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Port performance indicators

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INTRODUCTION

(i) In response to the request by the Committee on Shipping at its third session for work on port statistics,[1] the UNCTAD secretariat prepared a manual on the subject.[2] The manual provided guidance for the establishment of better statistical processes. In addition to the above work, the study on berth throughput[3] included a chapter on port performance indicators.

(ii) The present report advises port authorities on the collection and the use of a set of performance indicators concerning both operational and financial aspects of port operation. The benefits associated with each indicator are discussed to aid in the selection of indicators for implementation. All indicators have been selected with a view to providing assistance to port management in medium-term planning and control.

(iii) In chapter I the reasons for using performance indicators are discussed. A set of performance indicators is proposed, and a discussion of how the indicators may be used to monitor performances is to be found in chapter II. Chapter III deals with a method of collection and presentation of port indicators, while chapter IV discusses the costs and benefits of such an exercise. Finally, the application of the indicators in a case-study port for a group of break-bulk general cargo berths is illustrated.

(iv) The UNCTAD secretariat wishes to thank the port authorities which co-operated in this study by furnishing information. In particular the secretariat would like to express its appreciation to the Port of Piraeus Authority for allowing the Port of Piraeus to be used for the purposes of a case-study.

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[1] See *Official Records of the Trade and Development Board, Ninth Session, Supplement No. 3* (TD/B/240), annex I, resolution 6 (III).

[2] *Port statistics: selection, collection and presentation of port information and statistics* (United Nations publication, Sales No. E.72.II.D.1).

[3] *Berth throughput: systematic methods for improving general cargo operations* (United Nations publication, Sales No. E.74.II.D.1), part one, chap. VII.

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Chapter I

WHY CALCULATE PORT PERFORMANCE INDICATORS?

1. Of the various reasons for collecting data relating to ports,[4] two are of primary concern to port authorities: first, the data can be used for improving port operations, and secondly, they can provide an appropriate basis for planning future port development. The UNCTAD manual on port statistics discussed the large amount of information available for collection in a port.[5] Basically, the statistical system must provide data on port facilities and operations, while the accounting system must provide data on port costs and revenues, if analysis of the port's performance is to take place. One form of analysis is the creation of a set of performance indicators.

2. Port performance indicators are simply measures of various aspects of the port's operation. To fulfil their purpose, such indicators should be easy to calculate and simple to understand. They should provide insight to port management into the operation of key areas. They can be used, first, to compare performance with a target and secondly, to observe the trend in performance levels. For example, the productivity for handling general cargo for the first month might be 15 tons per gang-hour. If successive monthly figures showed a decline from this value, clearly action to determine the reason for the decline and to remedy it would be called for. The indicators can also be used as input for negotiations on port congestion surcharges, port development, port tariff considerations and investment decisions.

3. The major purpose for collecting information to maintain performance indicators is to provide management information for planning and control. D. R. Daniel, in a paper on management information, has stressed that:

> The key to the development of a dynamic and usable system of management information is to move beyond the limits of classical accounting reports and to conceive of information as it relates to two vital elements of the management process-planning and control.[6]

The purpose of planning is to pre-determine a course of action and the purpose of control is to ensure progress towards the objectives defined in the plan.

4. A port authority with the over-all responsibility for the smooth functioning of the port is the logical correct organization to maintain a set of performance indicators. Such an authority is confronted with an extremely large volume of data and its response may be either to collect too little data or to collect masses of data which are never analysed. All information should be collected with a clear purpose in mind and not merely so that it may be available for some future as yet undefined analysis.

5. A set of indicators should exist for each category of cargo since the port provides different facilities according to the way cargo is handled. The following is suggested as a set of cargo categories;

Break-bulk general (or conventional) cargo
Unitized cargo
Liquid bulk
Dry bulk (ore, grain, cement, fertilizer)

A port handling a significant number of passengers may need to keep a set of indicators relating to passengers also.

6. The following factors make it attractive – indeed, necessary – for port management to plan:

(a) *Changing conditions:* As new trade develops, port labour working rules alter, shipping lines change, and cargo-handling technology changes, the priorities a port assigns to its various areas are likely also to change. This makes it necessary to build a framework within which such changes can be measured and so managed in an orderly and consistent fashion. For example, technological change in shipping and cargo handling is at present occurring so rapidly that regular reviews of replacement and improvement options should be held in order to identify significant shifts in cost/performance relationships and to develop contingency plans to handle them. Early recognition of changes calling for major port development is critical as the timelag between recognition of the need for a capital work and its completion is long, sometimes as much as three years or more.

(b) *Scarcity of management personnel:* The scarcity of trained, perceptive middle management personnel tends to be a characteristic of ports in developing countries. The development of performance standards, the establishment of reporting systems and the standardizing of methods for the collection and analysis of information can mitigate the problems created by this deficiency.

(c) *Scarcity of capital resources:* Port development is only one of many strategic investment opportunities for a country, and capital invested in it is obtained only at the expense of other areas. Justifying investment funds from these restricted resources necessitates adequate information for the development of long-range plans.

7. Although ports have little control over the level of demand for their services, they should nevertheless attempt

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[4] See *Port statistics. . . (op. cit.)*, chap. I.

[5] *Ibid.*, chap. III.

[6] D. R. Daniel, "Management information crisis", *Harvard Business Review* (Boston), vol. 39, No. 5 (September-October 1961), p. 113.

to control the response of the port of that demand. Control is being exercised when operations of the enterprise follow the guidelines in the plans adopted, are held within limits of tolerance in the face of varying conditions, or are returned to an acceptable state after deviations are located. Merely discovering out-of-line conditions, or securing detailed information about a situation, does not achieve control. Control is exercised by taking action, and action can be taken only by those having the appropriate information and the necessary authority.

8. Control of a process or an operation is possible only if there is some form of feedback of performance or results. Feedback involves the measuring of the actual output and comparing it with the desired output to determine what course of action to take. Figure 1 illustrates a system without feedback where the indicator is gang productivity measures in tons per hour. The target output is normally pre-determined by studies. In this example, feedback occurs only when actual productivity is so poor that management becomes aware of difficulties because of complaints from users. Figure 2, on the other hand, illustrates the system with a feedback loop. Here management may practise control by, for example, taking steps to identify the part of the operation that is holding down productivity to only y tons/hour, and then taking steps to improve this.

9. Control is the complement of planning and neither element is useful without the other. The fundamental step in control is the measurement of deviation from goals and standards which have been set during the planning activity. Thus the selection and the maintenance of indicators is a necessary step for ports to obtain effective control. If, in maintaining a set of performance values the port establishes the practice of using feedback, it will be exercising control. In addition, such a set of indicators will allow management to make improved utilization of resources by highlighting problem areas and thus improve service to port users and reduce unit costs. The following additional benefits might be derived from the proper use of a set of indicators:

(a) The highlighting of the start and the cause of a congestion period;

(b) The negotiation of a reduction in a port congestion surcharge as a result of monitoring and documenting port performance;

(c) The timely adjustment of port tariffs;

(d) The provision of a sound information base for port planning, and justification for capital development.

FIGURE 1

Open loop control system

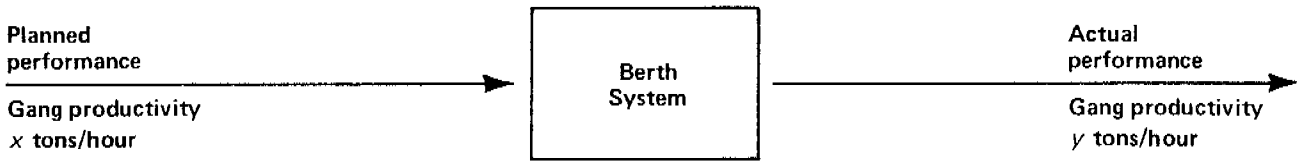
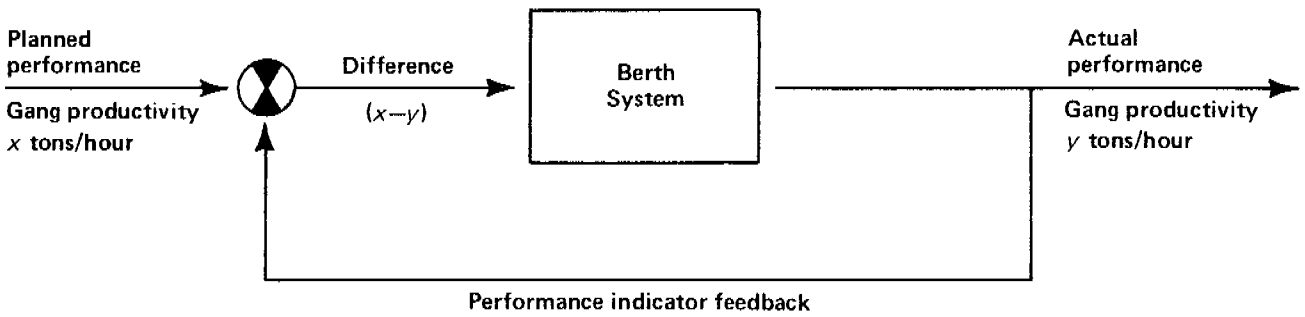


FIGURE 2

Closed loop control system



Chapter II

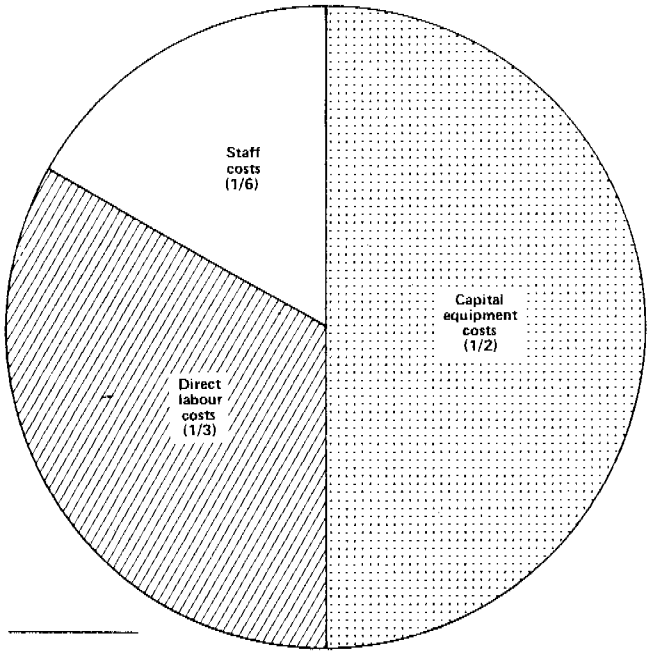
THE MOST IMPORTANT INDICATORS

A. Financial indicators

10. A port authority should be aware of the costs generated by its operations and the revenue resulting from these operations. The bulk of this information must come from the accounting system. The trend, even in countries where ports are not treated as autonomous bodies within the national economy, is towards making them increasingly financially viable. Sound financial information is a prerequisite to a sound port tariff system.

FIGURE 3

Expenditure breakdown for typical break-bulk berth in developing country*



Source: Based on information collected by the UNCTAD secretariat.

* Cf. *Unitization of cargo: Report by the secretariat of UNCTAD* (United Nations publication, Sales No. E.72.II.D.2), pp. 129-130, which imply the following breakdown of total costs: staff, 14 per cent, direct labour, 35 per cent; capital equipment, 51 per cent.

11. The UNCTAD secretariat report on port pricing discussed methods for converting capital expenditure into a flow of annual capital costs.[7] Capital costs for port facilities and equipment form the bulk of the fixed costs of a port. In turn, these fixed costs are normally a large portion of the total port expenditure. Figure 3 illustrates the approximate breakdown of costs for a typical break-bulk berth in a developing country. An important consideration is how fixed costs are to be allocated when selecting financial indicators. Since a large portion of fixed costs are associated with capital costs and since these costs are associated with a particular port area, the basis for their allocation is that which best represents the capacity for that area. For break-bulk general cargo berths, the most suitable basis is the quantity of cargo handled.

12. The remaining general overheads not allocated, for example supervision, staff facilities, utilities, etc., can only be allocated to the various cargo-handling areas of the port on an arbitrary basis. Thus it is recommended for control purposes that such costs are not allocated. Therefore each area will make a contribution (the difference between revenue and direct costs) which will cover overhead costs, return on investment and profit for the port. It should be remembered that although fixed overhead rates are important for costing and long-run pricing, such rates have limited significance for control purposes.[8]

13. Within each cargo class there are various commodities, various types of packaging and various types of operations.[9] The case is often made for maintaining productivity (tons/gang-hour) and cost figures for each combination. However, experience shows that the maintenance of these detailed productivity and cost figures entails the collection of a large volume of accurate and precise information – a task beyond the means of most ports.

14. For effective day-to-day control of the operations, the port must depend on an on-the-port manager who, by physical observation, obtains continuous feedback which allows him to resolve difficulties when they occur, rather than attempting to record the fact.[10] Nevertheless, the need exists to give management quantitative information concerning the productivity and cost/revenue performance of the various areas of the port. The maintenance of a set of performance figures for each category of cargo, as defined in paragraph 5 above, is suggested as a viable solution.

15. For the purpose of this study only the costs and revenue associated with the transfer of cargo to or from

[7] *Port pricing: Report by the UNCTAD secretariat* (United Nations publication, Sales No. E.75.II.D.7), annex V.

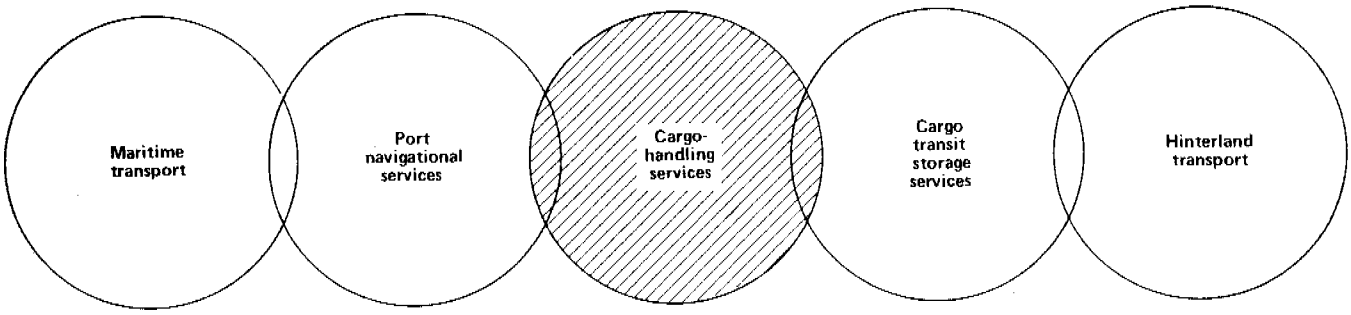
[8] See C. T. Horngren, *Cost Accounting: A Managerial Emphasis* (3rd ed., (Englewood Cliffs (New Jersey), Prentice-Hall International Inc., 1972), p. 277.

[9] For example, the various modes of transfer from the ship for import cargo; directly to hinterland surface transport, through port storage or through lighters.

[10] The need for an on-the-spot supervisor to co-ordinate the operation is noted in *Berth throughput . . . (op. cit.)*, part one, para. 162, 2 *(d)* and *(e)*.

FIGURE 4

Functional areas of the transport chain as seen by port management



Portion of chain (transfer of cargo to or from vessels) covered by port performance indicators.

ships are taken into account in the calculation of the various indicators (see figure 4). Thus cost and revenue generated from the transit storage and warehousing function and from the delivery and receipt of cargo via these storage areas are excluded. This decision is based on the fact that cargo handling to or from vessels takes place during a well-defined period of time, namely, when the ship is at berth, while for the same ship the delivery of discharged cargo from storage areas within the port can extend over a period of months. Thus a separate group of indicators should be developed for the transit storage and warehousing areas that are not linked to the particular ship call.

16. The port area should be divided into berth groups which are areas or sub-areas, each handling a different cargo class.[11] The primary financial indicator for each berth group is the contribution per ton of cargo handled over a specified time period. To arrive at this indicator, the costs and revenues produced at the berth group are first calculated to indicate the portion of each element to the contribution. The elements to be considered for each berth group are:

(a) Ship revenue related to the berth group;

(b) Cargo revenue related to the cargo handling; services of the berth group;

(c) Labour costs;

(d) Capital equipment costs.[12]

The ship revenue may come from berth occupancy charges or port dues. Normally, only a portion of the revenue from port dues is set aside to help cover the costs associated with the cargo-handling service. The assumption is made in the remainder of this report that this ship revenue comes from berth occupancy charges. The cargo revenue may originate from charges for the cargo-handling operation from ship to storage area and vice-versa. Port authorities may also charge dues to help cover the cost of this operation. In addition, they may contract private firms to handle one phase of the cargo-handling operation. In this case, only the costs and revenues flowing between the authority and the private firms should be considered when calculating the indicators, but the authority should nevertheless be aware of the charges made by the private firms. This report assumes that cargo revenue originates from charges made for the cargo-handling operation which is entirely the responsibility of the authority.

17. Figure 5 illustrates a format for monthly presentation. A negative contribution may not necessarily be a bad thing provided it has arisen as the result of a policy decision to allow other local or national economic interest to benefit from a port subsidy. If the policy of the port is to operate as a profit centre, the rate of return may be determined on the total capital employed in the port.[13] Such a measure is perhaps the best single indicator of the financial success of the employment of capital. However, as most ports are justified not on a micro-economic level but only on a macro-economic level, the use of the rate of return indicator is not proposed.

18. An extremely important indicator, both operationally and financially, is the monthly volume of the cargo worked. If, for example, the port charges for cargo handling are based on tons of cargo worked, management must be made aware of the variance between the budgeted and the actual quantity handled. This difference is an indication of the likely revenue variation. With volume variances, ship traffic and cargo projections can be re-

[11] For example, a port with 12 berths handling general cargo and 3 berths handling dry bulk could be divided into 2 general cargo berth groups of 6 berths each and a dry bulk berth group.

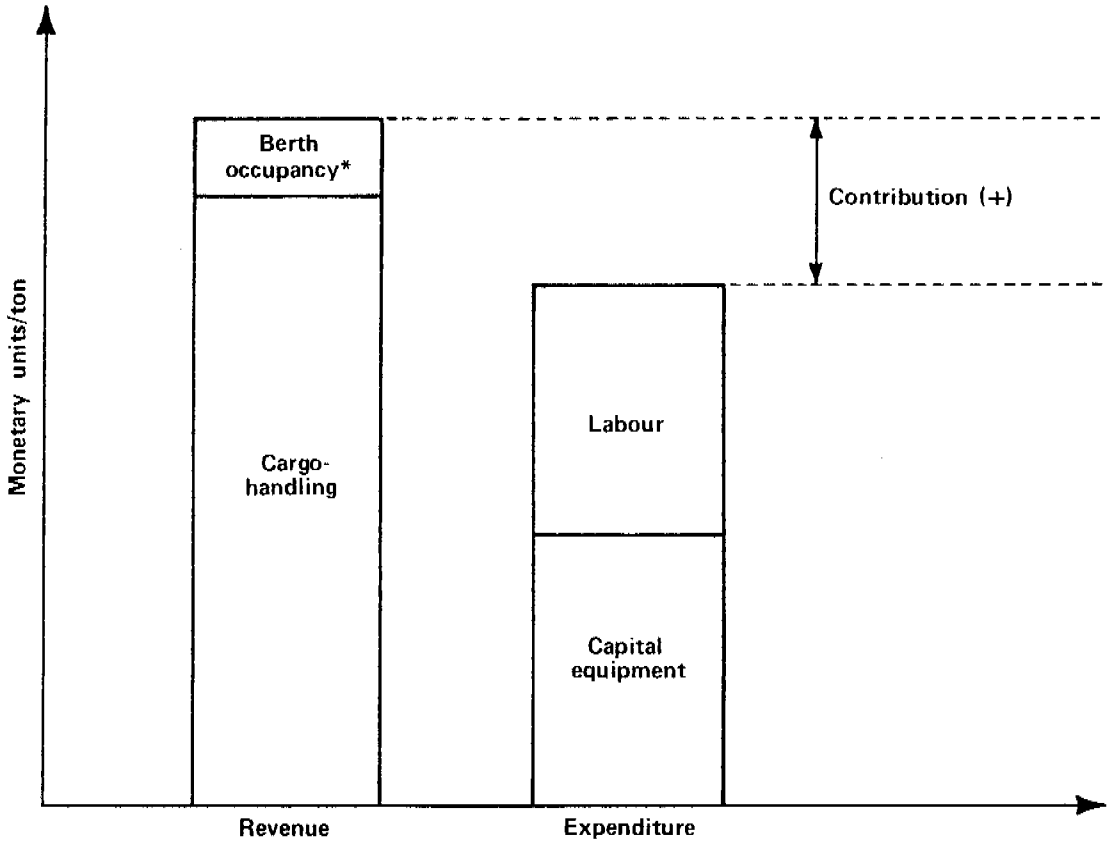
[12] Including amortization, maintenance and operating costs. The variable cost portion should be recorded on a monthly basis. The whole of the berth group's direct fixed expenses, which by definition is a constant quantity incurred during a period of time, is allocated to the quantity worked in that period, since the revenue produced by handling the cargo must be used to recover expenses. The costs should not be allocated to individual berths.

[13] The formula for calculating return on investment is as follows:

$$\text{Return} = \frac{\text{Gross revenue} - (\text{working expenses} + \text{staff and misc. charges} + \text{capital charges})}{\text{Working capital} + \text{present value of assets}} \times 100$$

FIGURE 5

Suggested presentation of monthly financial indicators for a berth group



* Revenue produced from tariff charged for the use of the quay alongside which the vessel is moored.

estimated and used to determine the course of action the port should follow. Possible alternatives to improve cash flow when the quantity of cargo handled is lower than expected are:

(a) Port maketing promotions to increase traffic and thus revenue;

(b) Increase in tariff to increase revenue;[14]

(c) Measures to increase productivity and thus decrease the variable cost per ton;

(d) Re-adjustment of deferable budgeted expenditure.

19. The following indicators should be calculated each month for the ships sailing from each berth group;

(a) *Total tonnage worked;*

(b) *Berth occupancy revenue per ton of cargo:* total berth occupancy revenue produced, divided by tonnage worked;

(c) *Cargo handling revenue per ton of cargo:* total revenue produced from transferring cargo to or from ships, from or to storage areas,[15] divided by tonnage worked;

(d) *Labour expenditure per ton of cargo:* total direct labour expenditure for transfer of cargo to or from ships, from or to storage areas, divided by tonnage worked;

(e) *Capital equipment expenditure per ton of cargo:* total amortization and interest allocated to and maintenance and operating costs incurred for the berth group, excluding the costs of transit sheds and warehouses, divided by tonnage worked;

(f) *Total contribution:* berth occupancy and cargo handling revenues minus labour and capital equipment expenditure;

(g) *Contribution per ton of cargo:* total contribution divided by tonnage worked.

20. The financial indicators proposed answer the following two questions:

(1) What revenue is produced from a service?

(2) What is the cost of the service?

With the development of these financial indicators, port management personnel would be supplied with the information necessary for them to take steps to achieve financial viability. If financial criteria for performance are removed, a significant incentive to efficiency also goes. In addition, financial viability criteria are often important when the port has to negotiate loans.

[14] The success of such a policy is dependent on the increased tariff not significantly affecting the volume of cargo.

[15] If cargo is being sent on direct, any revenue from discharge or loading of hinterland transport should be included.

B. Operational indicators

21. Perhaps of more direct concern to port management than financial indicators are operational ones. If port charges have been well thought out and actual traffic follows the projected figures, then through the control of the operational performance, management will control the financial performance of the port as well. Operational indicators have been discussed in other publications.[16] The indicators presented are not exhaustive but it is felt they are the most important ones for port management initially to select for medium-term planning and control.

22. Important information to maintain is the number of ship arrivals and a breakdown of the ships' time in port for each class of cargo. These data are of prime concern to the ship owners and operators for the setting of freight rates and thus of direct concern to shippers and consignees who must pay the freight rate. Perhaps the most complicated and intricate problem existing in the transport field today is the turn-round of ships in ports.[17] An excellent indicator to maintain of port effectiveness is the quantity of cargo worked per ship hour in port[18] with a high figure being desirable. To maintain this indicator, information on the arrival time, departure time and tons loaded/discharged for each ship must be recorded. In addition, the time of berthing, ship length and location of berthing should be noted. The various ship times must be accurately defined and then consistently recorded. In addition to the above information, data on the total hours at berth during which the ship was worked and on the total gross gang-hours worked[19] should be recorded, to permit measurement of the intensity of working.

23. From these records, the following averages can be calculated on a monthly basis[20] for each berth group servicing a cargo class:

(a) *Arrival rate:* number of ships arriving during a month, divided by number of days in the month;

(b) *Waiting time:* total time between arrival and berthing for all berthing ships, divided by number of berthing ships;[21]

(c) *Service time:* total time between berthing and departure for all ships, divided by number of ships;

(d) *Turn-round time:* total time between arrival and departure for all ships, divided by number of ships;

(e) *Tonnage per ship:* total tonnage worked for all ships, divided by number of ships;

(f) *Fraction of time berthed ships worked:* total time that berthed ships were actually worked, for all ships, divided by the total time between berthing and departure of all ships;

(g) *Number of gangs employed per ship per shift:* total gross gang time, divided by total time that berthed ships were actually worked;

(h) *Tons per ship hour in port:* total tonnage worked, divided by total time between arrival and departure;

(i) *Tons per ship hour at berth:* total tonnage worked, divided by total time between berthing and departure;

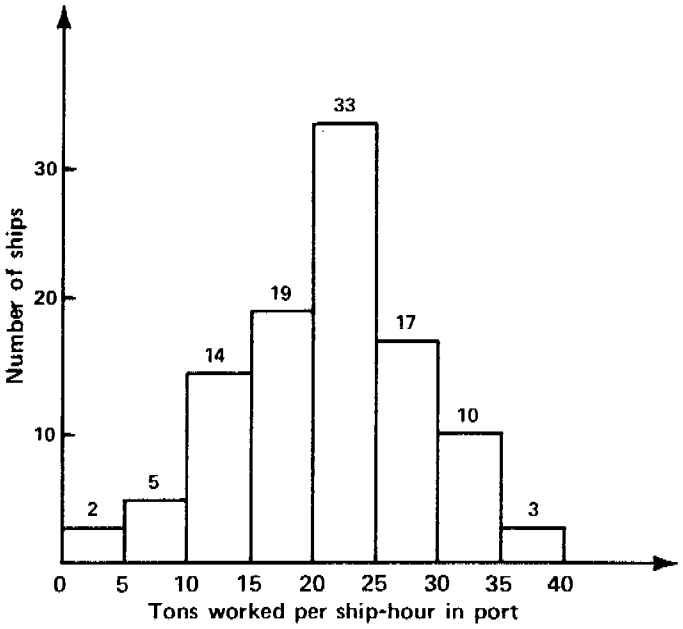
(j) *Tons per gang-hour:* total tonnage worked, divided by total gross gang time;

(k) *Fraction of time gangs idle:* total idle gang time, divided by total gross gang time.

FIGURE 6

Sample port performance chart showing frequency distribution of tons worked per ship-hour in port

Berth group : General cargo
Period : February 1975
Av. tons/hr. : 22.5 tons/hr. (21.5 tons/hr. previous period)
Number of ships : 103



24. In addition to the calculation of the above average figures, it is suggested that certains indicators be calculated on an individual ship-call basis and plotted as a frequency distribution. Figure 6 illustrates such a distribution for the tons per ship-hour in port.

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[16] *Berth throughput . . . (op. cit.)*, part one, chap. VII; Economic Commission for Asia and the Far East, "Collection of port operational statistics on a uniform basis" (E/CN.11/TRANS/Sub.3(X)/L.2) (mimeographed document of 28 August 1973); K. J. Chacko, "Statistical control of port operations", *Indian Ports* (New Delhi), vol. IV, No. 3 (February 1972), p. 131.

[17] *The turn-around time of ships in port* (United Nations publication, Sales No. E.67.VIII.5).

[18] See C. H. Plumlee, *Port Performance Index, Fifth Interim Report* (Port Hueneme (California), Public Works Consultants, 1975).

[19] A breakdown of gross gang-hours into idle gang-hours and gang-hours actually worked should also be recorded.

[20] For the ships departing within the period, unless otherwise noted in the definition for the indicator. Thus indicator *(a)* is calculated for all the ships that arrive at, indicator *(b)* for all the ships that berth at, and the remaining indicators for the ships that sail from the berth group during the month.

[21] Although this indicator, which is defined as the difference between arrival time and berthing time, is meant to measure the degree of congestion in the port, ports having a long entrance channel will naturally have a higher figure than ports without.

25. One aspect of port operation that management should carefully monitor and take steps to correct when unfavourable trends appear, is the productivity per gang. The maintenance of the tons per gang-hour indicator will supply the index for monitoring this important phase of port operation. The actual figures could also be compared with standards established by the application of such methods as work study.[22] Action should follow if values are outside an established range, to determine the reasons for this variation, and steps should be taken to correct the deviation.

26. The indicators that have been proposed are summarized in tables 1 and 2. These indicators allow port managers to measure, first, the quality of the service their ports supply and secondly, the demand for these port services. The fact that an indicator does not vary over time does not mean that the performance measured by that indicator is necessarily good. It may be consistently bad! Thus the need exists to establish standards or norms.

27. The decision regarding which indicators to maintain depends on the port authorities' particular requirements. Ports which do not have sufficient strength in their statistical sections to deal with the collection of the data and calculation of the chosen indicators should review the pruposes and benefits of other information collected by these sections. In addition, the accounting systems should differentiate between the various berth groups, to allow cost and revenue data to be collected easily. The following chapter proposes a manual system for the collection of the data necessary for the calculation of the indicators.

[22] An application of controlling operations by the comparison of actual productivity with standards is given in a paper by J. C. Telfer, "The control of cargo handling costs", *National Ports Council Bulletin* (London) 1972, No. 3, p. 32.

TABLE 1

Summary of financial indicators*

Indicators	*Units*
Tonnage worked	Tons
Berth occupancy revenue per ton of cargo	Monetary units/ton
Cargo-handling revenue per ton of cargo	Monetary units/ton
Labour expenditure per ton of cargo	Monetary units/ton
Capital equipment expenditure per ton of cargo	Monetary units/ton
Contribution per ton of cargo	Monetary units/ton
Total contribution	Monetary units

* Calculated monthly for each berth group servicing a cargo class.

TABLE 2

Summary of operational indicators*

Indicator	*Units*
Arrival late	Ships/day
Waiting time	Hours/ship
Service time	Hours/ship
Turn-round time	Hours/ship
Tonnage per ship	Tons/ship
Fraction of time berthed ships worked	–
Number of gangs employed per ship per shift	Gangs
Tons per ship-hour in port	Tons/hour
Tons per ship hour at berth	Tons/hour
Tons per gang-hour	Tons/gang-hour
Fraction of time gangs idle	–

* Calculated monthly for each berth group servicing a cargo class.

Chapter III

COLLECTING THE DATA

28. In the previous chapter a number of performance indicators to assist port management in the planning and controlling of port operations were described. In this chapter, a method for the collection of the necessary information to permit the calculation of these indicators will be discussed.

29. An integral part of the method is a set of interrelated files or registers. These files and their interrelationship are shown in figure 7. This chapter illustrates the layout of each entry or record in the file and discusses the use of the files to calculate the indicators for the general cargo break-bulk operation from ship to storage area or vice versa.

Berth facilities file

30. This file contains information on the physical characteristics, the capital costs and the amortization periods for the various berthing locations in the port. The file is static, with changes occurring only when new berthing facilities are added or old facilities taken out of service. A model of the information necessary to establish this file is shown in table 3. The development of a berth facility code system[23] will allow the file to be maintained

[23] For example 0101, where the first two digits refer to berth number 1 and the next two digits to the quay wall facility.

FIGURE 7

Main port management information files and their interrelationship

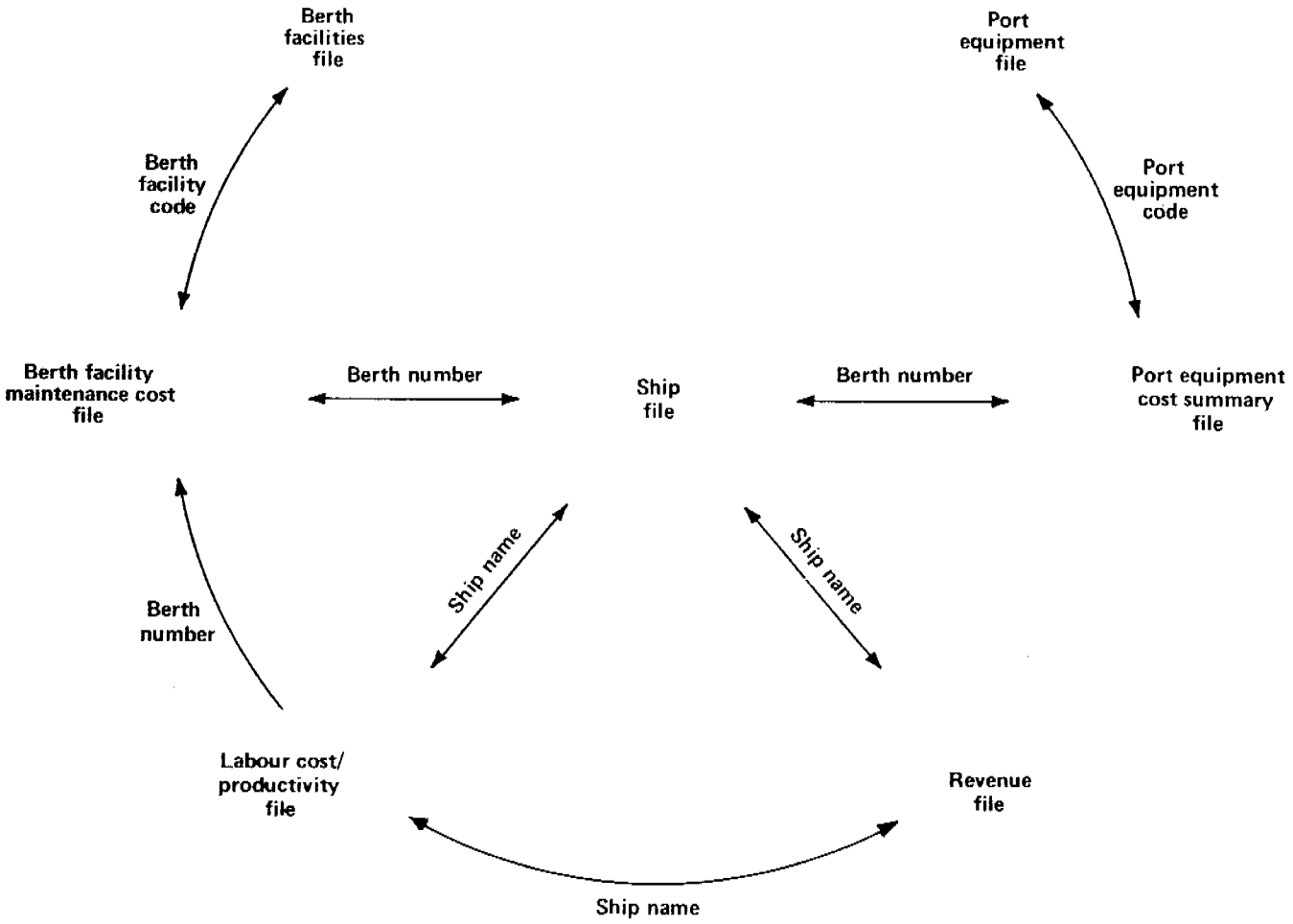

TABLE 3

Berthing facilities showing example of infomation required for one berth

Berth group: _____ *Berth number:* _____

Facility code	*Facility*	*Length(m)*	*Draught(m)*	*Area(m^2)*	*Date in service*	*Amortization period (years)*	*Capital cost (thousands of dollars)*
0101*	Quay	160	20	–	1970	40	1 280
0102	Surfaced open area	–	–	19000	1970	40	190
0103	Transit shed		–	10000	1970	30	400
0104	Other facilities						

* First 01:berth number; second 01:quay.

in code sequence. Such a coding system should be recorded on port plans or maps and also be consistent with the accounting codes used in the port.

Port equipment file

31. Information on the technical characteristics, date in service, expected life, purchase cost, current replacement cost and delivery time of major port equipment, is contained in this file. Again, a port equipment code should be developed.[24] It is suggested that this code be marked on the various pieces of equipment for ease of identification. This file is also static, with modifications being required only when equipment is added or taken out of service, and when replacement costs or delivery times change. Table 4 shows a model layout for the information and also suggests the various equipment classes.

Berth facility maintenance cost file

32. This file contains information on all maintenance costs incurred by the particular berth facility. A separate sheet can be kept for each berth. Thus all facilities for one berth are recorded on the same sheet. The description notes the specific berth asset maintained. The duration of the maintenance can be noted for utilization calculations. Table 5 illustrates a model format of this file.

Port equipment cost summary file

33. Each week, information from the department responsible for equipment maintenance plus information on operating cost is used to update the cost summary file. This file contains weekly figures on the equipment, the running cost and the maintenance cost allocated to each berth group. If the level of detail is too great for recording costs of individual pieces of equipment, the cost figures can be grouped by major equipment type. A suggested layout for this file is illustrated in table 6. The cost information is used for calculating capital equipment charges.

Labour cost/productivity file

34. The labour cost/productivity file is the file for recording how efficiently port labour is being used. As port labour is the main variable cost item in the port, effective control of this element will make a major contribution to

[24] For example, a four-digit code with the first digit specifying the equipment class and the remaining digits an identification number.

TABLE 4

Port equipment file showing some equipment classes

*Port equipment code**	*Port equipment*	*Technical characteristics*	*Main service area*	*Date in service*	*Average lifetime*	*Purchase price*	*Replacement cost*	*Delivery time*
1...	Quay crane							
2...	Mobile crane							
3...	Floating crane							
4...	Forklift							
5...	Truck							
6...	Trailer							
7...	Straddle carrier							
8...	Lighter							
9...	Tug							

* Four-digit code (see foot-note 24 above).

TABLE 5

Berth facility maintenance cost file

Berth group: _____ *Berth number:* _____

Date	*Facility code*	*Description of maintenance*	*Duration*	*Cost*

TABLE 6

Port equipment cost summary file

Berth group: _____ *Month:* _____

Port equipment code	*Week*	*Running cost*	*Maintenance cost*

the financial performance of the port. A model format of this file is shown in table 7. Each record of the file summarizes one shift of working. Multiple hatches may be worked by the gang during the shift, as such flexibility may reduce ship turn-round time or cargo-handling costs. The columns for tonnage worked, gross hours worked, labour cost and idle hours should be totalled for entry into the ship file.

Ship file

35. This file contains all the information necessary for the calculation of the operational indicators. A suggested format for this file is shown in table 8. Rather than assign a sequential number to each ship call, as is required with a mechanized system, it is suggested that a ship call be identified by its name and arrival date. If possible, the conference to which the ship belongs should also be recorded, since this information is important when analysing ship turn-round time in relation to congestion surcharges. The ship dimension or size recorded is the basic unit on which berth occupancy charges are calculated. The sum of the delays between the arrival and berthing and between any deberthing and subsequent reberthing of the ship is recorded as the berthing delay. The sum of the times between berthing and deberthing of the ship – the total time at berth – is recorded as the berth time. The sum of the berthing delay and the berth time is defined as the turn-round time of the ship for that berth group. If the ship sails to another berth group or waits in the port basin for sailing instructions, the total time in port will be greater than the above berth group turn-round time. A precise definition of the times used to calculate these intervals must be made to ensure the consistency of the data recorded. The following definitions are suggested:

(a) Arrival time: time the ship requests, and is ready to proceed immediately to, a berth;

(b) Berthing time: time the ship arrives in a position to prevent the use of the berth by another ship;

(c) Deberthing time: time the ship sails from the berth.

36. A code for the reason for the berthing delay should also be noted. The following might be used:

01 : Waiting for berth
02 : Waiting for pilot
03 : Waiting for tugs
04 : Waiting for export cargo to arrive in the port
05 : Other

TABLE 7

Labour cost/productivity file

Berth group: _____ *Ship name:* _____ *Berthing date:* _____

Day	*Berth No.*	*Shift*	*Hatches worked*	*Foreman code*	*Gang size*	*Tons worked*[a]	*Gross gang-hours worked*		*Labour cost*		*Idle gang-hours*	*Idle time code*	*Gang performance (tons/ gang-hour)*[b]
							Regular	*Overtime*	*Regular*	*Overtime*			

[a] If desired, may be split into import and export tonnage.

[b] Tons worked, divided by the remainder of gross hours worked minus idle hours.

TABLE 8

Ship file

Berth group: _____ *Month:* _____ *Year:* _____

Ship name	*Conference*	*Size*[a]	*Arrival time*	*Berthing delay*	*Berthing delay code*	*Berth time*	*Berth location*	*Tons worked*[b]	*Hours worked at berth*	*Gang-hours*		*Labour cost*
										gross	*idle*	

[a] Ship length if berthing dues are based on length of vessel, or tonnage if berth occupancy charges are based on tonnage.

[b] If desired may be split into import and export tonnage.

The berth location (or locations) is recorded to determine which berth facilities are used. Information on the total tons of cargo worked are recorded from the labour cost/productivity file. From this file also, the cumulative hours worked at berth,[25] and the cumulative gross gang-hours worked are recorded. These data measure the intensity of working on the ship. Information on total labour costs for the transfer of goods from ship to storage area or vice versa must be recorded. A shift report kept for the payment of wages should supply sufficient information to calculate this figure.

[25] The total interval during which cargo was worked from or to the ship, for example, if two gangs worked the first shift of eight hours and one gang worked the second shift of eight hours, the cumulative hours worked at berth for that day would be 16.

Revenue file

37. The last of the port management information files to be illustrated is the revenue file, which maintains a record

of the revenue obtained from each ship call. Table 9 illustrates the sources of revenue about which information is collected for the purpose of calculating the financial indicators for cargo-handling. The ship name and arrival date allow this file to be linked to the ship file. Other revenue sources are discussed in the UNCTAD port pricing study[26] in conjunction with a possible pricing system.

Use of files to calculate indicators

38. For a berth group the information from the berth facility and port equipment files can be used to determine the annual capital charges.[27] For the reasons given in paragraph 15 the cost (including the capital charges) of transit sheds, warehouses and open storage areas and the revenue from delivery and storage are excluded when calculating the indicators. As storage space is required to operate a port, part of the contribution from the cargo transfer operation could be allocated to cover the above costs. An estimate of the annual berth facility maintenance charges based on the berth facility maintenance cost file plus any special maintenance work scheduled can be used to project the annual maintenance charge. The sum of the above costs gives the capital equipment cost portion of the annual expenditure for the cargo handling operation of the berth group. This sum can then be distributed over the twelve months of the year.[28]

39. The variable costs involved in the berth group operation are composed mainly of labour costs and the operating and maintenance costs of handling equipment. From the ship file for all ships sailing in that month, the totals of these costs can be added to the monthly fixed cost for that month to give the total expenditure.

40. The revenues derived from the berth occupancy and cargo-handling operation for every ship sailing in the period, are summed to give the total monthly revenue. This sum, minus the monthly expenditure, gives the total contribution for the berth group. The total contribution and the individual sums are divided by the tonnage worked to give the financial indicators as defined in paragrah 19.

41. The ship file contains all the information necessary to calculate the operational indicators as defined in paragraph 23. Certain indicators may be calculated for each ship in addition to the average monthly figure. The indicators on turn-round time and tons per ship-hour in port are the primary measures of the service provided to shipowners and operators. The arrival rate and tonnage per ship quantify the demand for the port cargo handling services. The fraction of time berthed ships are worked and the number of gangs employed per ship per shift indicate the intensity of working. Finally, tons per ship hour at berth, tons per gang-hour and the fraction of time gangs are idle are measures of the efficiency of port working.

42. An example illustrating the methods of collecting the data and the presentation of the indicators are given in the annex for a group of break-bulk general cargo berths in the case-study port of Piraeus.

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[26] *Port pricing (op. cit.)*, table 9.

[27] Annual capital charges are given by the formula:

$Cfi/1 - (1 + i)^{-nf}$

where Cf = capital cost of facility f;

i = annual interest rate;

nf = amortization period in years for facility f.

[28] For example, assuming the cargo handled each month is approximately the same, allocate 1/12 of the annual cost to each month.

TABLE 9

Port revenue file for ship to transit storage operation and vice versa

Berth group: _____ *Month:* _____ *Year:* _____

Ship name	*Arrival time*	*Revenue from berth occupancy*	*Revenue from cargo handling*

Chapter IV

COSTS AND BENEFITS OF USING INDICATORS

Costs

43. An estimate of the time required to collect, record and analyse the information for the indicators was made, as this is the main cost item. Often in ports there is some form of shift work-sheet which records the following information:

(a) Shift
(b) Date
(c) Ship's name
(d) Berth number
(e) Manning
(f) Production
(g) Idle time
(h) Equipment used.

Often the prime purpose of such a sheet is to record information necessary for the payment of wages. However, these records, when complete and accurate, give most of the information necessary to complete the labour cost/productivity file which is the most active file. Table 10 illustrates a sample layout of such a shift work sheet.

44. Experience gained in the case-study port showed that the average time for the extraction of the necessary information from the shift work-sheet and recording on the labour cost/productivity file is approximately 5 minutes. The total time taken per month is thus dependent on the

TABLE 10

Sample layout of shift work-sheet

Berth group: _____ Ship name: _____

Shift: _____ Date: _____ Berth No.: _____

Personnel in gang:

Labour production:

Description of work	*Hatch No.*	*Time on*	*Time off*	*Quantity (tons)*

Idle time:

Reason for idle time	*Time work stopped*	*Time work restarted*	*Time lost*

Equipment use:

Equipment No.																
Actual hours used																

Entries certified correct: _____

* If gang moves to a different ship or berth during shift, this information should be recorded on labour production portion of sheet.

number of gang shifts worked for the berth group during this period. The next most active files are the ship and revenue files which have a record entered when a ship completes working and sails from the port. Other active files are the port equipment file and the berth facility maintenance cost file.

45. In addition to the time required to complete the above records, an allowance must be made to locate the forms, raise queries, complete missing information, etc. Once the records are complete and verified, the data must be summed and the performance indicators calculated.[29] Based on an average berth occupancy of 80 per cent with an average gang allocation of 3 gangs per ship and 2 shifts worked per day with a 6-day working week and an average of 10 ships per berth per month, it is estimated that one statistical clerk would be required for each group of four berth. This estimate is based on the availability of data inputs such as the shift work-sheet and experience gained in the case-study port. Thus a port with, for example, 8 berths handling 800,000 tons of cargo per year, would require an additional staff of 2 statistical clerks to maintain the indicators.

Benefits

46. It is difficult, if not impossible, to quantify the actual benefits to be achieved from the introduction of the performance indicators. Information on performance is necessary for control of operations and this control must permit an improvement of operations. The possible extent of the savings from improvements in operation for a typical medium-sized port is noted below for comparison with the resources required to maintain the indicators.

47. For example, an 8-berth general cargo port operating with 80 per cent berth occupancy that obtains a 5 per cent reduction of berth time because of improved operational control, could experience almost a 12 per cent reduction in total port time.[30] For the above example, this amounts to a saving to shipping companies of 270 ship-days per year. The reduced turn-round time may also reduce port surcharges, which would be a cost saving to shippers. In most cases, the charge for cargo-handling is made per ton of cargo; thus any reduction in the cost per ton of handling the cargo will directly benefit the port stevedoring operation. The monitoring of financial indicators will show if tariff changes are necessary. Recognition of the need for a change at an early stage can save the port authority paying interest charges on borrowed working capital. Further, the availability of financial information for various berth groups can speed the acquisition of loans for port development.

48. The above observations show that the possible return from investing in a set of performance indicators is substantial, and vastly exceeds the cost. Port authorities must ask themselves if they can afford not to take advantage of such opportunities. Initial steps to implement the indicators can be taken at a pilot group of berths.

49. Port authorities which attempt to develop and implement the proposed system of port performance indicators may seek the advice of the Shipping Division of UNCTAD which, through the generosity of the donor countries to the Ports Project Trust Fund, has certain resources available to assist ports in applying the results of its research. In the event that more substantial outside help were to be required, UNCTAD has a number of inter-regional advisers in shipping and ports who are available, upon request by Governments, to visit developing countries to discuss problems in the field of shipping and ports, to give advice and to help formulate requests for more long-term assistance.

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[29] The use of a calculating machine for computing totals and calculating ratios will reduce the chance for error and simplify this task considerably.

[30] See *Berth throughput . . . , (op. cit.)*, part one, annex, table. From this table, the expected queuing time to service time ratio for an 8-berth port operating with 80 per cent berth occupancy is 0.286. A 5 per cent reduction in service time gives a berth occupancy of 75 per cent, which results in a new ratio of 0.196. This is equivalent to an 11.7 per cent reduction in ship turn-round time, or a reduction of 270 ship-days per year.

ANNEX

Application of the indicators to the Port of Piraeus

I. Physical description and organizational set-up, of the port

A. INTRODUCTION

1. To test the feasibility of the suggested approach in a real life situation, an application of the performance indicators to a port in a developing country was undertaken. The port selected was the Port of Piraeus, the major port of Greece. The port has trade characteristics which are common to most developing country ports, for example, a large portion of the traffic is imported break-bulk general cargo.

B. MANAGEMENT ORGANIZATION

2. The port is administered by a legal entity of public interest, the Port of Piraeus Authority (P.P.A.) which is operated under the supervision of the Ministry of Merchant Marine. The P.P.A. is directed by a seven-member Board of Directors which is the supreme organ of direction and administers its property and decides on all matters outside the jurisdiction of the P.P.A.'s other organs. The P.P.A. services are supervised by the general manager who represents the P.P.A. before the state authorities, supervises the operation of the port and the development and maintenance of all machinery, buildings and installations.

3. At the berths each gang, both on the ship and on the quay, is supervised by a gang foreman. Work is carried out in two shifts from Monday-morning till Saturday night:

From 07.30 to 14.30 (actual working time 08.00 – 14.00)

From 14.30 to 21.30 (actual working time 15.00 – 21.00)[a]

The possibility of night work and work on Sundays and holidays exists. All shifts are worked without a break.

C. PHYSICAL DESCRIPTION

4. The Port of Piraeus can be physically divided into three areas, the main port, Hercules port and the annexes of the port (see figure I). The total length of the port's quays is 18,300 metres, of which 8,289 metres are in the main port with 4,609 metres for commercial traffic, 3,134 for passenger traffic and 550 metres for auxiliary purposes.

5. The section selected for study (see figure II) comprises a length of quay 560 metres long which is divided into four berths each 140 metres in length. Each berth has a shed associated with it, three of these being single-storey sheds and one having four floors. The quay aprons are 15 metres wide and only the berth with the four-storey shed has quay crane facilities. The depth alongside varies from 10 to 11.5 metres. The section was selected because general cargo was worked there and the size of the area was sufficiently small to facilitate data collection. The operation studied was the transfer of cargo from ships to storage area or vice versa, and all costs and revenue generated from the storage and delivery of cargo were excluded.

[a] The extra half-hour before and after working time if for gangs to prepare or put away mechanical equipment, etc.

FIGURE I

Main port of Piraeus

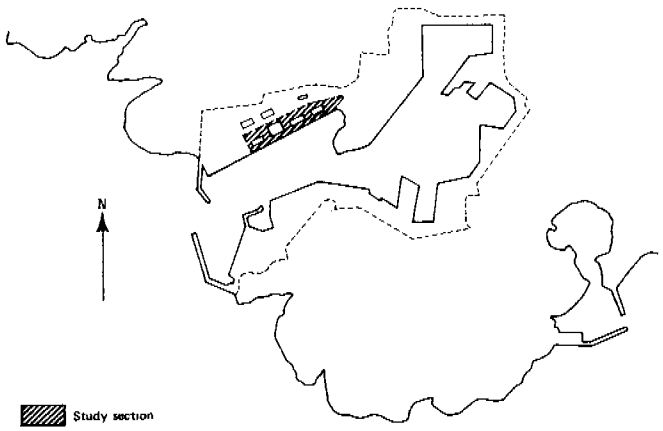
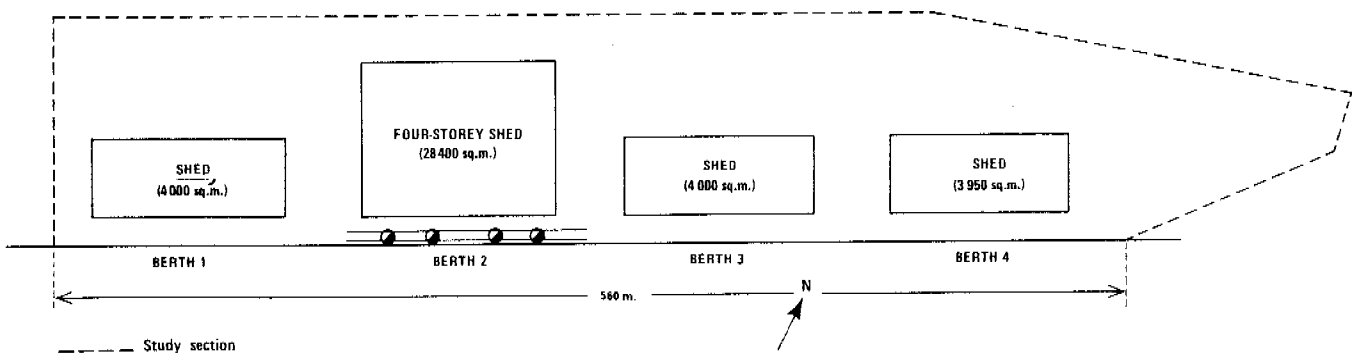


FIGURE II

Study section main port of Piraeus



D. RESPONSIBILITIES

6. The Port of Piraeus is responsible for:

(a) The construction and maintenance of harbour works, i.e., quays, storage sheds and buildings, dry docks, buildings and installations of the port, and also equipping them with all the necessary machinery and other means for their operation;

(b) The approach, anchorage and berthing of vessels and the assignment of points of loading/discharge of same;

(c) The loading/discharge, storage, safe-keeping and delivery of the goods imported and exported through the port;

(d) Services and facilities to vessels entering the port;

(e) Facilities to passengers moving through the port by sea;

(f) The general management, security and operation of the port, the right to impose dues and charges on vessels, goods and passengers for the use of the port, the right to draw up regulations governing all port work and the right to impose and enforce such regulations.

E. OPERATIONS

Operations before the vessel arrives at the berth

7. The ship's expected time of arrival is communicated by the agent to the Co-ordination Department along with the declared amount of tonnage to be worked. This information is used to allocate berths to the expected vessels. Berths 1-4 are used for foreign general cargo vessels. Pilotage is compulsory, with the exception of some smaller Greek ships which call frequently.

Operations on the berth

8. The ship's gangs work from the hold to the quay, under the supervision of the foreman. With the exception of berth 2, where electric shore cranes are used, all operations are carried out with ship's gear. Unhooking and transfer of cargo to the shed or open area (the so-called *"sotto palango"* operation) is carried out by the quay gangs under the supervision of a foreman. Delivery of goods from the place of storage to the consignee's transport is also carried out by P.P.A. personnel.

F. STORAGE FACILITIES

9. Approximately 65 per cent of the port's incoming traffic passes through the sheds. Of the remaining 35 per cent, 30 per cent is put into open areas and the remaining 5 per cent moves directly onto road vehicles. The rent for the first 8 days of storage within the port is included in the loading/discharge dues. A charge is made for the transfer of goods from the storage area to hinterland transport vehicles. From the ninth day, charges according to a sliding scale are levied per unit of 50 kg. per day. The average storage time of cargo in the sheds amounts to 30-60 days, about 20 per cent of the total port revenue being derived from storage dues. Thus the Port of Piraeus acts as a "storage port" rather than a "transit port".

II. Application of the performance indicators at the Port of Piraeus

A. SCOPE OF THE APPLICATION

10. The application of the performance indicators at Piraeus consisted of collecting information on the facilities and equipment used in the section under study, together with details of the ships and cargo worked[b] there during two months: January and June 1974. In addition, data on the labour used was collected.

B. DATA COLLECTION

11. The first step in the data collection exercise was to gather data on the berth facilities. This information was used later to calculate the capital equipment expenditure for the berth group. Table I illustrates the completed berthing facility file for berth 1. Individual maintenance records for the berth group were not available and an estimate of the cost was used. Information on the equipment used in the berth group was collected from the Engineering and Supply Departments. Table II summarizes these data and includes estimates of maintenance and operating costs. The sum of the total capital charges plus the maintenance and operating charges divided by the number of months in the year gives the monthly capital equipment expenditure used in the calculation of the financial indicators.

12. From a financial report prepared by the section for its operation in January 1974, an estimate of the mean cargo handling revenue per ton was made. The mean revenue per ton from ship to storage area or vice versa was assumed to be $4.33 per ton. Pension payments, which are 50 per cent of direct labour costs, were included as a portion of the labour costs when the financial indicators were calculated.

13. The remaining cost information necessary was synthesized from operational information and the appropriate rates and tariffs. Labour costs came from the labour cost/productivity file and information on berthing revenue from the ship file. Table III illustrates the labour cost/productivity file entries for one ship call. Table IV shows the entries in the ship file for the month of January. Finally, table V illustrates the revenue produced by the ships calling at the study area during the month of January.

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[b] In this application, the metric ton of 1,000 kilograms was used as the unit of measurement.

TABLE I

Berthing facilities for one berth at Port of Piraeus

Berth group: section I, general cargo berths, Berth number: 1

Facility code	*Facility*	*Length (metres)*	*Draught (metres)*	*Area (sq. (metres)*	*Date in service*	*Amortization period (years)*	*Capital cost (thousands of dollars)*
0101	Quay	140	11.5	–	1930	100	285
0102	Open berth area	–	..	12800	1930	–	..
0103	Shed	100	–	4000	1961	50	200

Source: Data collected by the UNCTAD secretariat in the case-study port.

TABLE II

Summary of berthing facilities and equipment costs of study section for ship/transit area operation

(Thousands of dollars)

Asset	*Capital cost*	*Amortization period (years)*	*Annual capital charge*[a]	*Annual maintenance and operating charge*[b]
Quays	1140.0	100	95.6	0.6
Cranes	244.3	25	22.8	40.0
Forklifts	181.9	8	31.6	36.4
Mobile cranes	128.0	10	9.0	10.0
Tractors	53.3	8	9.3	10.7
Trailers	48.0	10	7.1	2.4
Trucks	10.0	8	1.8	4.0
TOTAL			177.2	104.1

Source: See table I.

[a] Assumed rate of interest 8 per cent.

[b] Estimates based on a 1972 sample for the whole port.

TABLE III

Example of labour cost/productivity file

Ship type: Break-bulk general cargo

Ship name: Wilhelmina

Berthing date: 06/01/74

Day	*Berth No.*	*Shift*	*Hatch No.*	*Gang size*	*Tons worked*	*Gross gang-hours worked*		*Labour cost*[a]		*Idle gang-hours*	*Idle time code*[b]	*Gang performance (tons/gang-hour)*
						Regular	*Overtime*	*Regular*	*Overtime*			
06	3	8-14	1	17	70.0	–	6.0	–	225	1.5	01	15.6
	3	8-14	2	16	37.5	–	6.0	–	212	1.5	01	8.3
	3	15-21	1	17	99.5	–	6.0	–	225	–	–	16.6
	3	15-21	2	16	34.5	–	6.0	–	212	1.0	02	6.9
07	3	8-14	1	17	55.4	6.0	–	145	–	1.5	02	12.3
	3	8-14	2	16	52.2	6.0	–	137	–	1.5	02	11.6
	3	15-21	1	16	65.7	6.0	–	137	–	–	–	11.0
	3	15-21	2	17	34.9	6.0	–	145	–	–	–	5.8
	3	15-21	3	16	102.6	6.0	–	137	–	–	–	17.1
08	3	8-14	1	15	61.4	6.0	–	129	–	1.0	05	12.3
	3	8-14	2	16	34.3	6.0	–	137	–	1.0	05	6.9
	3	15-21	1	17	35.8	6.0	–	145	–	2.0	03	8.9
	3	15-21	2	16	46.9	6.0	–	137	–	2.0	03	11.7
	3	15-21	3	16	52.9	6.0	–	137	–	2.0	03	13.2
	3	21-07	1	17	25.0	–	10.0	–	375	7.5	03	10.0
09	3	8-14	1	14	49.1	6.0	–	121	–	–	–	8.2
	3	8-14	2	14	105.4	6.0	–	121	–	1.0	05	21.1
	3	8-14	3	16	40.0	6.0	–	137	–	1.0	05	8.0
	3	15-21	1	10	12.6	2.0	–	30	–	0.5	04	8.4
	3	15-21	2	10	26.0	2.0	–	30	–	–	–	13.0
TOTALS					1041.7	116.		3074.		25.0		

Source: See table I.

[a] Labour cost include supervision and have been converted from drachmas to dollars.

[b] The following delay codes were used: 01, getting ship ready; 02, collecting wood for dunnage; 03, rain; 04, work finished; 05, waiting for export cargo.

C. PERFORMANCE INDICATORS

14. The financial and operational indicators (defined in paragraphs 19 and 23) were calculated for the port study section. A tabular presentation of the results is given (tables VI and VII). The operational indicators show that although ship arrivals were fewer in January than in June, the port was more congested in January. This occurred for two reasons; first, the tonnage per ship was higher and secondly, the productivity – tons per gang-hour – was lower in January. These two factors increased the service time per ship and consequently increased the waiting time. Gang allocation to the ships worked was constant over the two periods. The higher fraction of idle time in January resulted from lost time due to rain.

15. The tabulation of the financial indicators shows a decrease in the labour expenditure per ton resulting from the increase in gang productivity between January and June. This decrease is greater than the increase in capital equipment expenditure per ton that resulted from the lower tonnage worked in June. Thus the contribution per ton and the total contribution from this berth group showed an improvement in June over the January figure.

16. Graphical presentation of two of the indicators calculated for individual ship calls are given in figures III and IV. Often a visual presentation is more useful to management as trends and exceptions are more easily recognized with this form of presentation than with a tabular one.[c] Figures V to VII illustrate how some of the performance indicators may be recorded graphically during the year.

[c] See *Berth throughput . . . op. cit.* part one, figure 17.

TABLE IV

Example of ship file

Berth Group: section 1 – general cargo berths *Month:* January *Year:* 1974

Ship name	*Length (feet)*	*Arrival time and date*	*Berthing delay (hours)*	*Berthing delay code*[a]	*Berth time (hours)*	*Berthing location*	*Tons worked*	*Hours worked at berth*	*Gang-hours*		*Labour cost (dollars)*
									Gross	*Idle*	
Adam S.	400	0830/22/12	–	–	323.5	4	5350	200	350	49	10550
Hollandia.	366	1100/28/12	1.5	01	210.5	3	1016	60	135	34	3429
Galiola	260	2315/30/12	10.5	01	81.0	2	1000	93	150	5	3633
Corinthian Trader	284	0745/31/12	49.0	01	102.0	2	1363	48	78	2	1565
Briseis	378	1345/31/12	43.0	01	85.0	1	1080	48	92	3	1920
Giuseppemme . .	313	0100/03/01	55.0	01	107.0	4	792	57	124	13	3235
Marco Polo. . . .	485	0920/03/01	–	–	82.5	2	992	54	110	10	2550
Wilhelmina. . . .	361	0100/04/01	55.0	01	80.0	3	1041	54	116	25	3074
Cap Sidero. . . .	410	0245/05/01	53.5	01	84.5	2	2272	60	130	13	2592
Ionion	137	1200/05/01	12.0	01	38.0	1	147	18	18	1	495
Oguzkan	189	1215/07/01	3.5	01	21.5	2	141	6	6	0	100
Georgios B. . . .	363	1730/07/01	48.0	01	36.0	1	230	12	12	–	210
Madinia.	321	1900/07/01	48.0	01	84.0	4	1375	52	104	9	2483
Dimitris	425	2115/08/01	–	–	94.0	1	134	8	8	2	77
Effy.	386	2130/09/01	10.5	01	31.0	3	330	24	40	7	899
Rapallo.	365	1500/10/01	18.0	01	82.5	2	415	54	80	19	1940
Tolmidis	486	0620/11/01	10.5	01	246.0	3	1490	138	251	80	5890
Pelti.	229	1525/13/01	18.0	01	36.0	1	272	18	24	3	540
Indiana	361	0930/14/01	16.5	01	59.0	4	370	30	48	1	1094
Satsuma Maru . .	514	1900/14/01	34.0	01	94.0	2	572	42	77	3	1785
Grecian.	263	0925/16/01	–	–	75.0	1	558	42	61	4	1405
Manthos M. . . .	270	0830/17/01	3.0	01	61.5	4	655	24	60	8	1200
Palladio.	363	0830/20/01	–	–	34.5	4	485	24	54	7	1333
Bratstvo	310	0830/21/01	–	–	112.0	2	1610	85	151	24	3364
Chantenay	198	1530/21/01	16.0	02	14.0	1	302	12	19	1	388
Georgios V. . . .	176	0200/22/01	–	–	15.0	1	76	7	7	3	117
Texelstroom. . .	260	0840/22/01	–	–	47.0	4	329	40	52	2	1250
Great Luck. . . .	428	0900/22/01	–	–	216.0	3	6269	160	410	66	10580
Ionian	137	1900/22/01	–	–	29.0	1	230	18	24	–	400
Tundraland . . .	393	0240/24/01	30.0	02	86.0	1	2245	60	168	23	3789
Andrea Gritti . .	479	0830/26/01	–	–	84.5	2	885	57	124	21	3251
Menna	168	0900/26/01	–	–	59.0	4	280	24	24	–	333
Georgakis	169	0900/26/01	–	–	112.0	4	659	42	60	4	1397
Astronaftis. . . .	355	1740/26/01	–	–	96.0	4	368	30	36	1	904
Agia Irini.	212	1300/28/01	–	–	77.0	1	379	27	39	0	713
Izumo Maru[b] . .	515	0740/29/01	24.0	01	–	2	–	–	–	–	–
Athenian[b]	308	1630/29/01	15.0	01	–	3	–	–	–	–	–
Livorno[b]	386	0830/31/01	–	–	–	4	–	–	–	–	–

Source: See table I.

[a] The following delay codes are used: 01, waiting for a berth; 02, other cause.

[b] Ship working not completed during month of January.

TABLE V

Example of revenue file

Berth group: Section I, general cargo berths *Month:* January *Year:* 1974

Ship name	*Arrival time and date*	*Revenue from berth occupancy (dollars)*	*Revenue from cargo handling* (dollars)*
Adam S.	0830/22/12	350	23183
Hollandia	1100/28/12	182	4403
Galiola	2315/30/12	43	4333
Corinthian Trader	0745/31/12	67	5906
Briseis	1345/31/12	95	4680
Giuseppenme	0100/03/01	73	3432
Marco Polo	0920/03/01	121	4299
Wilhelmina	0100/04/01	90	4511
Cap Sidero	0245/05/01	103	9845
Ionion	1200/05/01	8	537
Oguzkan	1215/07/01	6	611
Georgios B.	1730/07/01	45	997
Madinia	1900/07/01	80	5958
Dimitris	2115/08/01	106	581
Effy	2130/09/01	48	1430
Rapallo	1500/10/01	91	1798
Tolmidis	0620/11/01	334	6457
Pelti	1525/13/01	13	1179
Indiana	0930/14/01	68	1603
Satsuma Maru	1900/14/01	129	2445
Grecian	0925/16/01	44	2418
Manthos M.	0830/17/01	24	2838
Palladio	0830/20/01	45	2102
Bratstvo	0830/21/01	72	6977
Chantenay	1530/21/01	7	1309
Georgios V.	0200/22/01	5	329
Texelstroom	0840/22/01	17	1426
Great Luck	0900/22/01	241	27166
Ionian	1900/22/01	8	997
Tundraland	0240/24/01	98	9728
Andrea Gritti	0830/26/01	120	3835
Menna	0900/26/01	17	1213
Georgakis	0900/26/01	35	2856
Astronaftis	1740/26/01	89	1595
Agia Irini	1300/28/01	31	1642

Source: See table 1.

* Estimate based on mean revenue of $4.33 per ton.

TABLE VI

Port of Piraeus: Section I, general cargo berths
Summary of operational performance indicators

Indicator	*January 1974*	*June 1974*
Arrival rate (ships/day)	1.06_{35}*	1.33_{40}*
Waiting time (hours/ship)	16.1_{35}	5.4_{40}
Service time (hours/ship)	88.5_{35}	58.9_{40}
Turn-round time (hours/ship)	103.8_{35}	62.3_{39}
Tonnage per ship (tons/ship)	1020_{35}	734_{40}
Fraction of time berthed ships worked	0.56_{35}	0.51_{40}
Number of gangs employed per ship per shift	1.88_{35}	1.89_{40}
Tons per ship hour in port (tons/hour)	9.8_{35}	11.1_{39}
Tons per ship hour at berth (tons/hour)	11.5_{35}	12.5_{40}
Tons per gang-hour (tons/gang-hour)	11.0_{35}	12.9_{40}
Fraction of time gangs idle	0.14_{32}	0.05_{5}

Source: See table 1.

* Indicator given with number of ships in sample, e.g. 16.1_{35} i.e., sample of 35 ships gave a mean indicator of 16.1.

TABLE VII

Port of Piraeus: Section I, general cargo berths
Summary of financial performance indicators

Indicator	*January 1974*	*June 1974*
Tonnage worked (thousands of tons)	35.712_{35}	29.340_{40}
Berth occupancy revenue (dollars per ton)	0.081	0.066
Cargo handling revenue[a] (dollars per ton)	4.333	4.333
Labour expenditure[b] (dollars per ton)	3.297	2.811
Capital equipment expenditure[c] (dollars per ton)	0.656	0.799
Contribution per ton[d] (dollars per ton)	0.461	0.789
Total contribution (thousands of dollars)	16.463	23.149

Source: See table 1.

[a] Based on information from a financial report for Section I for January 1974 (shipworking: 62 drachmas per ton; "*sotto palango*" working: 68 drachmas per ton).

[b] Based on information extracted from the shift foreman's report for a sample of 35 ships for January and using ratio of gang productivities for the two periods to estimate the June figure. Pension payments of 0.5 of labour expenses are included.

[c] Based on information from the Supply Department and the Engineering Department (1972 data) and assuming a rate of interest of 8 per cent when determining amortization charges.

[d] The contribution per ton excludes revenue and cost generated from the delivery of cargo, which produces approximately 50 drachmas per ton of gross revenue and costs approximately 20 drachmas per ton for labour plus the capital equipment charges.

FIGURE III

Distribution of fraction of time berthed ships worked at Port of Piraeus

(Section 1, general cargo berths – January 1974)

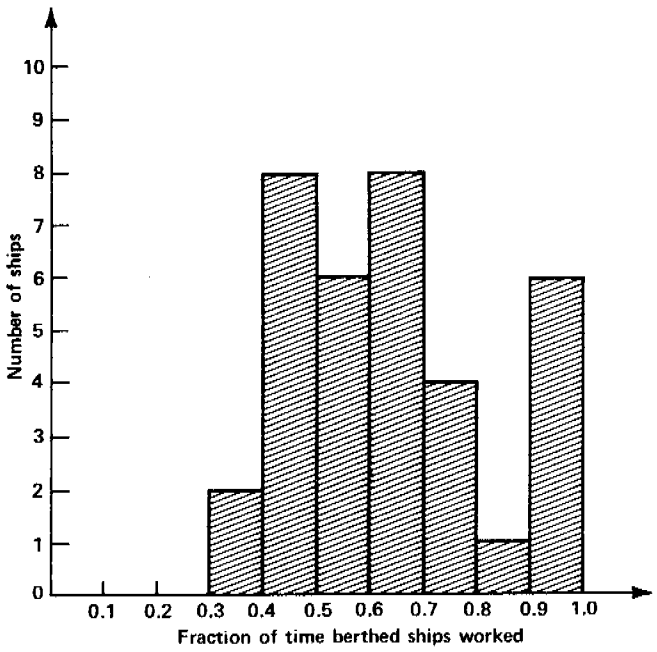


FIGURE IV

Distribution of tons per gang-hour at Port of Piraeus

(General cargo berths – January 1974)

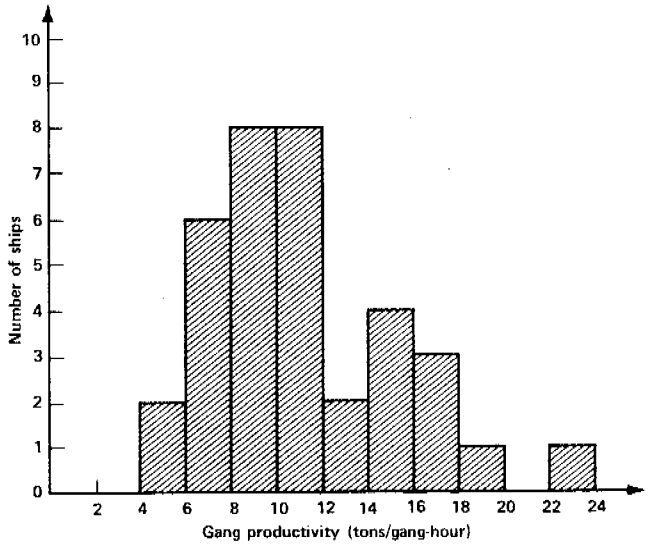


FIGURE V

Graphical presentation of tonnage worked indicator for a berth group

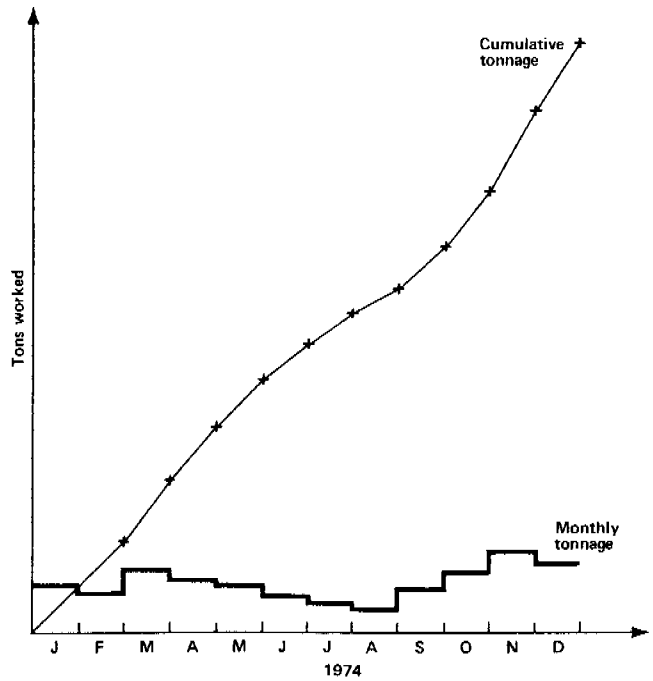


FIGURE VI

Graphical presentation of total contribution indicator for a berth group

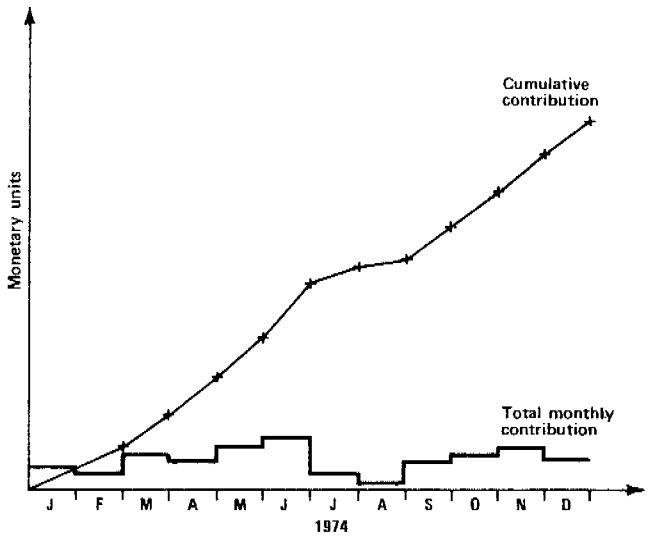
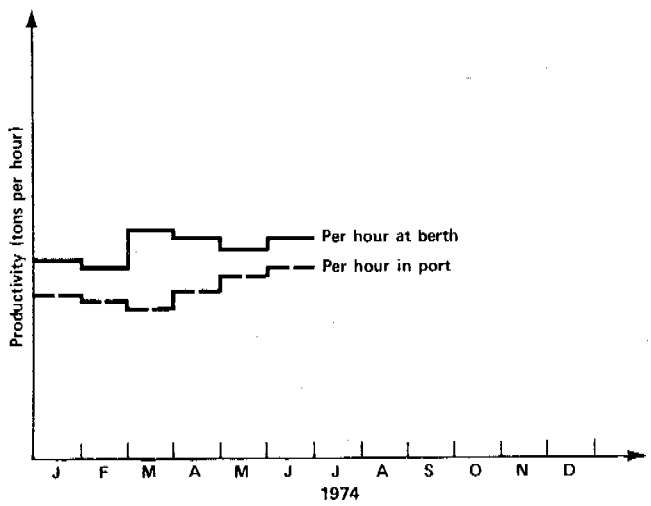


FIGURE VII

Graphical presentation of productivity for a berth group



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