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ECONOMIC EVALUATION OF PORT INVESTMENTS

Summary

The master plan sets the long-term development strategy for the port, which will influence the future levels of traffic that uses it. These developments may be either improving existing facilities or building new ones. Any other kind of activities that are performed to increase the intensity of port use can also be considered as port development. These can be in the field of law or reorganization too. In any way, an economic evaluation of port development investment should be considered before any action is taken. This is a decision making process where profitability of the new investment is questioned. The evaluation for such a port development project require a succession of costs and benefits over the whole useful life of the project. The main costs in a port development project are construction costs and maintenance costs, the benefits are mainly transport cost savings and reduced turn-round time. A fundamental characteristics of these costs and benefits are that they are transmitted to other participants in the trade rather than to the port authority. The matter of getting costs and revenues on a basis where they may be equitably and conveniently compared can be done by several investment appraisal methods. In this paper, evaluation of a port deepening project will be discussed by using benefit-cost methods. The costs and benefits of such a project will be identified by showing how the port depth affects the unit price of transportation cost.

Key words: port development, dredging, benefit/cost, depth

I. Introduction

The objective of investment in the private sector is generally understood to be profit maximization within a specific time frame. On the other hand, the objective in the public sector is the maximization of net social benefit. Given this objective, benefit/cost method is used to evaluate the investment in many types of public projects

from airports to highways, and is an accepted measure of desirability for project at most levels of government. Although there is currently a tendency towards "privatization" of ports in all over the world, in most countries the port owner is still the governmental authority. Whether national or regional or local, the governmental authority is responsible for finding the lowest possible overall cost for transportation of goods through the ports of the national port system and at the same time the government should protect the port users. The port users can be divided into two for the public ports: a) Direct users b) Indirect users. Ship owners are direct users of the port but they are not final users. The final users are those who really pay for the port services. The country' s producers and consumers are therefore final users of ports. The port that is expensive for the users is not necessarily the port with the highest tariffs; it is rather the port where the services are poor because of delays and inefficiency. In this sense, the user benefits are considered to be a benefit in Benefit/ Cost method for evaluating public projects.

So, in general Benefit/Cost method can be described simply as (Collier and Ledbetter, 1988):

$$B / C = \frac{\text{Net savings to users}}{\text{Net capital cost + net operating and maintenance cost}}$$

In order to evaluate the costs and benefits associated with the project, the costs and benefits are analyzed on an annual basis.

This paper discusses the overall role, which methods of cost benefit analysis might play in making economic appraisal of port investments. But when a decision is required whether to invest money in a port, whether it is worthwhile or not is a complex problem to be solved. The existing facilities either cannot meet modern technological needs, or do not have the capacity to accommodate expected increases in commerce, or perhaps an entirely new port is needed to permit the economic exploitation of the resources of the hinterland. Measuring the benefits of an investment made in a port presents certain and practical problems. This arises because the benefits are not circumscribed within the port but are passed on to various other sector and interest groups. A port investment may, depending on the situation, ease congestion, increase productivity, reduce ship' s waiting time cost, cargo-handling cost and finally reduce overall transport costs. A port project may stimulate economic development or increase economic activities both in the immediate surroundings of the port and elsewhere in the economy. Like in many projects, investment in port projects are also a decision making process. The choice between alternative ways of doing the same thing involves an engineering cost study. For this matter getting costs and revenues on a basis, where they can be compared for judgment has been the subject for many projects.

II. Port development

By port development, those activities that bring increased marine commerce to a selected transshipping point, is understood. These activities may be in the field of technical and civil engineering, in the field of law and in the field of business. One of the principal kind of civil engineering work executed in ports is dredging used mostly to increase the depth of a harbor. From engineering point of view, port development projects can be roughly divided into two categories: building of an entirely new port/ terminal in a new location or constructing a major extension of an existing port. The checklist of the steps involved in preparing a port development plan is summarized as follows (UNCTAD, 1984):

1) A performance analysis is carried out to determine the effect of different levels of port capacity on the level of service provided to the port' s customers (UNCTAD, 1987), (UNCTAD, 1987)
2) Engineering studies are carried out to determine the feasibility and approximate cost of each design.
3) Operational planning is done to determine how the proposed facilities will be used and what the productivity and the operating costs will be.
4) Benefit-Cost analysis and financial analysis are done to compare the desirability of each alternative which shows whether a facility will pay for itself.

III. Benefits and costs related with port development projects

Benefit/ Cost method

For the evaluation of an investment, the comparison of the construction and operating costs to the benefits associated with the project are commonly used. As the name implies the Benefit/Cost ratio is obtained by dividing one by the other:

Benefit/ Cost = Annual value of benefits/ Annual value of costs
(Tolga and Kahraman, 1994).

Initial construction and other capital costs are converted to equivalent annual costs. Costs are divided into two categories: 1) Capital costs which are usually considered as the construction, acquisition or other capital costs of a facility 2) Operation and maintenance costs which are the owner's costs for operating and maintaining the facility.

One of the major problems facing the analysis in determining B/C ratios is deciding which items to include in costs and which items to include in benefits.

Benefits related to port development projects

In case of port development projects, the most important point is to define the costs and benefits. The benefits of a port development project can be grouped into three categories:

1) Direct benefits to the port,
2) Benefits to users of the port facility,
3) Intangible benefits.

Direct benefits to the port

Firstly, because of the increased port activity, there is a direct financial return from ships and cargoes. This is achieved by a variety of charges for the use of facilities. These are mainly the fees charged against each ton of cargo that are handled at the port, the fees charged for cargo that remains in storage in terminal area more than a specified free time period, and various rental and other charges.

Secondly, due to the increase in economic activity, there will be additional rental of land made possible by the project. The affects of port traffic on the costs are shown in Figure 1 (UNCTAD, 1979). As the traffic volume increases in the port, port cost (cost per ton of cargo) decreases. On the other hand, the time ship spends at the berth increases with the increasing traffic. The total cost is minimized at a certain point at the traffic volume.

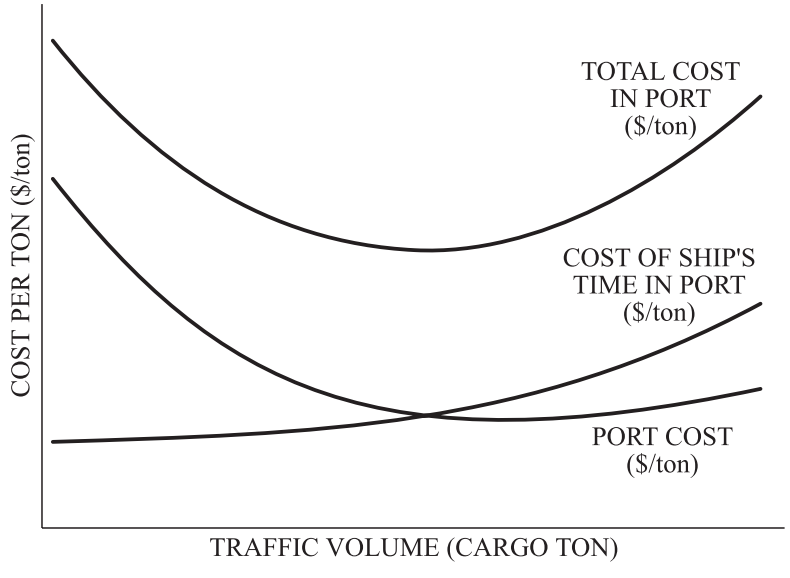

Fig. 1.: Variation of Total Cost in Port with Increasing Traffic

Benefits to port users

These are mainly cost saving benefits arising from reduced operating expenses, and reduced overall inland transport costs. Much of this saving is realized outside of the immediate port area and doesn't produce direct revenue to the area. However the reduced costs could result in improvement of the port' s competitive position and in the attraction of additional cargo to the port, thereby producing revenues and benefits noted in the above section. The transportation savings can also improve competitiveness of the port area, which can result in the expansion of the markets of the industries in the area. This is particularly relevant where a group of ports exist perhaps in different countries, all competing for the same traffic. But, for the ports at a national level and when they are operated at the national level, it is no longer necessary to consider the benefits stated above, and investment decisions can be based on the national good rather than on the welfare of the local port district (UNCTAD, 1977). In developing nations this is especially important, because capital is scarce and duplication of facilities cannot be tolerated. Another factor which should be considered as the cost saving, is the savings in ships' operating cost arising from economy of scale of operating larger ships. For example, consider the case of a port in a country, which is deepened to allow the use of larger ore-bulk carriers. Without the new project, vessels of 30,000 DWT could be used whereas with the investment, 50,000 DWT ships can be accommodated. The reduced transportation costs could allow the ore to be sold on markets which were previously out of reach. Since the price is probably determined on the overseas markets, the benefit from this investment would be the increased net revenue made possible by the reduced transportation use.

Intangible benefits

These are the benefits that can't be measured in monetary terms. Most of these benefits can't be evaluated in the benefit/cost method. A port may be constructed or developed because a country wants to be self sufficient and not dependent on neighboring foreign ports, or a port may be constructed/ developed because of national defense and security considerations or just because to increase prestige.

Costs related with port development projects

In a port development project, the engineering studies aim at identifying possible solutions and providing sensible estimates for their capital and maintenance costs. The costs related with the port projects are mainly the construction costs, which are estimated more accurately as the project develops. It is also important to consider the effect on cost estimates of different construction phasing. Costs and benefits are made comparable by appropriate discounting techniques.

III. Port development through port deepening

Planning of Dredging Operations

Dredging is a method of excavation in which soils are transported by means of water (Bates and Bray, 1996). Dredging is generally confined to bays, harbors, rivers, and other large bodies of water. As the size of ships has increased, the dredging of existing ports has become increasingly important. For the dredging activity, the nature of the ground to be dredged and the selection of the correct equipment are very important. The selection of the most suitable dredger depends upon the type of soil to be dredged, the depth of dredging (Sargent, 1989). In assessing dredging costs, it is important that if large equipment must be brought from far to do the work, it is a very heavy mobilization cost. The quantity of dredging required for any project is a great effect on the overall unit rate. In Table 1, the proper dredger for each type of soil and related costs are given (Anonymous, 1980).

Table 1.: Soil Type, Dredger Type and Cost Relationship

Dredger Type	The Type of Soil						Order of Increasing Cost
	Rock	Hard	Normal Soil				
			Grave	Fine, Medium, Course Sand	Clay, Silt	Loose	
Suction Dredger				←	→		1
Grab Dredger		←			→		2
Bucket Dredger		←		→			3
Excavator Dredger	←		→				4

Cost of Dredging and Productivity

The cost of dredging can be analyzed in two groups:

a) Direct costs: These are mainly the preparation costs like fuel, coal, electricity, and boring and soil investigation.

b) Indirect costs: These cover the costs like maintenance, overhead and depreciation (Anonymous, 1980).

Although depends on the type of work and of dredger, daily production rate of dredging is given as the values below:

Working rate in an hour:	%100
Dredging rate	%70-75
Waiting due to the accidents	%20-25
Periodic waiting	%10-0

The causes of accidents and percentiles are given below:

Accident type	Rate	Cause
Repair of dredger	7-6%	Soil hardness
Repair of the boat	3-2%	Excluding periodic repair
Waiting for the tug	12-10%	Depends on the weather
Position change	3-2%	Depends on the depth and size of the area to be dredged
Total	25-20%	

In the Web site of US Army Corps of Engineering, 2001, the costs related with dredging are given as in the Table 2.

Table 2.: Costs of Dredging

	Total Cost ($)	Quantitiy (m^3)	Unit Cost ($/$m^3$)
New Dredging	280,689	44,558	6.30
Maintenance Dredging	540,988	172,292	3.13

The same values, costs for new dredging as ($3/yd^3 – $5/yd^3) or (3.95 $/m^3 – 6.57$/m^3) are also given in other web sites as well (www.caller.com, 2001).

Relationship between port depth and transportation cost

The deeper the water in channels and harbors, the larger the ships, which can be employed. A port deepening project merely removes a physical bottleneck for the optimization decision of shipping. Thus, a project to widen locks or strengthen berths is identical in intention to a port deepening project. For ideal operating conditions, the water in the approach channel, in the entrance and in the harbor should be of sufficient depth to permit navigation at lowest low water when the ship is fully loaded. Until 2 decades ago, a harbor depth of 10-12 m. would care of most ships. While ships increased in tonnage, this depth has become not enough for some of them. In Figure 2 and Figure 3, the relationship between ship size and relative costs per ton-mile are given (Alderton, 1980).

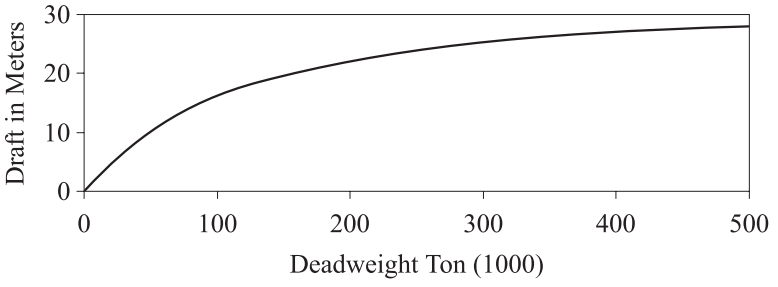

Fig. 2.: Relationship Between Ship Size and Draft

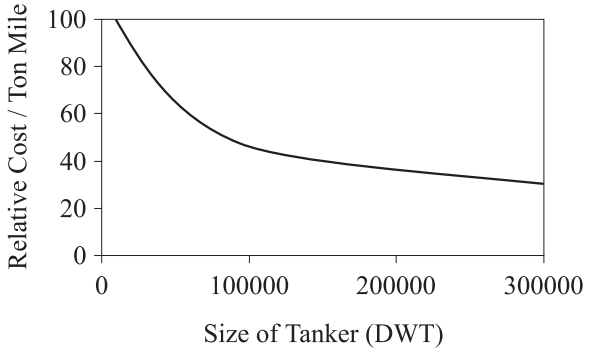

Fig. 3.: Relationship Between Ship Size and Relative Costs

So, in this respect, limitation of the size capacity of a port in depth will interfere with shipping costs since the optimum size of cargoes and vessel sizes are prevented from being used. But on the other hand, after a point, the size capacity of the port may be limited not by the depth but by the design of berths. Also ship owners and shippers may not find it profitable to employ large ships unless the service facilities in the port like cargo handling, storage, inland transportation links, etc, are adequate for larger ships.

In Table 3, real transportation costs of break bulk vessels are given to show the decrease in unit transport cost as the size increases. These values are 20-day voyage costs between USA-TURKEY. Also in Table 4, decrease in unit cost for yearly values are given. It is clear from both tables that there is a decrease in transportation costs as the size increases.

Table 3.: Transportation Costs of Break Bulk Vessel Between Turkey and USA East Cost for Single Port in Each Country (Batý Nakliyat A.Ţ., 2002).

Ship Size (DWT)	Port Charge ($)	Daily Running Cost ($)	Daily Fuel Cost ($)	Total Cost ($)	Unit Transportation Cost For Voyage ($/ DWT)
2000	5000	1000	600	37000	19
5000	12000	1500	1100	69200	14
8000	16000	2000	1700	104800	13
12500	22000	2300	2400	153600	12
28000	45000	2900	4500	267000	10
55000	65000	3000	6000	335000	6

Table 4.: Yearly Costs for Different Size Bulk Carriers (Stopford, 1997)

Ship Size (DWT)	Operating Cost $'000 (yearly)	Bunker Cost $'000 (yearly)	Total Cost $'000 (yearly)	Cost per DWT ($/DWT)
30000	1414	680	2094	70
40000	1476	778	2254	56
65000	1633	972	2605	40
150000	1940	1458	3398	23
170000	2120	1620	3740	22

The draft - size relationships for some break-bulk vessels are shown in Table 5.

Table 5.: DWT-Draft Relationship in Break Bulk Vessels (Frankel, Houmb and et all, 1981)

DWT	Draft (m)
10000	11.6
15000	13.6
20000	14.9
25000	15.9
30000	16.8

Similar to Table 3, real transportation costs for container vessels are given in Table 6.

Table 6.: Ship Size- Unit Transportation Cost Relationship Between Turkey and USA East Cost for Single Port in Each Country (Batý Nakliyat A.Ţ., 2002).

Ship Size (TEU)	Transportation Cost ($/TEU)
400	262
625	246
1400	191
2750	122

In Table 7, size- draft and in Table 8, size-berth length- depth for different size container ships are given to show the size – depth relationship.

Table 7.: Container Ship Size -Draft Relationship (Ports and Harbour Bureau, 1992).

Ship Size (TEU)	Draft (m.)
588	7.5
882	9.0
1470	10.8
2647	12.7

Table 8.: Container Ship Size -Berth Length-Berth Depth Relationship (Ports and Harbour Bureau, 1992) .

Ship Size(DWT)	Berth Length (m.)	Berth Depth (m.)
20000	250	12.0
30000	300	13.0
40000	330	14.0
50000	350	15.0

The basic and logical assumption underlying the role of the shippers is that they will always try to minimize the unit transport cost for any given commodity to be transported. In other words, the shipper will choose the cheapest mode of transportation, or he will choose a 30,000 DWT ship rather than a 10,000 DWT ship if the unit transport cost is less with the former than with the latter. The effect of depth constraint on unit transport cost curve is given in Figure 4 (Ray, 1970).

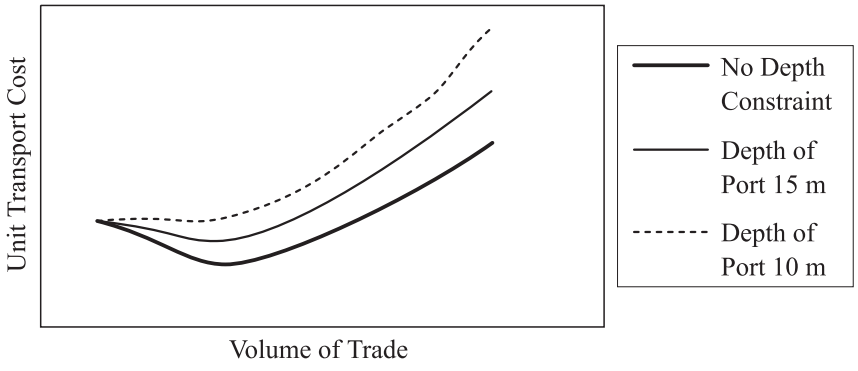

Fig. 4.: Effect of Depth Constraint on Unit Cost Curve

IV. Benefit/cost analysis applied to a port deepening problem

As discussed in the above sections, there are benefits and costs involved in port development projects. The final test in the evaluation of an investment is the comparison of the construction and maintenance costs to the benefits associated with the project. In order to convert the present value of payments to equivalent annual cash flows the following formula is used (Gönen, 1990):

$$A = P\left[\frac{i\,(1+i)^n}{(1+i)^n - 1}\right] \qquad (1)$$

Also, in order to find the annual payments with a constant increase in a cash flow the following formula is used:

$$A = G\left[\frac{1}{i} - \frac{n}{(1+i)^n - 1}\right] \qquad (2)$$

where:
P = Present worth,
A = Annual worth,
G = Constant increment to periodic series,
i = Interest rate,
n = Economical life of the project.

For solving the problem, standard tables are used for A/P and A/G obtained from the above equations. These ratios are simply designated as (A/P, i, n) factor and (A/G, i, n) factor for the usage of tables.

The following example illustrates how the benefit/cost analysis is applied for the port deepening project (Güler, 2000):

A port deepening project is proposed for Port A which can accommodate ships up to about 25,000-28,000 DWT. If the harbor is dredged to 12 m. from 11m., the ship sizes of 30-35,000 DWT can be accommodated at the port. The total output of export is 1,000,000 tons/year and expected to increase 50,000 tons each year. The sea transport cost can be lowered 1.80 US $ per ton in case of 35,000 DWT ships can dock at the port. The cost of dredging is estimated to be 10,000,000 $. Maintenance of the current harbor now runs about 600,000 $ per year, increasing about 50,000 $ tons per year each year. The estimated life of the project is 20 years. If the harbor is dredged, the maintenance will cost 800,000 $ per year and increase by 40,000 $ per year each year. The costs of the project are the dredging cost, which is the initial construction cost of the project, and the annual maintenance costs. The benefits of the project will be the savings obtained through the decrease in unit transport cost. The usual method for computing the benefit /cost ratio is to calculate all benefits and costs on an annual basis. Thus initial construction and capital costs are converted to equivalent annual costs by application of the appropriate (A/P, i, n) factor. Similarly user benefits, which are the savings in the transport cost in the above example are determined by estimating the total annual cost savings to the users for the deepening of the harbor. To convert the yearly increases in output of export and costs, the appropriate (A/G, i, n) factor is used.

To handle the sign notation the following terms are defined:

s = savings in unit transport cost = 1.80 $/ton
o = yearly output of export = 1,000,000 ton/year
e = expected yearly increase in export = 50,000 ton/year
c_1 = owner's capital cost for the proposed facility = 10,000,000 $
c_2 = owner's maintenance cost of the existing facility = 600,000 $/year
c_3 = owner' s maintenance cost of the proposed project = 800,000 $/year
c_4 = expected increase in maintenance cost of the existing facility = 50,000 $/year
c_5 =expected increase in maintenance cost of the proposed project = 40,000 $/year
n = economic life of the project = 20 years
i = interest rate per interest period = 15 %

Table 9.: Present Situation in the Port

Port Depth (m.)	Ship Size That the Port Can Serve for the Present Depth (DWT)	Cost of Maintenance for Dredging ($/year)	Increase in Cost of Maintenance for Dredging ($/year)	Cargo Throughput (Ton/year)	Increase in Cargo Throughput (Ton/year)
		c_2	c_4	o	e
-11	25-28,000	600,000	50,000	1,000,000	50,000

Project Life: 20 years, Project Interest Rate: %15

Table 10.: Proposed Port Deepening for the Port (o and e are the same values for both alternatives)

Port Depth (m.)	Ship Size That the Port Can Serve for the Present Depth (DWT)	Quantity of Dredging (m^3)	Cost of Dredging ($)	Cost of Maintenance for Dredging ($/year)	Increase in Cost of Maintenance for Dredging ($/year)	Decrease in Transportation Cost ($/ton)
			c_1	c_3	c_5	s
-12	30-35,000	1,587,302	10,000,000	800,000	40,000	1.8

So, the annual benefits of the project are calculated as:

$$B = s\,(o + e)\,(A / G,i,n) \qquad (3)$$

where (A/G,15,20) is used to find the uniform annual worth of the benefits since there is a constant increase of output. For the interest rate i =15 and n = 20, (A/G,15,20) = 5.3651 (from the table).
Substituting the values for the equation 3,
Benefits = 1.80 (1,000,000 + 50,000 (5.3651)) = 2,282,859 $/year
The annual costs of the project are calculated as:
Difference in maintenance cost = ($c_3 - c_2$) = 800,00 – 600,000 = 200,000 $/year.
Difference in expected increases in maintenance cost =
= ($c_5 - c_4$) 40,000 – 50,000 = –10.000 $/year

$$\text{Costs} = c_1\,(A/P,i,n) + (c_3 - c_2) + (c_5 - c_4)\,(A / G,i,n) \qquad (4)$$

where (A/P,15,20) = 0.15976 (from table) which gives the uniform worth of a present value for i = 15 and n = 20.

Substituting the above values for the equation 4

Costs = 10,000,000 (0.15976) + 200,000 + (–10,000) (5.3651)
Costs =1,597,600 + 146,349 = 1,743,949 $/year
B/*C* = 2,282,859 / 1,743,949 = 1.31

In the above solution when i = 15% taken, and when the benefits and costs are compared to the present situation, on an annual basis, the port deepening project for Port A shows a *B*/*C* of 1.31, or an implied showing of 1.31 for every $1 invested.

If the above proposed project is resolved while taking i = 20% in this case:

Benefits 1.80 (1,000,000 + 50,000 (*A* / *G*, 20,20) = 2,201,787 $/year
Capital cost 10,000,000 (*A* / *P*, 20,20) = 2,053,600 $/year.
Maintenance costs 200,000 – 10,000 (*A* / *G*, 20,20) = 155,357 $/year

B/*C* = 2,201,787 / (2,053,600 + 155,357) = 0.99

The proposed project is not acceptable for i = %20 since the *B*/*C* gives a value below 1 which means that costs are bigger than the benefits on an annual basis. So the above project can be acceptable up to i = %19 where the benefits and costs are almost equal to each other.

Another parameter, which affects the *B*/*C* ratio, is the quantity of cargo throughput. If cargo throughput is below 873,338 ton, the *B*/*C* ratio becomes <1.

Based purely on the economic analysis, the project is acceptable for i = %15. If funds are available to carry out the investment project, it should be carried out.

VI. Conclusion

In the appraisal of port deepening projects, the direct benefits are the reduction in transportation costs while the costs are dredging and maintenance costs. In both the private and public sector, the central economic fact is that the investment should produce savings in transportation costs to the users. But on the other hand, in port development projects, the production of savings in transportation cost becomes a theoretical consideration and the main fact is that new or developed port should make possible the economic development of the region. In private sector the question of benefits is usually simple since the benefits are measured in monetary terms. When considering public port projects, however, direct income is not the only goal, but other types of benefits, both tangible and intangible must be considered very carefully. Ultimately the decision on what benefits to include is a political decision.

On the other hand in developing countries there are problems caused by a high rate of inflation. Prices and interest rates are determined from day-to-day in the market place. Some prices may be subject to government control, so the political factors might be very dominant in project choice. So the evaluation in port projects can be carried out from both the port's point of view, and from the country' s point of view. Costs and benefits by the port and the country need not necessarily be the same. A project, which may not present financial gains to the port, may be of significant economic benefit to the country.

There are certain points that should be considered for the *B*/*C* analysis:

A) The primary capital cost of the project is the dredging cost. The dredging cost will depend not only on the cubic area to be dredged, but also on the characteristics of the bottom soil, the wave regime in the area, and the mobilization cost of the dredging equipment.
B) In the example, only investments in the port necessary to affect the required results are taken. If other non-port investments had been needed, such as railroad connections between the port and the hinterland, it should be studied separately since other benefits and costs will also arise due to this,
C) It is also assumed that without this port deepening project, the favorable consequences that is the lowering of the unit transport cost could not have taken place.
D) If the market enlargement can be managed, under the conditions of the proposed project, this would be significant. The market enlargement could occur due to the lower transport cost, thus lowering the export price. On this case the project can be evaluated under this forecasting.
E) The ports which Port A is in trade with should be investigated so that whether they are available to accommodate 35,000DWT ships.
F) The two parameters which affect the acceptability of the project are the interest rate and cargo throughput.

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EKONOMSKA PROCJENA ULAGANJA U LUKU

Sažetak

Generalnim planom je utvrđena dugoročna lučka strategija koja će utjecati na buduće kretanje prometa u kojem se luka koristi. Ta kretanja mogu unaprijediti postojeće prometne veze ili izgraditi nove. Bilo koja druga vrsta djelatnosti koja ima svrhu povećati intenzitet korištenja luke također se može ubrojiti u djelatnosti za razvoj luke. To se može odnositi i na pravno i reorganizacijsko područje.
U svakom slučaju, o ekonomskoj procjeni ulaganja u razvitak luke treba voditi računa prije poduzimanja bilo kakve aktivnosti. To predstavlja postupak donošenja odluka u kojem se preispituje profitabilnost novog ulaganja. Procjena takvoga projekta lučkog razvoja zahtijeva nizanje rashoda i prihoda tijekom cijeloga korisnog trajanja projekta. Glavni rashodi u projektu lučkoga razvoja su troškovi izgradnje i održavanja, a prihodi uglavnom nastaju iz ušteda na prijevoznim troškovima i kraćem vremenu obrtanja. Temeljna je značajka tih rashoda i prihoda da se prenose na ostale sudionike u poslu, a ne na lučku upravu. Postoji nekoliko metoda za procjenu ulaganja kojima se rashodi i prihodi dovode na mjeru na kojoj se mogu objektivno i prikladno uspoređivati.
U ovome se radu razmatra procjena projekta za produbljivanje luke temeljem metode prihoda i rashoda. Do rashoda i prihoda takvoga projekta doći ćemo na primjeru koji pokazuje kako dubina luke utječe na jediničnu cijenu prijevoznih troškova.

Ključne riječi: razvoj luke, čišćenje, dobit/cijena, dubina luke

VALUTAZIONE ECONOMICA DEGLI INVESTIMENTI PORTUALI

Sommario

Il piano generale o macroprogetto fissa la strategia di sviluppo a lungo termine del porto con effetti decisivi per il futuro dei suoi livelli di traffico. Lo sviluppo può comprendere il miglioramento delle attrezzature esistenti oppure la costruzione di impianti nuovi. Ogni altro tipo di attività intrapresa per incrementare l'uso intensivo del porto può venir inteso come sviluppo portuale. Queste attività possono riferirsi sia al campo legislativo che a quello organizzativo.
In ogni caso una valutazione economica degli investimenti per lo sviluppo portuale si rende necessaria prima di intraprendere qualsiasi attività. Ciò comporta un processo decisionale in cui si esamina e discute le possibilità di profitto. La valutazione di un progetto di sviluppo portuale deve prevedere la successione di costi e ricavi includendo tutta la durata utile del progetto. I costi maggiori del progetto di sviluppo portuale riguardano i costi di costruzione e i costi di manutenzione, mentre gli utili derivano principalmente dai risparmi sui costi di trasporto e dalla riduzione dei tempi di rotazione. La fondamentale caratteristica dei costi ed utili è che questi vengono ripartiti tra i partecipanti al trasporto, a cui non partecipa l'amministrazione portuale. La questione di ripartizione di costi e ricavi, dove questi possono venir equamente e convenientemente comparati, può venir affrontata con diversi metodi di valutazione.
Nel saggio si tratta il progetto di dragaggio del porto in base al metodo di costi/ricavi. I costi e i ricavi di tale progetto vengono individuati dimostrando quanto il fondale del porto possa incidere sul prezzo unitario del costo di trasporto.

Parole chiave: sviluppo portuale, dragaggio, ricavo/costo, fondale portuale