EFFECT OF CONTAINER BERTH DEVELOPMENT
- Case Study of Large Scale Container Berth Development -

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Abstract: In recent years, the necessity of port development is being discussed. But there are few studies which evaluated the significance of port operation from the viewpoint of national and regional economy. In this study, the methodology for evaluation of port development 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.

1. Background and Purpose of this research

In recent years, the need for international container port function improvement of this country has discussed lively. This is because of certain change in the situation surrounding Japanese international ports which happened during these past several years.

- relative drop in quantity of international cargo handling
- the commission of big ship called Over-panamax which can transport cargo of more than 5000TEU
- emergence of international trunk route without passing Japan

There is a few research which analyzed economic benefit of container port development. For import/export cargo of this country, 98 % in quantity has been carried by marine transportation. Even if it is converted into forehead, approximately 80 % drops in at marine transportation. It is clear that port activity greatly influences the economic activities of a city situated in the hinterland of that port.

It is clear that harbor activity gives great influence to hinterland economy and nation. In this paper, it is clear a definition of port function in East Asia. The effects of functional improvement of container ports are shown from the viewpoint of regional economy and national economy in addition to corporation/agency concerned with the port.

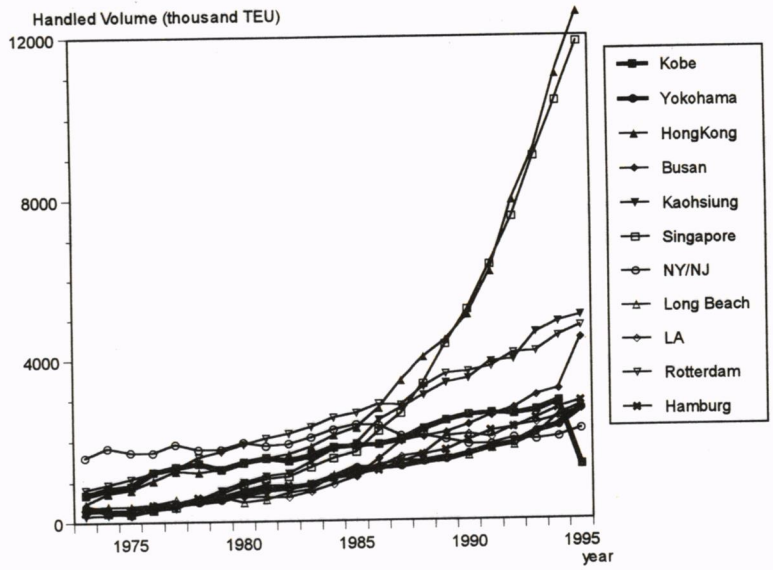

Figure-1. Trend of Handled Container Cargo Volume

2. Present Situation of Ports in East Asia

In recent years, the order of handled container cargo volume at Japanese ports is relatively low, as shown in Figure -1. On the other hand, the figure shows that the growth of the various ports in other countries, such as Hong Kong and Singapore, is remarkable. Figure-2 shows Handled Cargo Volume at the main-ports and import/export cargo volumes of countries. It examines the difference in port characteristics among these countries.

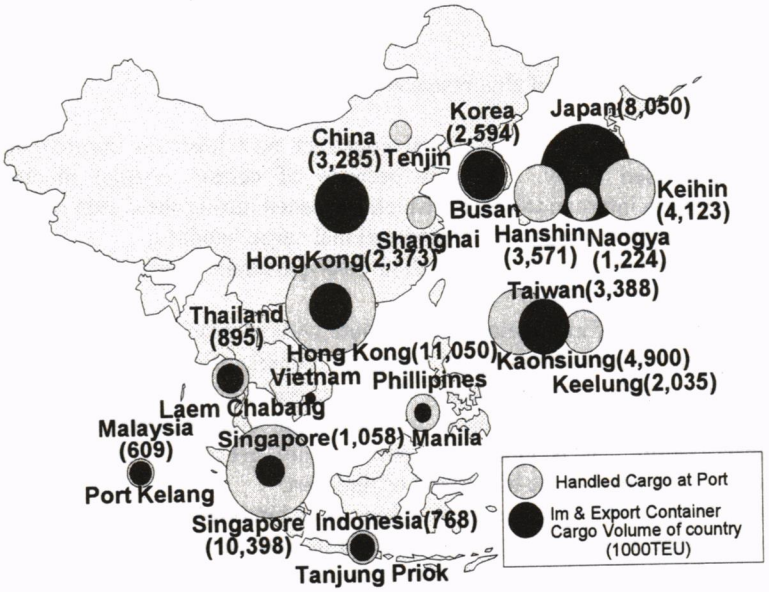

Figure-2 Handled Cargo Volume at Major Port and Import/Export Container Cargo Volume in Each Country

The volume of export and import cargo volumes is small compared with the handled cargo volume in Singapore and Hong Kong. It is understood that the transshipment function, which collects cargo from peripheral countries, and transfers them to trunk routes to Europe / North America is excellent at these ports. Total national cargo volume is almost as same as the volume of import/export cargo at port of Busan in Korea. Also, the cargo volume of transship is small in Japan. Ports in Japan are handling export/import cargo only (Fig-3). Concentration of cargo to three bays located 5 main ports in particular is remarkable. It is understood that one port influences a wide area. According to port role, these ports can be classified as follows:

-The Port depends on Hinterland demand: Kobe, Yokohama, Kaoshiung, Busan
-The Port collecting demand from peripheral area:
- country area dependence: Hong Kong
- dependence on peripheral countries: Singapore

Port is an important transportation infrastructure that supports economic activities of the whole country in addition to hinterland in Japan

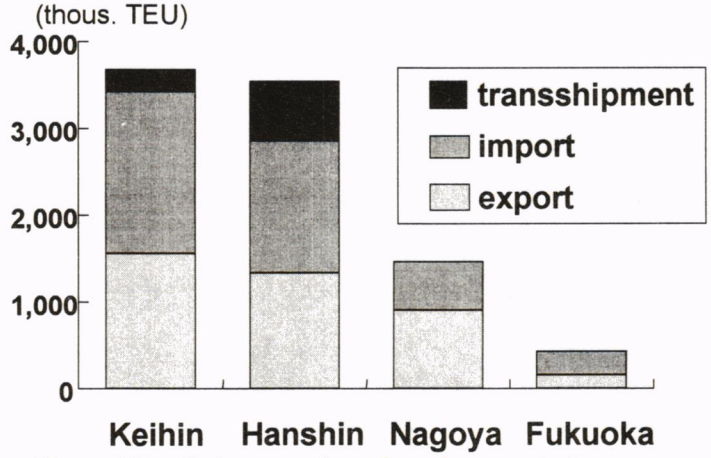

Figure-3 Handled cargo volume in major ports in Japan

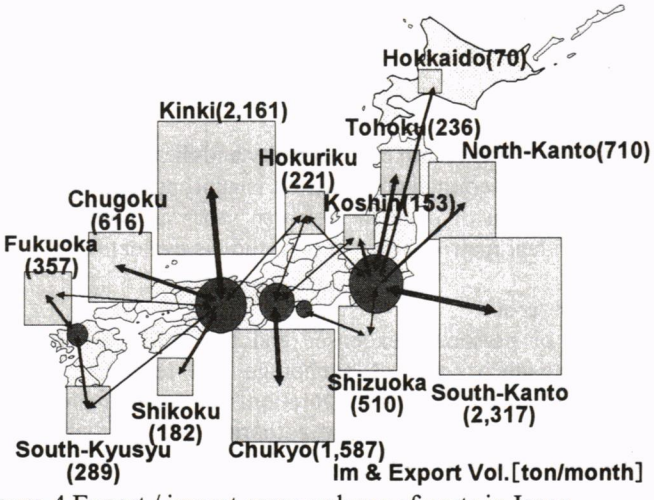

Figure-4 Export / import cargo volume of ports in Japan

3. Construction of Evaluation Method of Port development

In this study, benefit incident matrix is applied as evaluation method for comparison and examination of the impacts of port development.

3.1 Related Sectors and Evaluation Factors

3.1.1 Related Sectors

The following sectors are considered related to port development and operation. The sector is divided into 4 group, 1) port authority as the construction and managing sector, 2) sectors who utilizes port directly, transportation enterprise, corporation and the person who located in hinterland of a port, 4) area except hinterland meaning whole country.

1) port authority
2) transportation enterprise
    a) shipping company
    b) port mover company
    c) land transportation company
3) hinterland area
    a) port connected industries
    b) other industries
    c) residence c1) consumer
                  c2) worker
    d) local government
4) whole country
    a) enterprise
    b) nation b1) consumer
               b2) worker
    c) central government

3.1.2 Factors of Cost and Benefit

The factors of cost and benefit for port development are as follows:

1) Construction cost
2) Operation cost
3) Revenues
4) Transportation cost
    -Sea-Transport Cost
    -Loading Cost
5) Prices
6) Income
7) Subsidy
8) Tax

1) Construction Cost

The sectors concerned with construction are port authority and the public port corporations. All cost concerned with container terminal construction is appropriated. But construction costs is converted into the amount of payment between years as capital costs, and it is necessary that the benefit incident matrix shown in this study is evaluation of a single year.

2) Operation and management cost

General management costs of personnel expenses and the others are appropriated as operation cost. The maintenance costs of anchorage and terminal are to be each appropriated as operation cost of public port corporation, and maintenance cost of water way is considered as the operation cost of the port authority. All of these are concerned with container terminal administration is appropriated, and this is done with operation cost.

3) Revenues

The rates between sectors related to in the cargo handling and transportation are appropriated for rate income of receiving sectors. The various fares/charges are to be appropriated for factor for the transportation costs for the payment side adversely. Table-1 shows these items.

Table -1 Fares/Charge and Sectors

	RECEIVER	PAYER
Port Due	Port Authority	Shipping Company
The Rent for Terminal	Port Public Corporation	Terminal Operator
Sea Transportation Fare	Shipping Company	Port Connection Industry / The Other Industry / Enterprise
The Yard Fee for Use	Terminal Operator	Shipping Company
Wharfage		
The Crane Fee for Use		
Line Handling Fare	Port Mover Company	Shipping Company
Taggage		
Pilot Charges		
Agency Commission		
Loading Work Charges		Terminal Operator
Land Transportation Fare	Land Transportation Company	Port Connection Industry / The Other Industry / Enterprise

4) Transportation Efficiency

4-1)Sea-Transport Cost

The cost of transport of shipping company includes sea transport cost, line-handling fare, taggage fare, pilot fare (bay and harbor), the agency commission.

4-2) Loading Cost

The yard fee, wharfage, the crane fee are the main components of the loading cost paid by shipping company. Loading work charges for port mover company is appropriated. The thing which paid off money flow to affect these items, 1)-4),for port activity is shown in table-2.

5) Prices

As the transportation efficiency is improved similarly, shipping company expenses decrease. This is reflected by the decrease in transport cost. This cost decrease reduces industrial transportation costs paid. Reduction of the transportation costs returns to price of production entirely. The decrease in cost production results to the appropriation of consumer surplus.

6) Income

Expansion of consumption and production activity leads to the expansion of industrial employment opportunity. This is appropriated for income effect.

Table-2 Money flow between sectors concerned with the transportation

	Port Authority		shipping company		Port mover company	Land transportation 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 transportation fare	Yard fee for use, Wharfage, Crane fee for use	Line handling fare, Taggage, Pilot charges, Agency commission, Loading work charges	Land transportation fare	
4)The transportation cost							
4-1)Sea-Transport Cost			Sea transportation costs, Port due, Line handling fare, Taggage, Pilot charges	The yard rent			Land transportation fare, Sea transportation fare
4-2) Loading cost			The yard and crane fee for use, Wharfage	Loading work charges			

7) Subsidy

There is the following subsidy, the exchanges of the investment. For Port Authority, there is a subsidy corresponding to construction costs from local government and the central government. There are free interest loans from the government, loan from private sectors, the investment from shipping company that a public corporation receives.

8) Tax

Five kinds of tax are object.

- Tonnage is a tax paid from shipping company to government for every port arrival. 20/36 of tonnage returns to local government as donation tax, special donation tax.
- The corporate tax is paid the government from port mover company, land transportation company, port connected industries and other industries.
- Consumption taxes are paid by consumer to government
- Residence tax is the tax paid from consumer to local government
- Income tax from worker to government.

3.2 Impact of effect

The factors for evaluation mentioned above don't occur independently. There are the relations between factors and sectors. Figure-5 shows the impact of port development. It also shows what kind of impacts are given to each factor, for example, when port improvement of harbor deepening and rationalization of port service was done, and improvement of the transportation efficiency was achieved. Competitions between sectors are reflected by decrease in transportation costs and full in consumer prices. Finally, increase of consumer's surplus is expressed.

3.3 Measurement method of port development effect

1) Construction costs

2) Operation and management cost

Construction, operation and management costs becoming necessary by function

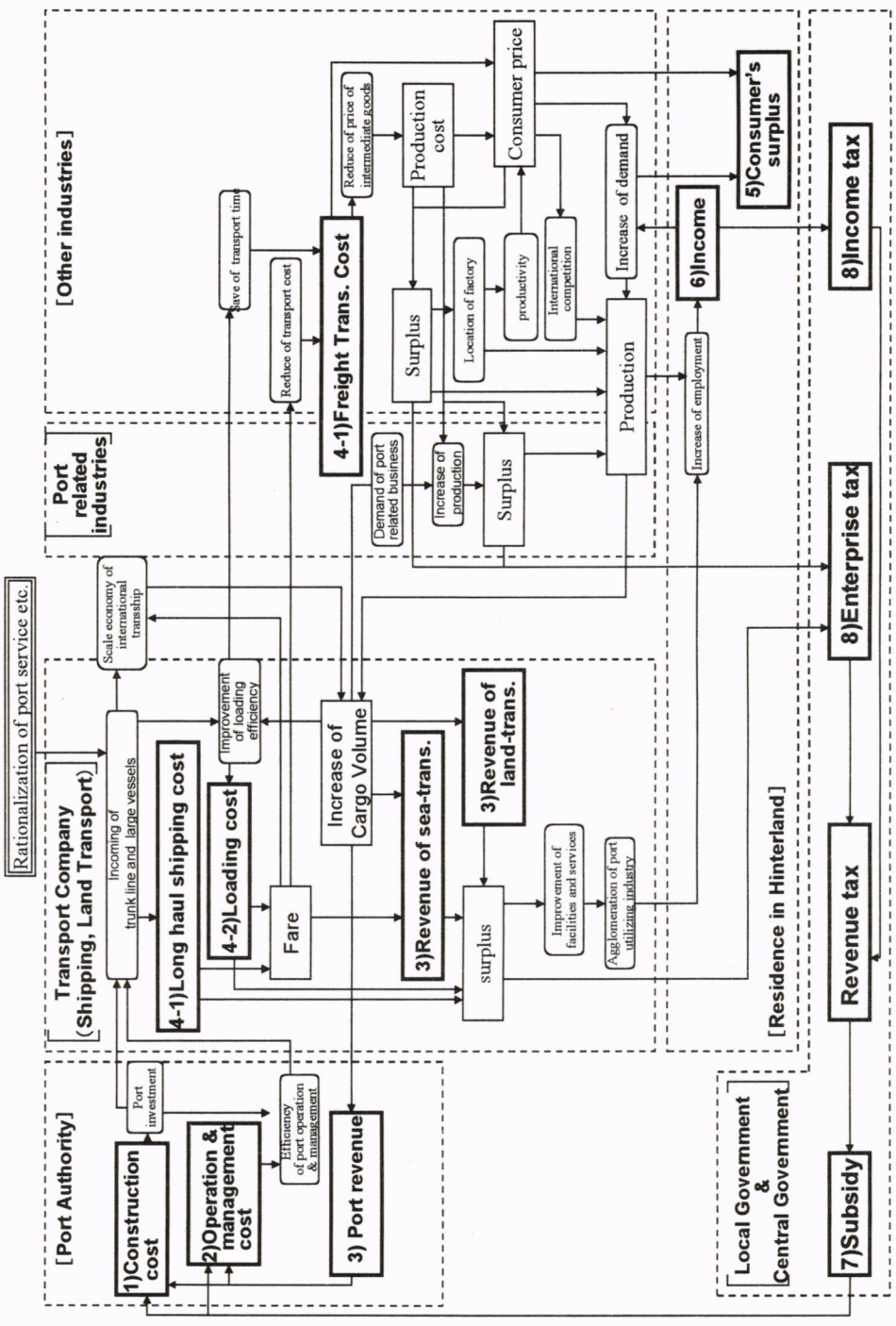

Figure-5 Impact of Port Development

improvement of each port are to be appropriated in benefit incident matrix. Construction cost is converted into the amount of payment between the year that considered social discount rate (5 %) as social capital costs, and it is shown to be evaluated on a single year.

3) Revenues
Among the various fares changed in port activities, only the rent is paid in a unit between every year, and the other fare are paid for every arrival in port. There are fares that depend and do not depend on the handling volume by one arrival in port. The rent fare that terminal operator pays to a public port corporation is around 1200 million –1500 million yen per 1 berth in a year. Port due depends on the model of a ship, and it is fixed at 2.7 yen×G/T. Line handling fare, taggage, pilot charges differ by model of ship, but there is no clear proportion at relation. These fares contribute to the increase in income by the increase of number of arriving ships, but the handled cargo volume is not related directly. 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 transportation fare and land transportation fare are provided by taking advantage of rate unit price every OD cargo volume. Sea transportation fare reflects the increase and decrease for the transportation costs described in next section. A change of cargo volume at port brings about change in sea transportation fare.

4) Transportation Cost
Various fare described in 3) become cost for the payer. Figure-6(a) and (b) 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 due, line handling fare, taggage and pilot charges. When handled volume per ship arrival is fixed, and handled volume between years increases, it is shown that the transport cost for 1 TEU decreases. The rent remains constant in a year, because it does not depend on handled volume. On the other hand, Figure-6 (b) showes 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 will decrease for every arrival in port and loading with the increase of handled volume.

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

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 with port development are major factors that increase or decrease of transportation costs and fare. In other words, the new fare is calculated by [present fare + (the increase and decrease value for sea transportation costs + cargo loading costs)].

5) Prices (consumer's surplus)
6) Income
Increase of handled cargo volume and improvement of the transportation efficiency by a call of a big ship at a port reduces the transportation cost. As a result of competition, a decrease in the transportation costs reflects 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.

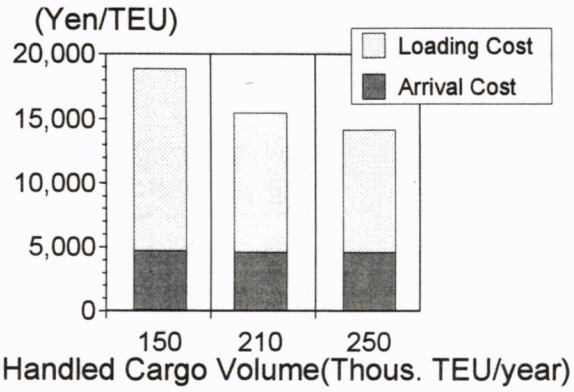

Figure -6 (a) Change in the port cost with handled cargo volume
(Model of a ship:4420TEU, Loading volume per 1 ship: 843TEU)

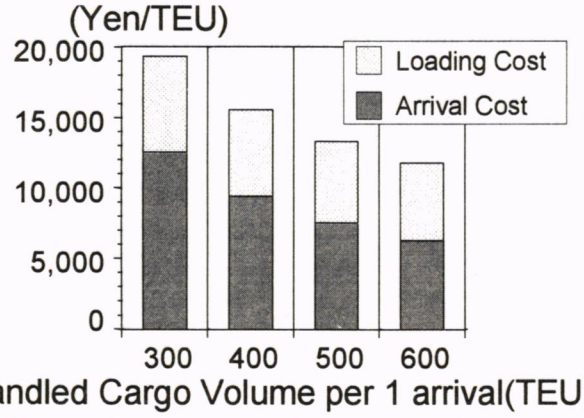

Figure -6 (b) Change of loading cost with change of the handled cargo volume per ship
(Model of a ship:3400TEU 210000 TEU a year handling

Table -3 Function for sea transportation costs

Model of ship (TEU)	Sea transportation cost per 1 TEU (1000 yen)	Test calculation value (yen)
500	(12.1+34.0/1000*d)/R	163,000
1000	(6.76+17.6/1000*d)/R	85,086
2000	(4.07+10.1/1000*d)/R	49,100
4000	(2.56+5.96/1000*d)/R	29,200

The distance that d navigates (nautical mile), R is load factor ($0< R \leqq 1$).
d: navigation distance (nautical mile) R: load factor ($0< R \leqq 1$)
A test calculation value is sea transportation cost per 1 TEU for a case of navigation distance of 3,000 miles and load factor of 70 %.

[Estimate of the demand function]
The demand function used for calculating consumer's surplus includes benefits of price decrease and demand expansion as explanatory valuables. This function is then used for estimating input data to IO analysis and aggregation of domestic demand.
The demand function is estimated as follows:

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

The explanatory variables are, X1: family budget and X2: consumption price deflator. Estimation results are as follows.

		$\ln A_0$	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

[Estimate of Export Function]
A function to represent export volume is estimated below

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

where X1 is the export price index here. The export price elasticity value is estimated as follows:

1)	Agriculture and the marine products industry	-0.4217
2)	Article of food	-0.4127
3)	Fiber	-0.2660
4)	Paper & Pulp	-0.6222
5)	Chemistry	-0.9872
6)	Iron and steel	-0.1852
7)	Non-metal	-0.7549
8)	Metal product	-0.9132
9)	General machinery	-0.6805
10)	Electrical machinery	-0.7868
11)	Transportation machinery	-0.2846
12)	Precision instrument	-1.1114
13)	Other manufacturing industries	-1.2740

[Change of production and consumption activity by change of prices]
When the value of sea-transport cost increases or decrease, loading costs are calculated by analysis of transportation efficiency which then affects fare, and a new fare is assumed.

The increase and decrease value for fare

= present fare +(increase and decrease value of Sea-transport Cost and loading costs)

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

Import price = present price ×(1+ increase and decrease rate of assumption fare

× transportation contribution degree)

The transportation cost is assumed here to be approximately 5% of the imported products 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:

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

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

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^f : import inverse coefficient vector

Γ : added value vector of unit production

The domestic price elasticity value of the import products price led by this model is shown as following.

1) Oil products	0.509
2) Non-metal	0.406
3) Textiles	0.100
4) Foods	0.082
5) Electricity machinery	0.032
6) Metals	0.015
7) General machinery	0.014
8) Rubber products	0.005

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

A)the amount of last demand = aggregate domestic demand + export

B)production of each sector estimated by IO analysis

C) Income : Sector production × sector wage rate

By the demand function, the consumer's surplus is estimated.

7) Subsidy

Government subsidizes 50% of the construction costs to port authority for its improvement projects. The port authority as a development organization, shoulders the remaining costs.

8) Tax

Tonnage is allocated to the income of the central government and local government. Unit price of tonnage is a value in proportion to N/T of ship. A corporate tax with profit expansion such as land transportation companies, other port connection industries, port-dependent industries is charged to government. It is assumed that income tax from a worker is paid to the central government and residence tax is paid to the local government and consumption tax from consumer to the central government.

3.4 Constructing of benefit incident matrix on port development

Table-4 is the benefit incident matrix that indicates the cost and benefit item for the related sectors. The amount of real cost / benefit equivalency is shown on the alphabet part in the matrix. The sum total of the column shows the surplus that each sector receives finally. In following chapter, the impact of port development is analyzed through a case study.

Table -4 The benefit incident matrix which affects port development

		Port Authority	Transportation enterprise			Hinterland					whole country				Total
								resident				nation			
			Ship company	Port mover company	land transport company	port related industries	other industries	consumer	worker	local government	enterprise	consumer	worker	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

4. An estimation of large-scale container berth development impact

The effect of incoming big ship with a high transportation efficiency and concentration of cargo volume should be high. Two case studies are considered in this study:

Case 1 : improvement of two major bays and concentration of cargo to these ports

Case 2 : improvement of ports located in regional areas, and the trial cargo throughout the country.

Project life of both case studies is 30 years. Evaluation is done with the single year evaluation for year 2010.

4.1 Case study of two major bay improvements

Hyogo, the hinterland of port of Kobe, and the port of Kobe are objects of this case study. When big ship called at port and handled cargo volume increased by port development, the degree of impact was analyzed.

1) Assumption

In this case study, increase of port handled cargo volume and deepening of harbor are assumed. Contents of berth development, as shown in Table-5, are improvement of current berth to -15m depth berth that can handle 5000TEU ship. Improvement cost per berth is around 5 billion-yen and whole cost is 45 billion-yen. On the current berth, two gantry cranes are installed. Assuming further that one gantry crane was added to the berth for big ship, them a total of cranes were established. 27 gantry cranes are to be installed for the improvement of 9 berths. The cost of gantry crane can be repaid in 15 years. It was assumed that 61 gantry cranes was rearranged in the whole port of Kobe after 15 years. If one gantry crane is costs one billion yen, the investment of 88 billion yen is necessary. Accordingly, total investments amount to 133 billion yen including improvement costs and total cost of gantry crane installation. This is appropriated in benefit incident matrix for costs to build which is 92.2 hundred million yen assessed in 2010. Handled cargo volume of port of Kobe in 2010 is predicted as follows:

Without-case: 4,680,000TEU (increase by an annual rate of 3 %)

With-case: 5,550,000TEU (870,000 TEU is added in without-case).

2) Evaluation by benefit incident matrix

Estimation result for the fare income and transportation costs are shown in Table-6. Reduction effects for the cost with concentration of cargo and calling of big ship is shown. The fare is considered to reduce the cost, and it is established. Fare income of shipping company increases, too so that cargo volume increases. A fall in the imported goods price can be established as a result of estimation for these transportation costs. Table -7 compared the transportation cost per 1 TEU for without-case and with-case. 13,449 yen, that is the reduction share for the transportation costs per 1 TEU provided here is approximately 10.5 % of the fare (weight account mean for a separate fare).

Table-5 The setting depth of berth improvement

Depth	model of a ship (TEU)	Berth number	
		Without-case (present)	With-case
～-10m	1000	0	0
-12m	2000	14	14
-13m	3000	4	0
-14m	4000	5	0
-15m～	5000	2	11

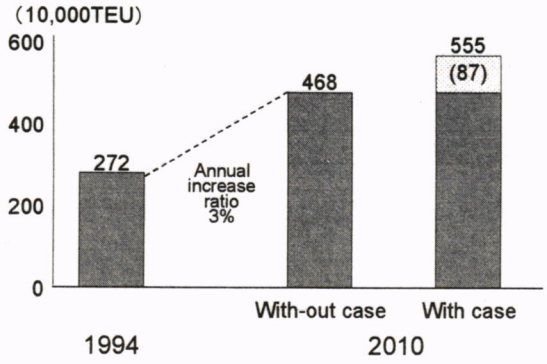

Figure -7 Setting of handled cargo volume

The sea transportation cost ratio of the import price is 5 %. Property as a share of an inheritance of the container transportation for the amount of export / import is 50 %. If decrease of transportation cost is reflected in fare and prices, the import goods price decrease approximately 0.26 %. Using this import price decrease, domestic price of production and change of consumption expense by the demand function are analyzed by IO analysis described above. Consumption expenses becomes 104,873 hundred million yen in without-case. 104,951 hundred million yen is been in without-case. In other words, the increase in consumption is approximately 77 hundred million-yen.

Table -6 (a) Estimation result of fare income (unit: hundred million yen / year)

Sectors	Fare item	Without-case	With-case	Balance
Port Authority	Port due	2.9	3.1	+0.2
	The yard rent	350.0	350.0	0.0
Shipping company	Sea transportation fare	6029.0	6401.0	+372.0
Port mover company	Line handling fare, taggage, Pilot charges, agency commission, loading work charges	244.0	245.0	+1.0
Land transport company	Land transportation fare	3123.0	3210.0	+87.5

Table -6 (b) Estimation results for the transportation costs (unit: hundred million yen /year)

Sectors	Cost item	Without-case	With-case	Reduction for the cost
Shipping company	Sea-transport Cost	1,624.0	1239.3	384.7
	The arrival cost	120.1	98.4	21.7
	The yard rent	350.0	350.0	0.0
Port connection industry/the other industry transportation cost	Transport Cost	4904.0	4793.0	111.1
Shipping company	Loading work charges	126.6	150.1	-23.5

Table -7 Change of the transportation costs per 1 TEU (unit : yen/TEU)

	Without-case	With-case	Cost reduction
Sea-transport Cost	33,572	22,575	10,997
Loading cost	17,035	14,583	2,452
Total	50,607	37,158	13,449

Table -8 Calculation results of the impact of the port of Kobe improvement

(unit : hundred million yen)

		Port Authority	Transportation enterprise			Hinterland					whole country				Total
								resident				nation			
			Ship company	Port mover company	land transport company	port related industries	other industries	consumer	worker	local government	enterprise	consumer	worker	government	
1) Construction cost		-92.2													-92.2
2) Operation cost		-0.0													-0.0
3) Revenues		0.2	372.0	1.6	87.5										461.2
4) Transport Cost	4-1) Sea-Transport Cost		406.4			16.7	94.4				149.3				666.9
	4-2) Loading Cost		-23.5												-23.5
5) Prices						-26.1	-62.1	88.2			-408.8	408.8			0.0
6) Income				-3.0	-4.5	-38.4	-62.3		108.3		-154.8		154.8		0.0
7) Subsidy		92.2	-20.8							-25.3				-46.1	0.0
8) Tax			-1.1	-0.3	-0.4	-11.8	-11.9	-9.3	-8.7	18.6	-40.8	-19.3	-12.4	97.3	0.0
TOTAL (Surplus)		0.2	732.9	-1.7	82.6	-59.6	-41.9	78.9	99.7	-6.7	-455.1	389.5	142.4	51.2	1012.4

Approximately, the total production of the hinterland increased 359 hundred million yen. As a result, the income increases by approximately 109 hundred million yen. These results were shown with benefit incident matrix of Table-8. For an investment of 92 hundred million yen, benefit of 708 hundred million yen (7.7 times) was obtained.

4.2 A case study of local port improvement

The port of Niigata which is one local port in Japan is the focus of this case study. A function of the container transportation was strengthened, and calling of mainstay route was assumed.

As assumption, an additional two new berths are developed as -14m depth, there are currently 2 berths, and handled cargo volume is assumed at 267,000TEU for the with-case and 37,000TEU for the without-case. The result is shown in Table-9. It is estimated that a benefit of 18.1 billion yen is enjoyed by the residents in the hinterland and thee rest of the country for an investment of 2.4 billion yen in this case study and overall benefit of 18.9 billion yen.

4.3 Comparison of a case study

The analysis results that studied the port of Kobe and the port of Niigata that assumed two scenarios as shown above.

In this study, benefit incident matrix is made for each case study equally about two ports and sequel back areas of the port of Yokohama and the port of North Kyushu (port of Hakata, port of Kitakyushu). The total sum of benefit provided by those ports are shown by Table-10. All ports in the country were not considered. By this analysis, the impact on the hinterland by the concentration on two major bays is large. In case of local port improvement that assumed dispersion, the tendency that benefit spread across to nation was shown.

Table -9 Estimation of benefit of port of Niigata improvement

(unit : hundred million yen)

		Port Authority	Transportation enterprise			Hinterland					whole country				Total
			Ship company	Port mover company	land transport company	port related industries	other industries	resident		local government	enterprise	nation		government	
								consumer	worker			consumer	worker		
1) Construction cost		-23.6													-23.6
2) Operation cost		0.0													-0.0
3) Revenues		28.2	115.3	14.9	269.8										428.3
4) Transport Cost	4-1) Sea-Transport Cost		-130.7			4.4	24.7				-107.9				-209.5
	4-2) Loading Cost		-6.2												-6.2
5) Prices						-42.6	-93.9	136.4			-12.1	12..1			0.0
6) Income				-0.5	-0.7	-8.2	-27.5		36.9		-4.9		4.9.		0.0
7) Subsidy		7.6	0.0							0.0				-7.6	0.0
8) Tax			-0.2	-0.0	-0.1	-3.0	-2.8	-6.3	-3.0	4.9	-1.3	-0.3	-0.2	12.0	0.0
TOTAL (Surplus)		12.2	-21.8	14.4	269.1	-49.5	-99.5	130.2	33.9	4.9	-126.2	11.8.	4.7.	4.4	189.0

Table -10 Comparison of case study analysis (unit: hundred million yen)

	Improvement of ports of two major bays	Local port improvement
Hyogo (port of Kobe)	1,012	203
Kanagawa (port of Yokohama)	577	163
Fukuoka (port of North Kyushu)	-46	23
Niigata (port of Niigata)	-3	189

5. CONCLUSION

5.1 Findings of research

This research evaluated the impact that ports improvement brought. In addition to direct impacts on the port related sectors, indirect effects to regional economy of hinterland and national economy were evaluated by a form of benefit incident matrix. The relation of burden of cost and benefit return was shown quantitatively. The method of benefit incident matrix is not new, and there are already several studies on the measurement of impact to hinterland with port function improvement. Findings of this research can be summarized by the following 2 points:

1) impact of container port development is evaluated.
2) benefit measurement by the benefit incident matrix which has not yet been applied until now in the field of sea ports

5.2 Knowledge

As shown in 4.1 and 4.3, the total benefit was estimated approximately 5-10 times of the amount of investment when the handling of container cargo was concentrated to two major bays that is the port of Kobe and Yokohama. It was also shown that there was a significant impact by the calling of big ship and increase of handled cargo volume by container wharf improvement. The cargo volume increase can not always be expected even after improvement such as deepening to -15m depth of berth and installation of gantry

cranes. For the transportation efficiency improvement, there are some issues, such as cancellation of loading limit of the labor and management custom, reduction of port fare and simplification of the transportation procedure.

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