4 -Change in the port cost with handled cargo volume (Model of ship: 4420TEU, Loading volume per 1 ship: 843TEU)

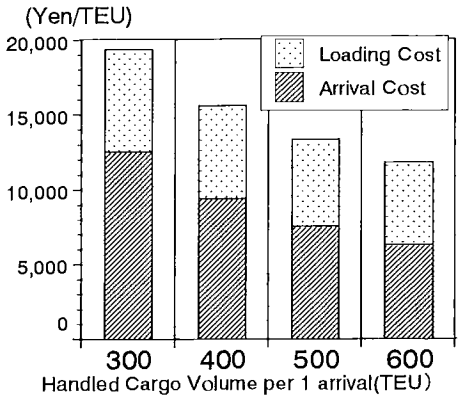

Figure 5 -Change of loading cost with the handled cargo volume per ship (Model of ship: 3400TEU, 210,000 TEU: a year handling)

Table 3 - Model for sea transport costs estimation

Model of ship (TEU)	Sea transport cost per TEU (1000 yen)	Test calculation value (1000 yen)
500	(12.1+34.0/1000*d)/R	163
1000	(6.76+17.6/1000*d)/R	85
2000	(4.07+10.1/1000*d)/R	49
4000	(2.56+5.96/1000*d)/R	29
5000	(2.18+4.93/1000*d)/R	24

d: navigation distance (nautical mile) R: load factor ($0< R \leqq 1$) Test calculation value is sea transport cost per 1 TEU for the case of navigation distance of 3,000 miles, similar to the distance between Yokohama and Singapore, with a load factor of 70 %.

big ships reduces the transport cost. As a result of competition, a decrease in the transportation costs effects a decrease in fare and prices. First, 1) demand function and 2) export function is estimated, and 3) change of production activity and consumption activity by change in prices, are analyzed.

[Estimation of the value of the demand function]

The demand function used for calculating consumer's surplus includes benefits of price decrease and demand expansion as explanatory variables. This function is then used for estimating input data to IO analysis and aggregation of domestic demand.

The demand function is estimated as follows:

$$Y=A_0 x_1^{\alpha} x_2^{\beta} \quad (1)$$

The explanatory variables are, x_1: family budget and x_2: consumption price deflator.

Estimation results are as follows:

Table 4 - Estimation parameters of the demand models

variables	A_0	α	β
1) Food	10.12	0.2831	-0.1487
2) Clothes	9.492	0.6854	-0.6511
3) Water services	8.192	0.5911	-0.04270
4) Household electric appliances/furniture	10.89	0.9900	-1.292
5) Medical care	7.153	0.6663	-0.02891
6) Transportation	9.515	1.405	-1.256
7) Recreation	12.46	2.331	-2.810
8) Others	10.17	1.218	-1.144
9) Whole consumption	12.70	1.213	-1.280

[Estimation of Export Function in value]

A function to estimate export value is estimated as

$$Y=A_0 x_1^{\alpha} \quad (2)$$

where x_1 is the export price index here. The export price elasticity value is estimated as follows:

1) Metal product	-0.9132	4) Transport machinery	-0.2846
2) General machinery	-0.6805	5) Precision instrument	-1.1114
3) Electrical machinery	-0.7868	6) Other industrial products	-1.2740

[Change of production and consumption activity by change of prices]

When the cost of sea transport increases or decreases, loading costs are calculated by analysis of transportation efficiency which then affects fare, and a new fare is assumed.

The increase and decrease of fare value
= present fare +(increase and decrease in value of sea-transport and loading costs)

Furthermore, the rate of increase or decrease of the import price of each product is determined by using fare decrease rate.

Import price = present price× (1+ increase and decrease rate of assumed fare
× transportation weight)

The transportation weight is assumed here to be approximately 3% of the imported product price. A change of the domestic price with the import price decrease can be estimated using import list of table of economical statistics as follows:

$$P^d = A_d^T P^d + M^T P^m + \Gamma \quad (3)$$

$$P^d = (I - A_d^T)^{-1} (M^T P^m + \Gamma) \quad (4)$$

$P^d i$: the domestic price of i-product
$P^m i$: import price of i-product
A_d^T : domestic product inverse coefficient vector
M^T : import inverse coefficient vector
Γ : added value vector of unit production

The domestic price elasticity value of the import products used by this model is shown as follows:

1) Textiles	0.100	4) Metals	0.015
2) Foods	0.082	5) General machinery	0.014
3) Electricity machinery	0.032	6) Rubber products	0.005

Using these models, the expansion of the domestic consumption demand with the decrease in price of production and the export demand are estimated, using the total demand.

A) the amount of total demand = aggregate domestic demand + export
B) production of each sector estimated by IO analysis using the amount of total demand as input data
C) Income : Sector production × sector wage rate

Furthermore, using the consumer's price estimated by function (4) and consumption demand, the consumer's surplus is estimated.

7) Subsidy

The central government subsidizes 50% of the construction costs to the port authority for its improvement projects. The port authority as a development agency shoulders the remaining costs.

8) Tax

Tonnage is allocated to the income of the central government and local government. The unit price of tonnage is a value proportional to N/T of ship. The central government charges a corporate tax to profit organizations: such as land transport companies, port related industries and port-dependent industries. It is also assumed that income tax from workers is paid to the central government and residence tax is paid to the local government and the consumer pays consumption tax to the central government.

Benefit incidence matrix of port improvement

Table 5 is the benefit incidence matrix that indicates the cost and benefit items for the relevant sectors. The amount of real cost / benefit equivalency is expressed as alphabetic and numeric characters in the matrix. The sum total of the column shows the final surplus that each sector receives. In the following chapter, the impact of port development is analyzed through a case study.

Table 5 - The benefit incidence matrix of port improvement

		Port Authority	Transport enterprise			Hinterland					Country				Total
								Resident				People			
			Shipping companies	Port mover companies	Land transport companies	Port related industries	Other industries	Consumer	Workers	Local government	Enterprise	Consumer	Workers	Government	
1) Construction cost		A(-)													A
2) Operation cost		B(-)													B
3) Revenues		C1(+)	C2(-)	C3(+)	C4(+)										C1+C2+C3 +C4
4) Transport Cost	4-1) Sea-Transport Cost		D1	D2		D3	D4				D5				D1+D2+D3 +D4+D5
	4-2) Loading Cost		D6												D6
5) Prices						E1(-)	E2(-)	E3(+)			E4(-)	E5(+)			0
6) Income				F2(-)	F3(-)	F2(-)	F3(-)		F4(+)		F5(-)		F6(+)		0
7) Subsidy		G1(+)	G2(-)							G2(-)	G3(-)			G4(-)	0
8) Tax			H1(-)	H2(-)	H3(-)	H4(-)	H5(-)	H6(-)	H7(-)	H8(+)	H9(-)	H10(-)	H11(-)	H10(+)	0
TOTAL (Surplus)		①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭

ESTIMATION OF CONTAINER BERTH IMPROVEMENT EFFECT

As shown in Figure 2, the commission in ratio of large-sized container ships of more than 5000TEU grade, which envisaging the improvement of transport efficiency, is increasing due to the stiff competition between shipping companies and the globalization of international business.

Corresponding to this change of situation, the enlargement of deep container berths to a depth of more than -15m was planned to make the reception of big ships possible at major international ports in Asia including Japan. Some ports have already started construction, while some ports have started operating.

It is expected that there will be noticeable effects in the hinterlands and the national economy, when big ships arrive due to port improvement and transport costs decrease. A fall in the cost by transport efficiency improvement raises competition in the international market of a port. Furthermore, through the concentration of container cargo volume, the economies of scale can be enjoyed.
On the other hand, when the adaptation to the changing of the situation in international container transport comes too late, that port is excluded from the European and American main route where big ships are coming into service. The port may become a feeder port and the competitive power of hinterland industry will fall due to the rise of the transport cost.
Using the evaluation/measurement method of the port improvement effects mentioned above, the effects of port improvement in order to accommodate to large-sized container ships can be calculated quantitatively. It has been calculated for three case studies:

Case 1: container ships go into service under the present berth situation and fleet constitution
Case 2: berth improvement of -15m depth is carried out, and big ships are able to call
Case 3: cargo to Europe is transported as international feeder transport changing at the port of Kaoshiung, because of the accommodation of big ships is delayed

The port of Yokohama is analyzed as a study area. The project life is 30 years, and evaluation is done in a single year, 2010. Assumptions, such as the number of berths, are established taking into account the present situation and the future plan of the port of Yokohama, and are described in following section.

Assumption

Handled Cargo Volume
It is expected that handled cargo volumes are different among these 3 cases, if port service varies with port improvement.
However, it is extremely difficult to estimate the future cargo volume of a port. Because there are many factors which should be considered for cargo volume forecasting, such as the relation of international ports surrounding the objective port and the economic growth of the country. For the purpose of evaluation of port improvement corresponding to the commission of big ships according to this analysis, the handled cargo volume in 2010 of both cases is supposed to be equal. Handled cargo volume in the port of Yokohama in 2010 was established by the following methods.
Firstly, the total import/export cargo volume of Japan was estimated using a multi-regression model on the basis of economic index (Table 6). Economic growth rate is set up as in Table 7, and cargo volume of Japan in 2010 was estimated resulting in a total cargo volume of approximately 15 million TEU and an annual increase rate of 1.65 %. Using this increase rate, the handled volume in 2010 of the port of Yokohama is estimated as 2.92 million TEU. Here, international transshipment cargo volume was assumed to be 250,000 TEU, which is same as present situation.

Table 6 - Model for Cargo Volume (TEU)

variables	parameter
GDP of Japan(bill. yen)	21.1 (3.5)
GDP of East Asia (mill. US$)	5.39 (7.3)
GDP of developed country (mill. US$)	-1.83 (-1.8)
constant	$-4.14*10^6$
correlation	0.994

Table 7 - Assumption of Economic Growth Rate

	Japan	East Asia and Developed country
before 2005	1.1%	2%
after 2005	-0.1%	2%

Berth Improvement
Considering the present situation and the future plan of the port of Yokohama, the conditions of berth improvement are set. As shown in Table 8, the total number of berths was set with 21 berths in

every case. It is assumed that 4 berths with -14m water depth were improved to berths with -15m depth to accommodate a 5000TEU ship. Big ships, which exceed 5000TEU, need 3-gantry crane. So it was assumed that it was necessary to install 3-gantry cranes to each improved berth, the total number of new gantry cranes is 12.

Table 8 - The setting depth of berth improvement

water depth	model of ship (TEU)	number of berths	
		present case 1 & 3	improved case 2
~ -11m	1000	3	3
-12m	2000	8	8
-13m .	3000	6	6
-14m	4000	4	0
-15m~	5000	0	4
total		21	21

Construction Cost

Improvement cost per berth was around 5 billion yen and the total cost was 20 billion yen.
The gantry cranes should be repaid in 15 years. 12 gantry cranes should be rearranged after 15 years. If one gantry crane costs one billion yen, an investment of 24 billion yen is necessary.
Accordingly, total investment amounts to 44 billion yen including improvement costs and the total cost of gantry crane installation. This is appropriated in the benefit incidence matrix for cost of construction, which is 2.9 billion yen assessed in 2010 using an interest rate of 5%.

Composition of ship in commission

Composition of the models of ship commissioned is set referring with the prospective composition rate of the commissioned ship in the world (Figure 2). Representative models of ships are set, such as 3000~5000TEU ships on European & American line, and 1000 and 2000TEU ships on Asian line. According to the average handled cargo volume per 1 ship of each model of ship, the number of ships arriving annually is set. First, in Case 2, using the prospective composition rate of ships in commission, the number of arriving ships is set. In Case 1, 5000TEU ships cannot call at the port because berths were not improved. So it is supposed that the cargo, which is handled by 5000TEU ship in Case 2, is transported by 3000 and 4000TEU ships in Case 1. In Case 3, it is supposed that the cargo to Europe, (volume is 260 thousand TEU), is transported by 1000 and 2000TEU ships from the port of the Kaoshiung. The results of volume of each model for the number of ships arriving and cargo handled are shown in Table 9.

Table 9 - Assumption of Handled cargo Volume by each model of ship

model of ship (TEU)	average handled volume by one ship (TEU)	prospective composition rate of commission ship (%)	Case 1 transported with present composition		Case 2 transported by big ship		Case 3 transported as transshipment from Kaoshiung (Cargo from/to Europe)	
			number of ship	handled volume (1000 TEU)	number of ship	handled volume (1000 TEU)	number of ship	handled volume (1000 TEU)
1000	137	6.7	588	80.5	588	80.5	682	93.4
2000	357	47.5	4143	1493.1	4143	1493.1	4829	1742.8
3000	667	19.4	961	641.2	585	390.1	773	516.0
4000	862	16.5	817	703.9	497	428.3	657	566.5
5000	1330	9.9	0	0.0	299	526.8	0	0
total		100.0	6509	2918.8	6112	2918.8	6919	2918.8

Estimation results of transport cost, revenue, consumer's price and income

Estimation results for the revenue and transport costs are shown in Table 10(a)&(b).

Table 11 compares the fare per 1TEU for European lines for each case. Compared to the Case 2, fare increases approximately 25% in Case 3.
Comparing Case 2 and Case 1, fare falls in Case 2 and the revenue of shipping companies decreases.

Table 10(a) - Estimated results for the transportation costs (unit: hundred million yen /year)

Sectors	Cost item	Case 1	Case 2	Case 3
Shipping companies	Sea-transport Cost	977.0	933.2	1007.6
	The arrival cost	153.0	141.5	156.2
	The yard rent	294.0	294.0	294.0
	Loading work	78.8	78.8	78.8
Port-related industries, Other industries, Enterprises	Transport Cost	2793.0	2742.7	2902.3

Table 10(b) - Estimated result of Revenue (unit: hundred million yen / year)

Sectors	item	Case 1	Case 2	Case 3
Port Authority	Port dues	4.0	3.7	3.7
	The yard rent	294.0	294.0	294.0
Shipping companies	Sea transport fare	3069.2	3013.9	3189.4
Harbor transport companies	Line handling charge	8.7	7.8	8.5
	tuggage	40.7	38.4	43.4
	Pilot charges	84.8	77.2	85.2
	agency commissions	9.2	8.7	9.8
	loading work	78.8	78.8	78.8

Table 11 - Example of comparison of fare (unit: yen/TEU)

Case 1 transported with present composition		Case 2 transported by big ship		Case 3 transported as transship from Kaoshiung (Cargo from/to Europe)	
route	fare	route	fare	route	fare
Yokohama		Yokohama		Yokohama	
↓	165,000	↓	156,000	↓ Koashiung	65,000
Rotterdam		Rotterdam		↓ Rotterdam	146,000
Total	165,000	Total	156,000	Total	211,000

On the other hand, this is reduced for the transport costs for port-related industries, the other industries in the hinterland and enterprises of the whole country. A fall in the price of imported goods can be estimated by these transport costs. The portion of transport cost for the imported goods' price is 3 %. The financial share of international import/export cargo by container transport is almost 50% in Japan. If a decrease of transport cost is reflected in fare and prices, the imported goods price decreases by approximately 0.05 %. Using this import price decrease, the domestic price of production and change of consumption expenditure by the demand function are analyzed by the IO analysis described above. Approximately, an 8 hundred million yen increase in consumption expenditure increases the total production of the hinterland by 2.4 hundred million yen. As a result, the income increased by approximately 5 hundred million yen.
Comparing Case 3 and Case 1, the imported goods' price increases by approximately 0.1 %. It is estimated that consumption expenditure decrease by 17 hundred million yen, the total production of the hinterland by 4.9 hundred million yen and income by 1 hundred million yen.

Effect of transport by big container ships

The results comparing Case 2 with Case 1 are shown in Table 12. This table shows the effect when big ships transport some of the cargo of the European and American route instead of the usual ships due to berth improvement. For an investment of 2.9 hundred million yen to enable big ships to call at the port, compared to the present transport pattern, the transport cost decreases by 105.6 hundred million yen which is a direct effect of port improvement. In the breakdown, the shipping

companies get the biggest benefit with 55.3 hundred million yen. The transport cost reductions of 4.7 hundred million yen benefits to port-related industries in the hinterland, 26.6 hundred million yen to other industries in the hinterland, and 18.9 hundred million yen to enterprises in the rest of the nation.

Improvement of transport efficiency due to big ships brings several indirect effects, such as a fall in consumer's prices due to transport cost decrease and an increase of income. These effects on each sector are evaluated as follows.

Port-related industries in the hinterland receive benefits of 2.1 hundred million yen, other industries in the hinterland get benefits of 8.1 hundred million yen and enterprises in the rest of the nation get benefits of 9.2 hundred million yen. The total amount of benefits to these sectors is 19.4 hundred million yen. Furthermore, as prices fall, benefits of 13.7 hundred million yen come to consumer in the hinterland and benefits of 4.1 hundred million yen as income increase to workers in the hinterland, 2.7 hundred million yen to consumers and 4.8 hundred million yen to workers in the rest of the nation. The total amount of benefits to consumers and workers is 25.3 hundred million yen, which is almost equal to the investment. Transporting by big ships entails big benefits to both industries and the people.

On the other hand, shipping companies lose benefits due to decreased revenues. It seems that there is little incentive in providing big ships. However, the decrease of fare reflects the demand. Now, it is assumed that 100 thousand TEU of transshipment cargo increases at the port of Yokohama. In this case, the shipping companies receive large profits, i.e. 103 hundred million yen as revenue (Table 13). This means that shipping company have advantages due to the provision big ships because of an increase in demands.

Table 12 - Effects of the case where big ships transport some of the cargo of the European and American route instead of the usual ships by port improvement

(unit :100million yen/year)

		Port Authority	Transport enterprise			Hinterland					Country				Total
								Resident				People			
			Shipping companies	Port mover companies	Land transport companies	Port related industries	Other industries	Consumer	Workers	Local government	Enterprise	Consumer	Workers	Government	
1) Construction cost		-29.0													-29.0
2) Operation cost		0.0													0.0
3) Revenues		-0.3	-55.3	-11.2	0.0										-66.8
4) Transport Cost	4-1) Sea-Transport Cost		55.3			4.7	26.6				18.9				105.6
	4-2) Loading Cost		0.0												0.0
5) Prices						-1.4	-13.6	15.0			-3.7	3.7			-0.0
6) Income				-0.1	-0.2	-0.8	-3.8		4.9		-5.3		5.3		-0.0
7) Subsidy		29.0	-6.6							-8.0				-14.5	0.0
8) Tax			-0.1	-0.0	-0.0	-0.4	-1.0	-1.3	-0.8	1.6	-1.8	-1.0	-0.5	5.4	0.0
TOTAL (Surplus)		-0.3	-6.6	-11.3	-0.2	2.1	8.2	13.7	4.1	-6.4	8.1	2.7	4.8	-9.1	9.7

Table 13 - Benefits in case of transshipment cargo increase (additional benefit from case 2) (unit :100million yen/year)

	transport enterprise		hinterland		nation	total
	shipping companies	Port mover companies	port related industries	other industries	enterprises	
Revenues	102.8	3.4				106.2
Transport cost	-34.8		1.2	7.0	5.0	-21.6
total	68.0	3.4	1.2	7.0	5.0	84.6

Economic influence in case of transporting cargo to / from Europe as feeder

The commission of large-sized container ships of more than 5000TEU is in progress on main lines in particular European lines. In this case, it is considered that the cargo will be transported as international feeder cargo and transferred to the main lines at other ports in Asia when the port is not improved to enable big ships to dock. Here, the economic influence is evaluated when the cargo to/from Europe carried as international feeder cargo. The volume of cargo to/from Europe at the port of Yokohama is 26000TEU in a year. It is assumed in Case 3 that this cargo is transferred at the port of Kaoshiung.

Benefit incidence matrix is compared with the Case 1, which is the case of direct transportation of cargo to/from Yokohama by current model of ship, and it is shown by Table 14.

When the cargo to/form Europe is transported as international feeder cargo, revenues of shipping company increases 120.2 hundred million yen.

On the other hand, transport costs for the port-related industries and the other industries in the hinterland and enterprises in the rest of the nation increase greatly with 109.3 hundred million yen. Furthermore, residents of the hinterland and the nation as a whole incur serious losses of 54.1 hundred million yen as a result of rise in prices, and the reduction in both consumption and production. From this result, it can be understood that transport as international feeder cargo entails a benefit of 86.4 hundred million yen for shipping companies. On the other hand, the serious loss of 97.4 hundred million yen exceeds the profits of shipping companies.

Table 15 shows the effects of port deepening with the 29.0 hundred million yen investment for improvement of the situation where the cargo for Europe is transported as international feeder cargo.

Table 14 - Influence in the case that the cargo to/from Europe carried as international feeder cargo (unit: 100million yen/year)

		Port Authority	Transport enterprise			Hinterland					Country				Total
								Resident				People			
			Shipping companies	Port mover companies	Land transport companies	Port related industries	Other industries	Consumer	Workers	Local government	Enterprise	Consumer	Workers	Government	
1) Construction cost		0.0													0.0
2) Operation cost		0.0													0.0
3) Revenues		-0.3	120.2	3.6	0.0										123.6
4) Transport Cost	4-1) Sea-Transport Cost		-33.8			-10.2	-57.9				-41.2				-143.1
	4-2) Loading Cost		0.0												0.0
5) Prices						2.7	27.3	-30.0			7.5	-7.5			0.0
6) Income				0.2	0.3	1.6	7.6		-9.6		10.6		-10.6		0.0
7) Subsidy		0.0	0.0							0.0				0.0	0.0
8) Tax			0.1	0.0	0.0	0.5	1.4	1.7	1.0	-2.1	2.4	1.3	0.7	-7.0	0.0
TOTAL (Surplus)		-0.3	86.3	3.8	0.3	-5.4	-21.6	-28.3	-8.6	-2.1	-20.7	-6.2	-9.9	-7.0	-19.5

Table 15 - Benefit of transport by big ships for improvement of the situation where the cargo for Europe is transported as international feeder cargo (unit :100million yen/year)

	Port Authority	transport enterprise		hinterland		nation	total
		shipping companies	Port mover companies	port related industries	other industries	enterprises	
Construction cost	-29.0						-29.0
Revenues		-175.4	-14.9				-190.3
Transport Cost		89.0		14.9	84.6	60.1	248.7
total	-29.0	-86.4	-14.9	14.9	84.6	60.1	29.4

As direct effects, the revenue which shipping companies and harbor mover companies receive is 190.3 hundred million yen decreasing. But sea-transport cost is reduced 248.7 hundred million yen. In other words, a benefit of 58.4 hundred million yen, that is the balance between revenue and transport cost is produced. This is approximately 2 times the amount of investment. It is understood that a large benefit of 159.6 hundred million yen is brought to the port-related industries and other industries in the hinterland and enterprises in the rest of the nation due to the drop of sea transport fare. This is approximately 5 times of the amount of investment.
If the current main line is removed from the port of Yokohama, and the international feeder transport expands, great economic disadvantage will be brought to the industries and people in the hinterland and the social public welfare of resident will be damaged.
It is clear that economic benefits exceeding the amount of investment will come to the hinterland, when the berth improvement is carried out.

CONCLUSION

This research shows a particular evaluation method for the port improvement. In addition to the direct impact on the port related sectors, indirect effects to the regional economies of the hinterland and national economy were evaluated by the benefit incidence matrix. The relation of the burden of cost and benefit return was shown quantitatively. The findings of this research can be summarized by the following 2 points:

1) impact of international container port improvement is evaluated.
2) benefit measurement by the benefit incidence matrix which has not yet been applied in the field of sea ports

In the case studies, the benefit of transportation by big ships due to port improvement is shown as the comparison with cases without improvement. As a result, the following things became clear:

1) When the case of cargo transported by large-sized container ship is compared with the case of the cargo transported with the present composition of models of ship, benefits due to reduction of transport costs for shipping companies and industries exceeds the amount of investment. Moreover, if the transport cost reduction reflected in price drop, benefit which balanced with the amount of investment was brought for resident of the hinterland and the nation.
2) In the case when implementation of the commissioning of big ships is late and the cargo is transported as international feeder cargo via a port in a neighborhood country, an extremely large loss was brought to industries and residents in the whole country. This means there is a large influence to the regional and national economy. When port improvement is carried out to avoid this situation, industries and residents enjoy large benefits which exceed the amount of investment.
3) On the other hand, in addition to the increase of the benefits to shipping companies, large benefits for industries and the people are produced if the commissioning of big ships is implemented where the high transport efficiency is achieved, and the subsequent increase in the volume of cargo handled.

REFERENCES

Morisugi, H.(1989) Recent topics on project evaluation theory, **Proceedings of Infrastructure Planning(JSCE)** No.7, 1-33

Nakano, T. and Inamura, H.(1982) Development and application of synthetic economic evaluation model for planning; **Report of the Port and Harbour Research Institute**, Vol. 21, No. 2

Inamura, H. (1984) Measuring the Economic Benefits of Port Development; **Report of the Port and Harbour Research Institute**, Vol. 23, No. 3

Ueda, T. and Morisugi, H.(1997) Benefit incident analysis, **Socioeconomic Evaluation of Road Investment Project**, Toyo Keizai Inc.