0842

Distr.
LIMITED
E/ECWA/NR/SEM.1/6
September 1977
Original: ENGLISH

UNITED NATIONS

ECONOMIC AND SOCIAL COUNCIL

ECONOMIC COMMISSION FOR WESTERN ASIA
Seminar on "Technology Transfer and Change in the Arab Middle East"
Beirut, 10 - 14 October 1977

TRANSPORTATION BOTTLENECKS AND THEIR RELATION TO TECHNOLOGY TRANSFER AND CHANGE WITH SPECIAL REFERENCE TO PORTS AND THE ADJOINING TRANSPORT LINKS

Transport, Communications and Tourism Division
ECWA.

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TRANSPORTATION BOTTLENECKS AND THEIR RELATION TO TECHNOLOGY TRANSFER AND CHANGE, WITH SPECIAL REFERENCE TO PORTS AND THE ADJOINING TRANSPORT LINKS [1/]

Introduction

The last few decades have witnessed spectacular changes in technology in all fields of human activities. Those that affect the daily life of most people and at the widest scale, however, would be changes and progresses in transport technology. To mention just a few of these, one may refer to the recent development and introduction into commercial operation of wide-bodied aircraft, very large and increasingly automatized maritime carriers for oil and minerals. Worth mentioning are also the techniques of unitized cargo packaging, storing, handling and the related methods of inter-modal transportation, etc. All the technology changes referred to above have brought along with them far-reaching consequences on many modes and links which are inter-related within the transportation system. In many instances, the pace of progress has been so rapid that investment assets were not fully amortized yet when their replacement became necessary because of technology obsolescence.

Transportation activities, on the other hand, contrary to most of those in other economic sectors, present the unique feature of being widely spread over space, between given sets of origin and destination. A variety of transport "modes", technology and operators are involved, which compose the overall transportation chain. Each of the transportation links of that chain has its own technological and developmental problems, management objectives, interests and constraints which, altogether, make it exceedingly difficult, if not impossible, to be co-ordinated effectively.

It is no wonder that, as a result of that complexity, technology

1/ This paper was prepared by the Transport, Communications and Tourism Division, ECWA, as a document for consideration at the Seminar on Technology Transfer and Change, 9-14 October 1977, sponsored by ECWA.

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development and progress in the various transportation modes and links have not been achieved as consistently as they should be throughout the transport chain. At many interfaces where transport links are adjoining, there are discrepancies in techniques and operational procedures which eventually result in differences in transportation capacity and bottlenecks which often negate all the benefits expected from technology advances achieved elsewhere.

It should be further mentioned that, in addition to problems arising from those rapid technology changes in general, the recent upsurge of economic growth in some developing countries, especially those in Western Asia, endowed with capital surpluses which are derived from their oil resources, has generated a corresponding and explosive increase of demands for transport. These have further stretched out the capacity of existing transport facilities to their extreme limits and, yet, have not met all the transport requirements; hence, further problems of transport bottlenecks such as port congesions, road traffic jams etc.

Under the pressure of such an "over-heated" development growth, problems are arising as to whether transportation bottlenecks should be resolved by further investments in technology "hardware", to be coupled with the related changes such as additional high capacity and sophisticated port equipment, facilities, etc., or rather by an adequate improvement and re-organization of operational and management procedures and techniques, the so-called "software" components of technology, or by both.

These are the issues to which the present paper, submitted for review and discussion at the ECWA-sponsored Seminar on Technology and Change, 9-14 October 1977, is intended to address. Although some solutions are suggested hereinafter, these could by no means be considered as comprehensive, nor final, as to how transportation bottlenecks are to be eventually resolved. This is expected to come out as one of the results of the Seminar itself.

I. Understanding the transport system

1. The transport chain, as a succession of primary transport activities

Transportation usually involves a succession and great variety of primary transport links, combined with interface facilities. A typical chain of transport of, say, manufactured goods from Europe to the Arabian Gulf area, comprises usually a short haul from factory to an European port, either by roads or railroads, then an ocean shipping leg from the European port to a port in Western Asia, say on the Mediterranean coast, and finally a long transit journey overland, by trucks across several countries in Western Asia, from the Mediterranean port to its final destination (the customer's town and warehouse). The transport chain, as described above, includes necessarily a number of different modes of transport and interface operations whereby the transported goods are unloaded from one mode, re-loaded on the following mode and so on, with intermediary handling and storage at several interface facilities, including sea ports.

The transport capacity of the chain, of course, depends essentially on that each of its elements. But the concept of "capacity" of the transport chain is not as simple as expected, and is not necessarily linked with that of the weakest element of the chain.

2. Intrinsic capacity and slack of a transport link

If a transport link or an interface facility is considered in isolation, i.e. as separated from all other links and facilities of the chain, it would be relatively easy to define, as will be explained below, what could be termed as its "intrinsic capacity", say, in terms of tons of goods the link/facility could help flowing through, over a unit of time (day, week, month or year). But, even under such an over-simplified assumption, "intrinsic capacity" is expected to depend on the type of goods to be transported or handled and the steadiness of its flow over time. It is obvious that, if types and volumes of the commodities to be transported keep changing or fluctuating over time, the intrinsic capacity of the transport link/

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facility under consideration should also be defined according to the commodity mix and flow patterns involved.

In the final analysis, a transport link or facility could be viewed as a "converter" which, out of an actual traffic input composed of certain commodity mix and flow pattern, produce an actual traffic output characterized by another commodity mix and flow pattern which may, at times, differ from those of the traffic input. This is especially the case when the transport link/facility under consideration includes some internal storage capacities.

Since internal capacities are necessarily limited, the average traffic inputs are however expected to equalize the average traffic outputs, at least in aggregate quantitative terms and over a certain period of time, depending on the commodity mix to be handled. In other words, if flow patterns and commodity mix of actual traffic are assumed to remain somewhat stable over time, the actual average traffic inputs are expected to be equal to the actual average outputs, as long as both averages are below a certain maximum level of traffic. This maximum level of traffic could then be termed as the "<u>intrinsic capacity</u>" of the transport link or interface facility involved.

If, on the other hand, traffic inputs increase and is about to reach that "intrinsic capacity" level, the resulting traffic outputs start to show signs of distortion with respect to both commodity mix and flow pattern, so that they are no longer comparable with the actual traffic inputs. Soon thereafter, when internal storage capacities are filled up, the transport link or facility could no longer process any further traffic, thus giving rise to a transport bottleneck.

As long as actual traffic flows remain below the critical level of intrinsic capacity, the reserve capacity still available, also called "slack", is there to cater for further traffic increase.

The concept of traffic <u>intrinsic capacity</u> and <u>slack</u> is, of

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course, applicable to any link or interface facility of a transport chain, provided they could be isolated and defined as a transport or handling primary activity.

3. Transportation bottle-necks as results of discrepancies in intrinsic capacities

As indicated above, a transportation bottle-neck is the result of a transport traffic built-up beyond the intrinsic capacity of a specific link or interface facility of the transport chain.

The first reaction of a transport operator, when faced with bottle-neck problems, would be to increase the intrinsic capacity of the link or interface facility immediately involved. But this might not always be the most appropriate reaction, because bottle-necks may just shift from one link to another, further down-stream on the transport chain. There are cases where an expansion of intrinsic capacity of the "narrowest" link of the transport chain eventually results in a complete change of the traffic flow down-stream of that link to the extent that a new reduction of intrinsic capacity appears where it does not exist before, under previous and different circumstances of commodity mix and flow patterns.

It may be summarized from the exposé above that, to resolve effectively transport bottle-necks, it is of course necessary to take action towards expanding the intrinsic capacity of the immediately following transport link or interface facility. But this might not be sufficient in all cases, because bottle-necks may just shift to other stages down-stream, or re-appear at other stages of the transport chain, as a result of changes in commodity mix or flow patterns of the increased traffic.

It is, therefore, indispensible to tackle transport bottle-neck problems from an integrated transport standpoint, i.e. throughout the overall transport chain, taking into account all aspects of the transport modes, technology, countries and operators involved. Solutions are all the more difficult to find out because changes in

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commodity mix and traffic flow patterns could usually not be predicted with accuracy. In case where a comprehensive solution is needed, the whole transport chain should be analyzed and translated into a model which reflects the behaviour of each link to traffic changes. A process of simulation should then be applied, often with the help of computerized calculation if the model is too complex and the parameters and assumptions of changes are too many.

4. <u>Technology changes and their relation to transport bottle-necks</u>

As indicated earlier, if the transport chain is considered in its entirety from given origin to destination, bottle-necks are bound to happen at certain interface facilities where a discrepancy in intrinsic capacities of the adjoining transport links prevents the traffic from flowing freely from one link to the next. Such a situation may result from either one of the following two circumstances:

(a) Lack of co-ordination during the investment stage in design specifications of the technology "hardware" concerned, i.e., when the physical assets involved, such as construction, infrastructure, super-structure and equipment specifications, have not been consistently designed so as to offer more or less equal intrinsic capacities; or,

(b) Discrepancies in the technology "software" concerned, i.e., during the operational stage differences, in efficiency and effectiveness of the operational and management procedures being applied.

Because of the diversity of modes and operators throughout the transport chain, the two circumstances of technology inconsistencies or discrepancies, as referred to above, are found to happen very frequently in the transport system. The usual reaction of a transport operator, who is faced with problems of transport bottle-necks, tends to be different, whether he is normally endowed with resources in capital or skill.

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In a developing country, capital resources used to be the scarcest, whereas skill could easily be developed subject to investment at a much smaller scale in training facilities. The most advisable solution to a transport bottle-neck problems, in the context of that developing country where shortage of capital is supposed to be prevailing, is obviously to try improving to the maximum possible extent the "software" technology, i.e., the operational and management techniques to be applied. Only, when limits of skill and human resources available are reached, that further capital investment in "hardware" technology is to be considered and acted upon.

But developing countries in Western Asia might not be all similar to the one just referred to above. In many of them, especially those in the Gulf area, skill and human resources might be the scarcest to be counted upon and, therefore, should be used in the development process only with utmost care. Under the present pressure of development growth, the most expeditious solution to lifting transport bottlenecks could not be anything, for those developing countries, but investment in additional sophisticated and more productive "hardware", even if the management and operation of those "hardware" components imply the necessity of depending for some time on imported skills and knowhow.

But whatever resource endowment is for individual countries of Western Asia, the solution to problems of transport bottle-necks is not to improve only those links which are under the control of the local transport operators. Problems are much more difficult to resolve because of their being the results of technology changes in other transport links, beyond the control of the countries and local operators concerned. This is the case in particular, of international shipping where bottle-necks are bound to appear in ports but result from advances in shipping technology or the lack of it, elsewhere. Ports are just interface facilities where international shipping under the control of foreign operators, is interlinked with handling, storage and land

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transport facilities, usually under the control of local operators. Despite the huge investment and operational improvement efforts being made in Western Asia, over the past ten years, bottle-necks are still to be resolved in ports. Further elaboration of this subject will be found in the following chapter.

II <u>Transportation bottle-necks in ports</u>

1. <u>A brief review of technological developments in ships' design, cargo unitization and handling, and their impact on ports of Western Asia</u>.

The problem with technological development in maritime transport is rather more complex than that in most industries. In industry it is simply the product or output which counts and the manner in which that has been achieved is irrelevant to the user. Of course, the manner in which it is achieved may influence the nature of the product or its price, in which case it is not irrelevant to the user but, so long as homogeneous product can be produced and sold at the same price by any one of a number of different technologies, the actual one used is irrelevant to the consumer. In the case of shipping, however, the product of shipping, namely ton/miles of carriage, cannot be bought alone, but has to be bought in association with services bought in the ports at which goods are transferred between shipping and other transport modes. In so far as the technology of shipping affects the technology of ports, the user of shipping services is not indifferent to the technology because, while the ton/mile cost to him may be the same for different shipping technologies operating under different relative cost levels, the handling costs in the ports are likely to be quite different for different shipping technologies.

One important point to consider in looking at the costs of new technologies is the fact that the technology may cause costs to shift, or, while saving costs in one area, it may be imposing costs in another. In the case of large tankers, other bulk carriers, for example, costs in transport are saved, but ports are subjected to heavy costs in dredging and providing mooring facilities and the right type of loading and unloading equipment to ensure that the economies of transport gained by the ships are not counterbalanced by the diseconomies in port.

The technological developments in ships' designs have produced specialized ships larger in size and with deeper draught than the conventional ships. The ports at which such ships will call need to adapt to the technology introduced in shipping. Otherwise shipping technology will produce bottlenecks at the interface. The adaptation requires, among other things, increase in the intrinsic of capacity of the port and port facilities; such as suitable water depths alongside berths, navigable channels and approaches to ports. Complementary changes in port's traditional infrastructure become inevitable. In some cases where the intrinsic capacity of port infrastructure is not capable of required extention, new solutions have to be found such as construction of entirely new ports in more suitable locations, or off-shore loading/unloading facilities. Although a good number of ports/anchorages have been or can be developed for use of VLCC'S, developing access channel for such larger vessels considerably restrict the number of sites that can reasonably be developed for such vessels. Existing port sites, owing to limitations on the dimension of both the port and its access channels, are often unsuitable for large tankers and bulk carriers.

Port planners either attempt to modify the existing port to cater for these increasing ship sizes or to leave the traditional sites and develop new bulk port facilities in more appropriate places. In some cases resort has been made to building "sea islands", connected to shore by submarine pipeline, such as Mina Al Ahmadi terminal in Kuwait (located 16 kms off-shore), in Ras Tanura (Saudi Arabia), and Kharg Island (Iran). However, the submarine pipeline system being expensive more than double that of surface pipeline, thus reduces the cost advantages associated with off-shore terminals. However, whereas it

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is possible to discharge, e.g. oil tankers very quickly whatever the vessel size, this has by no means been the case with dry bulk cargo vessels, where increased size has been held back by increased loading/discharging times in port:

The development of slurrying could radically transform the position a range of what have normally been dry bulk cargo materials such as coal iron ore, phosphate, can be slurried. This material handling method is likely to make considerable progress, and may sometimes radically effect the nature of port facility requirements for the maor bulk cargo trades. Slurrying-involving the pumping of cargo to/from vessels holds - nearly has the fast cargo handling, short ship turnaround time characteristics of bulk liquids. Given sufficient transport movement demand, there is likely to be a considerable stimulus to further increases in vessel size. The faster ship turn-around time also means an increased potential through-put for port installions, so decreasing port facility requirements for a given tonnage.

Turning from the economies of size in bulk carriers and from slurrying to developments affecting general cargo, a development of topical interest in the ECWA region is the emerging use of barge-carrying-vessel (BCV) such as the LASH system. Some five or six systems have been evolved, with lighters lifted to/from and/ or floated to/from the conveying vessels. The use of BCV seemed to be the ideal solution to the shipping problems of developing countries. They seemed to provide a compromise between the demands of differing capital intensities at each end of a trading route between developing and developed countries and to make minimum for new port facilities in developing countries'.

The BCV technology produces a bottleneck of legal nature in some countries. The type of operation envisaged for the sea-borne barges falls under the definition of domestic water transport, which under many countries' cabotage legislations is reserved for craft registered in the country with which requirement the sea-borne barges naturally

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cannot comply. The success of BCV system necessarily depends on the solution of such problems, for it is clearly most unfortunate if the cargo has to bear additional handling costs merely for legal reasons.

A significant development in shipping technology is containerization which provides essentially two-fold benefit; containerization makes possible greatly improved vessel port turn-round time, a major saving, and it also considerably reduces cargo handling costs. Ideally, container ship cargo should move through to/from inland destinations/origins, rather than simply to distribution warehouses in port sites for stripping subsequent on-distribution. And of course, a vital requirement through container movement is the availability of roads adequate to accept container carrying trucks (and ancillary equipment inland to discharge/ load containers from trucks).

The cargo aspect is of course, crucial in determining the scope for containerization on a given route. The economies-of-scale factor means that there must be very considerable flow of appropriate commodities that physically can be containerized, that would move satisfactorily at less cost by other techniques (e.g. in bulk or semi-bulk; unpacked form). Furthermore, traffic flows must be reasonably balanced both directionally and seasonally over time.

The intermediate technologies also have some useful characteristics in this connection. For example, the use of pallets in ships with sideport discharging and lift-on/lift-off loading enables many of the advantages of mechanical handling to be achieved without the capital investment involved in full container operations. At many ports in developing countries, the use of containers is unlikely to be economic in the foreseeable future because of the throughput factor, and the use of an intermediate technology achieves significant economies over break-bulk and thus produces significiant savings in total transport cost.

In response to the technological developments in shipping, such as modern ships' design and techniques of cargo unitization and handling, many of the major ports in Western Asia have undergone radical changes, not only with respect to improvements of their infrastructure and superstructure, but more importantly regarding

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the complex procedures and practices of management and operations.

Port activities represent, in fact, the most typical interface operations within an overall transportation chain which involve cargo handling, transfer, delivery and storage. Shipping, as a transport mode, is bought to interact with the interland transport system.

Different ship technologies and subsequent changes in cargo consignment places new demands on the port's individual activities. The dominant activity in the ship cargo handling system and the capacities of the other linked activities must match it if major bottlenecks are to be avoided. The operation of the port, after the cargo has been discharged by the carrier, is directed to facilitate onward movement of cargo through one of the following routes:

(a) The indirect route, i.e. transportation to the transit shed or open storage for subsequent delivery to interland transport;
(b) The semi-direct route, i.e. the cargo is put down temporarily because the rail wagon or the truck cannot handle it immediately;
(c) The direct route, i.e. direct discharge of cargo from the ship onto the truck or rail wagon for further transportation.

The interaction between the ' ship cargo handling system ' and, either the transfer system to the storage, or direct delivery to the land transport, calls for complementary matching of capacities of these two links, otherwise bottlenecks will be created.

It is therefore, essential the port authority should monitor the performance of these links and compare it with the intrinsic capacity of each link. It is only by doing so that it can be identified as to which linked operation is creating the bottleneck. In the case of direct delivery route (from the ship to rail wagon or truck) it should be identified whether the ship's cargo handling system, or the vehicle loading capacity, or the availability of the vehicle, is creating the bottleneck.

The storage capacity could also produce bottleneck on its own to the berth throughput. Its main function is to act as a buffer

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between import/export cargoes and ship loading/unloading. It also enables necessary processing of customs formalities and documentation. The intrinsic capacity of port storage should likewise match the other parts of the berth system. Measurement of the intrinsic capacity, as explained above, is however complex and is dependent on cargo mix, which will differ with various classes of cargo and also on the period of time cargo stays in the storage.

Technological change in shipping, ship design, size of cargo load, cargo unitization etc., require relevant changes in the ports and transport sub-systems. Where there is not consistency of technology in all the links in the total transport chain, the advances in shipping technology alone are likely to create bottlenecks. On the other hand technological progress in land transport and port facilities for achieving a higher throughput may also be counter-balanced by the inappropriate shipping technology available for some specific traffic. A case in point is the transportation of Jordanian phosphate exports through the port of Aqaba which is presented hereinafter.

2. Special problems in co-ordinating technological developments in shipping and ports in Western Asia; the illustrative case of Aqaba Port with respect to exports of phosphate.

As already referred to under Section I above, it has proved to be exceedingly difficult to co-ordinate and apply the newest technological developments in shipping and ports because there are two different stages in the overall transport chain, usually under the control of different transport operators. Shipping is usually operated by international shippers or ship-owners whose interests are not limited to one country but to many of those located on their shipping routes. On the contrary, ports are constructed and operated by individual governments or, on their behalf, by government sponsored public agencies. Therefore, interests of shippers and ship operators may not necessarily coincide with those of port operators. Aqaba Port is a typical case of that conflict in transport technologies with respect to the adjoining links.

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Phosphate rock is the major export commodity of Jordan. Government's plans have provided for increase in production of phosphate from 1.5 million tons in 1974 to 7 million tons by 1980. Exports are expected to be made mostly through Aqaba Port, to take the full benefits of markets which have been developed in Asia and the Far-East over the past ten years. Hopefully markets are to be regained in Europe on account of shipping advantages which are being derived from the newly re-opened Suez Canal.

For this purpose, the Government of Jordan has over the past ten years, heavily invested in developing the new phosphate mines in El Hasa, and surrounding areas, 140 km. South of Amman, rehabitating and strengthening more than 150 km. of the old Hedjaz Railways, from El Hasa to Hittiya, and building brand-new, 140 km rail-line, over a very difficult terrain, to directly connect the railways system to Aqaba Port. As it is, the present overland transport system, with the modernized and expanded Hedjaz railways, is easily capable of handling up to 10 million tons of phosphate exports per year, subject only to minor additional investments, when required, in building some intermediary stations and extra rail sidings.

To further enhance the competitive position of Jordanian phosphate on the international markets, the Jordan Government has also invested a large amount of capital in phosphate rock handling and storage and in the harbour works and equipment at Aqaba Port to accomodate large bulk carrier vessels. The port has, at present, two specialized mechanical phosphate rock loading berths, known as "berth A" and "Berth B", which came into use in December 1959 and January 1969 respectively, Berth A has a draft of 10.5 meter and is equipped with a fixed position shiploader rated at 500 tons/hour. Berth B was designed for loading vessels up to 100.000 DWT, with draft of 15.5 meter alongside, and is equipped at present with a travelling shiploader rated at 1,500 tons/hour. The installations at Berth B were designed, space and stores were provided for a second shiploader and associated conveyors to be installed at a later date. Plans are actually under-

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way to install that second shiploader with a rated capacity of 2,100 tons/hour. On its commissioning, the existing and somewhat lower capacity shiploader will be taken out of operation for uprating to the same, 2100 tons/hour capacity and re-commissionning a few months later.

Assuming that both Berths A and B are generally available for phosphate traffic and on the basis of a berth occupancy of 60 percent, it has been estimated that the two berth operating at present in Aqaba Port without any further improvement, would have intrinsic capacities as follows:

- Berth A = 750,000 tons/year
- Berth B = 2,000,000 tons/year
- Total Port Capacity = 2,750,000 tons/year

Upon completion of the second Shiploader and improvement of the first one at Berth B, total capacity of Aqaba Port, in terms of phosphate exports, would be in the range of 4,500,000 to 6,000,000 tons/year, depending on the types of vessels calling Aqaba.

Even if all current limitations are taken into account, Aqaba Port is easily the technologically best equipped, among all ports in Western Asia, for handling phosphate exports. Its accessibility to ships up to 100, 000 DWT and loading capacity over 4,000 tons/hour compare favourably with Beirut (Lebanon) and Safaga (Egypt) which are not suitable for ships over 10,000 DWT. Tartous (Syria), on the other hand, offers at present only 5 meter draft, but may be deepened to 11.0 meters to accomodate larger ships up to 30,000 DWT. But its single shiploader could not provide more than 1,000 tons/hour loading capacity.

In terms of expansion capabilities, Aqaba Port is even more promising. Its "Berth B", as indicated earlier, with a draft alongside of 15.5 meters and two shiploaders of 4,200 tons/hour

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in total, is at present capable of acoomodating bulk carriers up to 100,000 DWT. Two possible sites are existing in the vicinity of "Berth B" for construction of additional bulk berths of equal or higher loading capacities, whenever required, together with the necessary storage facilities.

But problems of operating Aqaba Port facilities for bulk exports are elsewhere, not in the technological advances of those at present existing or planned. Against the existing overland transport and loading capacities at Aqaba, which were estimated at 2,750,000 tons/year at present and 4,500,000 to 6,000,000 tons/year very shortly, the actual volumes of phosphate exports have only been limited to 1,500,000/2,000,000 tons/year, over the past three years. Yet, all berths available have been fully occupied.

The reason for this under-utilization of installed capacities has been the unsuitability of ships calling at Aqaba Port for loading phosphate rock. In more specific terms, these under-capacity performances resulted from the following discrepancies in technology developments:

1. Ships calling at Aqaba for loading phosphate have been, almost without exception, of break-bulk types, usually over-aged, multi-decked and small size vessels not exceeding 10,000 DWT;

2. Time has been lost on account of "Warping" of the ship, i.e. changing its position to bring hatches opposite the loader, when loading is made at Berth A, where the mechanical shiploader is not movable, and ship's hatches are too small;

3. At "Berth B", where the shiploader is mobile and capable of positioning itself opposite to ship's hatches, time has also been lost because of the necessity of "trimming" the cargo after it being mechanically loaded, i.e. to spreading or levelling it out. This operation is normally effected manually and requires frequent interruptions of the mechanical loading.

The problems of phosphate transport bottle-necks at Aqaba Port are, therefore, readily identifiable: They result from the present

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shipping and chartering practices of buyers, and especially the employment of small, mainly multi-deck vessels which have prevented the loading installations of the Jordan Phosphate Mines Co. from operating at anything near their rated capacities. These problems are more acute to the Jordanian Government in the short-term, as the port of Aqaba is incapable of handling the targeted throughput with utilization of the present facilities, despite of their most technologically advanced design.

Additional shiploading facilities are, therefore, required and actually being erected to enable the Jordan Phosphate Mines Co. to circumvent the problem. A less expensive solution would be of course, to persuade the buyers of Jordan phosphate rock to improve their freighting arrangements and practices by introducing larger and more efficient ships into the trade. But this implies a change in shipping arrangements for other commodities and destinations, because the ships calling at Aqaba are involved in other shipping operations as well, beyond the control of the Jordan Phosphate Mines Co. and the Government of Jordan.

This is a typical case where transport bottlenecks result from inconsistencies of transport technologies at a specific interface, where the adjoining transport links are under the control of different operators.

3. Measures necessary for ports to come to terms with the shipping technology through appropriate improvements.

The advances in shipping technology have also led to the necessity for ports to improve its own technology, either with respect to its "hardware" aspects, i.e. its equipment, infrastructure, storates, berth, etc., or its "software", i.e. its management, organization, operational procedures, customs clearance, etc. or both.

The port function is to receive, service and dispatch ships and their cargoes and its entire operation should be designed to perform that function efficiently. The movement of ships, their arrival pattern, delays, service times and total turn-round times,

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and the handling of cargoes are the two key operational activities in port and are the basis of related activities. A large number of ports in the developing countries are suffering extended ship turn-round times, inordinate delays and service times, and congestion of cargo on the wharves and in sheds. Sometimes, solutions just consist of the alteration of the operating rules, by changes in the organization of labour and/or by capital expansion.

There are basically two ways in which port capacity can be increased:

- improvement in operational methods
- expansion of physical facilities

Although the emphasis in most countries in ECWA region has been on the expansion of ports physical facilities, like provision of new berths, an alternative means of expanding the capacity of an existing system is that of improving service or cargo handling rates through the introduction of improved methods and techniques and increased hours of working. Reduced service times could reduce vessel turn-round and waiting times so that improved cargo handling practices may be a less expensive alternative to the provision of new berth. In the context of the present situation where most regional ports are suffering from severe congestion, the alternative of operational improvements usually provides a satisfactory early counter to the problems of growing congestion.

There is a significant scope for improvement of the present port capacities in most regional ports by this alternative. This has been recently demonstrated by the port of Aqaba (Jordan), taken again as an illustrative example. Although berth throughput improvement has not been analysed in details it is reported that by introducing a number of streamlining measures, the port has increased its general cargo throughput across the wharf by some 50 per cent and its storage capacity by almost 100 per cent. This has resulted recently in greatly reduced ship waiting time and removal of all congestion surcharges a rather exceptional and spectacular improvement for sea ports in the region. This has been the result of operational improvements, in the case of Aqaba Port and could be recommended for application to other ports of Western Asia;

(a) Control of information and reporting procedures

Management information system and reporting channels are necessary for the smooth and efficient functioning of the port.. The system should help considerably the process of decision making and should provide means of identifying problem areas quickly and in advance to enable corrective action to be taken well in time.

(b) Cargo clearing procedures including customs

Slow customs and port procedures are a major obstacle to a speedy cargo throughput at most ports, with consequent congested conditions of port storage areas and delays in ship departure. On the whole, the efficiency with which import/export cargoes are processed is low. An improvement of that efficiency has resulted in the overall performance improvement of Aqaba Port, as referred to above, to the extent that infrastructure and berth expansion projects are being now revised and postponed, thus leading to significant savings in capital investment.

(c) Port operational data and performance indicators

Most ports in the region collect statistical data of some sort which, in many cases, are in a form difficult to retrieve or interpret and which, in fact, never reaches the executive decision makers. Collection of data which cannot be used either in the day-to-day operation of the port or in longer-term developments, becomes a futile exercise. There is a need for a careful revision of the whole approach to the relevant data collection and use in Western Asia.

Port management requires constant monitoring of port performance. Port managers should know whether port services to the users are improving or deteriorating and should be able to identify the cause for taking immediate corrective action. The fall-off in labour productivity, increases in ship turn-round time and delays in clearing good out of the port, can be recognized in the short-term. However, when short-term trends persist and performance indicators suggest that port facilities have been stretched to their optimum capacity, then investment in new berths, storage facilities handling equipment, etc., may be necessary.

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identified, which may form the basis for some process of optimization with respect to the best use of existing capital resources and skill. the best technological alternative should be then identified and applied in this context. A world-wide integration of transport from both standpoints of infrastructure development and transport operations might not be conceivable at this stage. Therefore, the ideal and most advanced transport technology might not be the most feasible, humanly and economically speaking.