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DEVELOPMENT AND IMPROVEMENT OF PORTS

Development of Bulk Terminals

Report by the UNCTAD secretariat

CONTENTS

Introduction

1. This report has been prepared pursuant to Conference Resolution 144(VI), paragraph 10, in which the UNCTAD secretariat was requested, inter alia "to undertake an in-depth study on the development of bulk terminals, their physical characteristics; management, operation and availability and conditions of international financing". Since, in its paragraph 1, this same resolution requested the review and updating of the report "Ship and port financing for developing countries" (TD/B/C.4/190) and, in paragraph 9, an examination of the modalities of foreign investments in ports, a separate report dealing with the whole subject of port financing, including that of bulk terminals, has been prepared.1/ The present report, therefore, confines itself to the physical characteristics, management and operation of bulk terminals.

2. The request for this report follows a series of reports2/ dealing with the international sea transport of bulk cargoes and its effect upon the development of the merchant marine of developing countries. The present report examines the port facilities to handle the following cargoes: crude oil, iron ore, coal, grain, bauxite/alumina and rock phosphate. Other cargoes cannot be properly examined in this general study of bulk because of the relatively limited quantities in which they are moved and the rather diversified requirements for their handling.

1/ "Port financing" TD/B/C.4/291.

2/ See, for example, the report of the Group of Experts on problems faced by the developing countries in the carriage of bulk cargoes on its first and second sessions (TD/B/C.4/221 and TD/B/C.4/234 respectively); and "Participation of developing countries in world shipping and the development of their merchant marines: the maritime transport of hydrocarbons", (TD/222/Supp.3).

Chapter I

THE DEVELOPMENT OF BULK TERMINALS

A. Bulk commodities

3. Bulk commodities, which are those loaded or discharged in loose or fluid form, account for the biggest share of the world seaborne trade. During 1983, 68 per cent of that trade, measured by weight,3/ consisted of tanker cargoes and the major drybulk commodities.

4. Crude oil and petroleum products are tanker cargoes while iron ore, coal, grains, bauxite/alumina and rock phosphate constitute the main drybulk cargoes and are referred to as the "major" drybulks. They are traded in large quantities and shipped almost exclusively in bulk carriers. Other cargoes often carried in bulk form, such as sugar, salt, cement, tapioca, etc. are referred to as "minor" drybulks. Lately, the term "neo" bulk4/ has come into use for cargoes such as vehicles, forest products, etc., because they are often shipped in full shiploads.

5. The major drybulks are not completely homogeneous. Grain for example includes wheat, maize, soyabeans, sorghum, barley, oats and rye. Nevertheless broad classifications can be made. Grain may be split into two categories: foodgrains, such as wheat and maize for human consumption, and feedgrains comprising those grains used for feeding cattle. There are also "coking" and "steam" coals, the former agglutinates when heated and is used in steel production, whereas the latter is used in power generation. Moreover, the production of aluminium requires bauxite or alumina, the latter being the refined product of the former. A more detailed classification takes into account the nature of the commodity. Iron ore is thus classified according to the iron content, coal according to the calorific value, and so forth.

6. A common feature of these commodities is that the main users can be easily identified; this is shown in table 1 below. Further, with the exception of grain, bulk cargoes are not seasonal.

Table 1: Bulk commodities and their main users

Commodity	Main user
Crude oil	Power generation; industries in general
Iron ore	Steel industry
Coal: coking	Steel industry
steam	Power generation; industries in general
Grain: foodgrains	Human consumption
feedgrains	Animal feed industry
Bauxite/alumina	Aluminium industries
Rock phosphate	Fertilizer industry

3/ Review of Maritime Transport 1984 (TD/B/C.4/289) p.2.

4/ "Changes in "neo-bulk" trade, transport and handling", Drewry Economic Study No 99. February 1982. p.3.

B. The economic framework

7. Bulk terminals were developed during two different trade environments. The first, covering the 1950s and 1960s, was a booming one; the second, starting in the early 1970s, was characterised by sluggish expansion. More precisely, during the period 1950-1973 world seaborne trade increased six-fold,5/ mainly due to the strong growth of bulk trades, particularly crude oil, while during the period 1970-1983 the world seaborne trade went up by only 20 per cent.6/ The volume of trade and percentage growth for each commodity in the second period is given in table 2.

Table 2: Bulk trades in the period 1970-1983

Commodity	Volume of trade in 1983 (millions of tonnes)	Percentage growth 1970 - 1983
Crude oil	1,020	3
Iron ore	257.4	5
Coal	197.0	92
Grain	199.4	106
Bauxite/alumina	35.8	16
Rock phosphate	43.3	37

Source: Elaborated from Fearnley and Egers Chartering Co. Ltd., World Bulk Trades 1983 (Oslo), and consultancy report prepared by CSR Consultants Ltd. for UNCTAD, London, 1984. Subsequently referred to as the CSR Report.

8. Crude oil was the preferred primary source of energy during the period of rapidly expanding trade and its consumption was doubling every nine years.7/ Transnational oil companies, which were controlling all activities from oil production to product distribution, arranged the transport and refining activities as a whole, taking full advantage of economies of scale. In the sea transport this was achieved by the employment of larger and larger

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5/ Review of Maritime Transport, 1974 (United Nations publication, Sales No. E.75.II.D.13).

6/ TD/B/C.4/289.

7/ G. Foley, Energy Question. (Penguin Books, London 1982) p.132.

vessels particularly on the longer routes, such as those linking the Persian Gulf to Japan and Western Europe after the closure of the Suez Canal, and the commissioning of some major transhipment ports able to accommodate them. Further, refineries were located at the ports of discharge in order to achieve economies of scale in their operations.8/

9. The developments in the energy field during the 1970s were heavily influenced by the successive increases in the price of crude oil and the resulting implementation of energy conservation policies. The volume of crude oil trade started to stagnate while trade in steam coal, seen initially as a substitute, had a short-lived boom.9/

10. The trend followed by the iron ore and bauxite/alumina trades, was similar to that already described for crude oil during the period of expanding trade. Thus, the fact that the major transnational corporations (TNCs) engaged in steel and aluminium industries, were controlling all activities from mining to manufacturing through ownership, equity participation or long term contractual arrangements10/ and were also facing an expanded consumption caused similar effects, namely, the introduction of larger specialized vessels trading in longer, often new, routes with the further processing of raw materials being undertaken at the port of discharge. This trend was less pronounced in the coal and rock phosphate trades. In the coal trade producers were, by and large, relying on traditional suppliers outside the control of the TNCs and it was the same for fertilizer producers in respect of the rock phosphate trade.11/ Although, the advantages of using large bulk carriers were recognised and a few new terminals were developed, the trend to larger vessels in these trades tended to be limited by the capacity of existing terminals.

11. During the period of sluggish expansion in the 1970s, the industrial sector, comprising steel, aluminium and fertilizer industries, suffered from weak demand although, due in part to the time-lag in the commissioning of large ventures planned in more buoyant times, this did not preclude new raw material producers entering the market.12/ More interesting, however,

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8/ P. Hanappe and M. Savy, Industrial Ports and Economic Transformations (The IAPH Head Office Maintenance Foundation, Tokyo 1980) pp. 37-41.

9/ Steam coal seaborne trade almost trebled, in the period 1977-1981. It accounted for 41 per cent of the coal trade in 1981. Source: " Analysis of existing and planned bulk commodity port facilities", CSR Report. op.cit. p.24.

10/ "Control by transnational corporations over drybulk cargo movements" para 64. (TD/B/C.4/203)

11/ Ibid, paras. 65 and 66.

12/ Iron ore exports from the export facility commissioned in 1976 at Saldanha Bay have been well behind expectations and there are doubts about the future of the operation. Source: Seatrade, August 1984, p.39.

was the observed trend towards greater industrialisation in some developing countries - encouraged by cost advantages in labour and energy[13/] although more advanced and cost-effective manufacturing processes[14/] and lesser environmental controls also contributed to this end.

12. The remarkable growth of the grain trade since the 1950s was also accompanied by changes in its composition. Until the beginning of the 1970s it was oriented towards human consumption and therefore dominated by the wheat trade with North American exports, often carried under concessional trade agreements,[15/] being paramount. Since the early 1970s, the trade has relied more on the increased demand for feedgrains in many countries, caused by higher meat consumption associated with higher living standards. Exporters remained unchanged throughout both periods and there was considerable involvement of TNCs on the export side through control of inland transport, storage and loading facilities in ports.[16/] Importers of grain, however, were and still are scattered around the world and demand fluctuates from year to year. In the past some steady importers of foodgrain managed to reduce their level of imports through the increased local production while more recently, others reduced feedgrain imports through the implementation of pricing policies[17/]. The resulting unpredictability of the trade and the multiplicity of destinations precluded the extensive employment of large specialized vessels[18/] and the construction of new import terminals was

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[13/]The production of aluminium requires large amounts of energy, therefore cheap energy is paramount in assessing smelter locations; in the Kuala Tanjung Industrial Port Project cheap hydraulic energy is supplied to a newly built aluminium smelter. Source: Ports and Harbors, September 1982. pp.21-25.

[14/]The impact of direct reduction steel mills in areas of cheap energy, may cause a large proportion of steel manufactures in the future to be reallocated in developing countries, for instance in Western Asia. Source: CSR Report op.cit. p.12.

[15/]Imports to India went on for 16 years under the USA P.L. 480. The Outlook for World Grain Trade. Drewry Economic Study No. 6. (June 1972) p.27.

[16/]TD/B/C.4/203, para 67.

[17/]The Common Agricultural Policy (CAP) of the European Community, increased the price of imported feedgrain, so that derivatives, comprising by-products from the flour milling, starch and distilling industries, have tended to be imported instead. Source: Bulk Handling and Transport, vol. III, p.44.

[18/]In 1970, 59% of the grain trade was carried by bulkers vis-à-vis 86% for iron ore and 69% for coal. Source: Bulk Handling and Transport, vol. I. p.14.

accomplished only in countries for which demand was assured. Elsewhere a good deal of grain was handled through general cargo or lighterage berths.

13. The relative importance of different regions engaged in bulk trades is shown in tables 3 and 4. From these tables it can be seen that, on the export side Western Asia and North Africa predominate in the crude oil trade with 60 per cent of the total; North America dominates the grain and coal trades, accounting for 71 per cent and 49 per cent respectively; South America and Australia are responsible for 59 per cent of the iron ore trade; Australia and Western Africa account for almost half of the bauxite/alumina trade and, finally, Northern Africa and North America make up more than two thirds of the rock phosphate trade.

14. On the import side there are two regions of heavy concentration, namely, Western Europe and Japan; the socialist countries of Eastern Europe and Asia are significant only in the grain trade, accounting for almost a third of imports; North America generates half of the bauxite/alumina trade and, finally, among developing countries, only those located in Southern and Eastern Asia are important importers.

C. Shipping developments

15. The trend towards increasing employment of specialized ships continued apace even through the period of sluggish trade growth - as a comparison of values from columns 3 and 1 of table 5 shows. In the iron ore trade, for example, the share of the trade carried by specialized ships went up from 85 to 93 per cent in the period 1970-1981. Still more important, the meaning of the term "specialized ships" evolved to cover ships able to trade economically in a handful of commodities rather than a single one. An example of this is the growing share of combined carriers in the total combined and bulk carrier fleet, which increased from 18 to 26 per cent during the last decade while the share of the ore fleet shrank from 12 to 6 per cent.19/

16. The increasing use of larger vessels emerges clearly from a comparison of columns 2 and 4 of table 5. Although factors such as the low unit value of the commodities, the large volume traded, and the longhaul nature of the trade explain, in general, this preference; the effect of complementary factors such as: adequate port facilities; regular, long-term buying commitments; and the degree of integration between buyers and sellers, have also contributed to this trend.

19/ Bulk Handling and Transport, vol. II, paper 6/1.

Table 3: Seaborne exports by main regions in percentage of the total trade measured in tonnes

	Crude oil	Iron ore	Coal	Grain	Bauxite/ alumina	Rock phosphate
Developed market-economy countries	11	38	79	72	24	28
North America		8	36	72		28
Australia-New Zealand		30	29		24	
Europe	11					
South Africa			14			
Socialist countries of Eastern Europe and Asia			11			
Eastern Europe			11			
Developing countries and territories	68	47		12	62	65
Northern Africa	10					41
Western Africa	8	9			29	8
Caribbean and North America					14	
South America - Eastern Seaboard		29		12	19	
Southern and Eastern Asia		9				
Western Asia	50					16
Percentage of the total trade	79	85	90	84	86	93
Unallocated	21	15	10	16	14	7
Total	100	100	100	100	100	100

Source: Elaborated from World Bulk Trades 1983. Fearnleys, Oslo, and the CSR Report op. cit. All data for 1983.

Table 4: Seaborne imports by main regions in percentage of the total trade measured in tonnes

	Crude oil	Iron ore	Coal	Grain	Bauxite/ alumina	Rock phosphate
Developed market-economy countries	66	83	86	35	85	60
North America	15				50	8
Japan	14	45	39	14	12	5
Europe	37	38	47	21	23	47
Socialist countries of Eastern Europe and Asia				32	8	16
Eastern Europe				7		16
USSR				15	8	
Asia				10		
Developing countries and territories	15	6	10	16		10
Northern Africa	7					
Western Asia				9		
Southern and Eastern Asia	8	6	10	7		10
Percentage of total trade	81	89	96	83	93	86
Unallocated	19	11	4	17	7	14
Total	100	100	100	100	100	100

Source: Elaborated from Review of Maritime Transport (TD/B/C.4/266) and CSR Report op. cit. All data for 1982 except bauxite/alumina (1981) and rock phosphate (1983).

Table 5: Percentage of trade, carried in specialized ships [a] in 1970 and 1981

Commodity	1970: per cent carried by all specialized ships (1)	1970: per cent carried by large specialized ships[b] (2)	1981: per cent carried by all specialized ships (3)	1981: per cent carried by large specialized ships[b] (4)
Crude oil	-	61	-	93[c]
Iron ore	85	46	93	90
Coal	69	15	85	69
Grain	59	8	91	47
Bauxite/alumina	59	16[d]	71	29
Rock phosphate	41	1[d]	61	10

Source: Elaborated from CSR Report *op. cit.*

Notes:

a/ Specialized bulker > 18,000 dwt.
b/ Large specialized bulker > 50,000 dwt; large tanker > 60,000 dwt.
c/ Only in tankers, the balance carried in combination carriers.
d/ 1975.

17. The proportion of seaborne trade carried by specialized ships of different sizes is given in table 6. In 1981, ships over 100,000 dwt carried almost three-quarters of the crude oil trade, two-thirds of the iron ore trade and almost one-third of the coal trade. Ships in the range 50,000 to 80,000 dwt, which can be roughly equated to Panamax size, accounted for the carriage of about one third of the coal, grain and bauxite/alumina trades. Finally, the handy-sized bulkers, mostly geared, were still important in the coal, grain, bauxite/alumina and rock phosphate trades.

Table 6: Percentage of the 1981 world seaborne trade carried by categories of specialised ship sizes

Commodity	18-50 000 dwt range (handy sized)	Large specialized ships (thousand of dwt)				
		50/80	80/100	100/150	150/200	>200
Crude oil		----26----		----21----		53
Iron ore	3	16	10	34	20	10
Coal	16	32	6	27	4	
Grain	44	35	3	9		
Bauxite/alumina	42	28	1			
Phosphate rock	51	10				

Source: Elaborated from CSR Report, *op. cit.*

D. Bulk terminals

18. During the last 25 years bulk terminals have become one of the well established features in international seaborne trade. Actually, the term is loosely applied but it can be understood as the combination of economic resources, namely, infrastructure, equipment and labour, provided and managed at a well defined modal interface for handling bulk commodities. There is considerable latitude in the above statement because infrastructure may mean simply an anchorage or a berth or include such items as dredging, breakwaters, silos, open yards, etc. The amount of equipment and labour provided will depend on the tonnage and the number of ships to be served at one time. Two other activities are sometimes added to the basic one of cargo handling. These are the ship movement to/from/within the terminal and possibly some degree of commodity processing due to marketing or manufacturing needs.

19. Bulk terminals are better discussed in terms of concentration. They are found in regions heavily involved in the bulk trades such as the Persian Gulf or Western Europe. However, even within these regions, they are concentrated in just a few ports.

20. At the export end for each region and commodity, one or few ports handle a substantial share of the trade. Clearly, this stems from commodity availability, the investment made to obtain it and the suitability of inland transport. The concentration of berthing facilities in Ras Tanura and Mina al-Ahmadi for exporting crude oil from the Persian Gulf is remarkable, as it is the concentration of grain facilities along the lower Mississippi River or the coal facilities in Hampton Roads. For the two latter examples, both located in North America, it has been estimated that during 1982, the 21 per cent of the total number of grain export facilities that were located there accounted for 42 per cent of the export trade. Similarly, 19 per cent of the total number of coal export facilities accounted for 54 per cent of the export trade.[20/] Further, just three ports - Tubarao, Dampier and Port Hedland - accounted for 71 per cent of the iron ore exported from South America and Australia;[21/] only one, Casablanca, accounts for 69 per cent of rock phosphate exports from Northern Africa[22/] and Conakry and Port Kamsar were responsible for almost all bauxite/alumina exported from Western Africa.[23/]

[20/] The 53 facilities in the region exported 141.3 mt of grain while 11 elevators in the Mississippi exported 59.8 mt. Source: World Grain January-February 1984 and CSR Report op.cit. Again, the 26 facilities in the region exported 77.7 mt of coal while 5 facilities in Hampton Roads exported 53 mt. Source: Journal de la Marine Marchande, 29 December 1983 and CSR Report, op. cit.

[21/] Total exports reached 164.7 mt (Source: CSR Report op.cit.) while exports by ports were : Dampier 28.3 mt, Port Hedland 29.6 mt. (Source: Journal de la Marine Marchande 29 December 1983) and Tubarao 58.6 mt (Source: Portos e Navios, August 1983, p.62).

[22/] From total exports of 15.8 mt Casablanca exported 11 mt. Source: CSR Report, op.cit. p.64, and data supplied to the secretariat.

[23/] Source: CSR Report op. cit. pp. 51 and 52.

21. On the import side the concentration is also quite marked. A list of 16 selected major ports having substantial involvement in the crude oil, iron ore and coal trades is given in table 7. Their share in each of the trades carried to Western Europe and Japan is showed in table 8. It can be seen that the eight selected major ports handling crude oil make up only 19 per cent of the total number of ports involved in this trade in both regions but accounted for 45 per cent of the total tonnage handled. A similar situation prevails in the iron ore and coal trades. Furthermore, seven out of the 16 selected major ports were dealing in at least two trades while three of them were involved in all the three trades.

Table 7: Participation of selected major ports in import trades by commodities

Port	Commodities		
	Crude oil	iron ore	coal
Rotterdam	0	0	0
Chiba	0	0	0
Nagoya	0	0	0
Marseilles	0	0	
Le Havre	0		0
Dunkirk		0	0
Antwerp		0	0
Yokohama	0		
Genoa	0		
Trieste	0		
Ijmuiden		0	
Hamburg		0	
Gijon		0	
Gent		0	
Venice			0
Amsterdam			0

Source: Elaborated from Journal de la Marine Marchande, 29 December 1983.

Table 8: Concentration of port facilities in Western Europe and Japan handling bulk commodities

Commodity	No. of Ports			metric tonnes (1982)		
	Total	Major	%	All ports	majors	%
Crude oil	42	8	19	622.2	282.4	45
Iron ore	59	10	17	224.2	93.1	41
Coal	60	8	13	174.8	45.1	25

Source: Elaborated from Journal de la Marine Marchande, 29 December 1983.

22. These major bulk ports, are not only engaged in linking sea and land transport but are also hubs of industrial activity. Refineries, steel mills, chemical and car plants etc. are located within the port area or in its vicinity. They are frequently referred to as industrial ports, implying that industrial activities have precedence over those arising solely from transport. The relevance of these ports for the present study arises from the fact that they have a substantial share in the discharge of bulk commodities. However, they do not have the monopoly and several factors may preclude bulk cargoes from going through them. Few smelters are located in these ports, for example, because cheap energy is paramount in the production of aluminium; also, grain demand arises in places with little or no industrialisation.

23. The main effects of this industrial activity in ports are: an enlarged port area basically oriented to industrial needs; the growth of population around the port; and, the recognition of the economic impact of such ports in regional development. Consequently, land use and environmental controls are major public concerns and studies have been made to assess the economic impact of this type of port in regional development. The latter is of considerable interest for countries, such as Mexico, which are pursuing accelerated economic development policies.

24. Industrial ports are found in countries which favour a co-ordinated national port policy established in harmony with the national economic policy. Some degree of financial support from the central Government is often allowed, as is the case in Japan and France. Indeed, this financial support has been identified as one of the major factors contributing to their establishment.[24/]

25. Transhipment is another feature at the unloading ports. It has been used extensively in the past in the crude oil trades and it is showing again its advantages with the "coal centre" concept. Countries relying heavily on imported steam coal will tranship it at major ports to smaller vessels capable of being handled at other national ports: Japan, Portugal and the Philippines, among others, have been active[25/] in this field.

26. Whether on the import or the export side, concentration still applies to the primary activity of bulk terminals, namely, cargo handling. Total ships' turnaround time is minimised by concentrating equipment and labour on one ship at a time rather than spreading them over all or some ships. Consequently, the minimum number of berthing facilities coupled with the maximum handling rate at each of them is the best way for servicing a given throughput and indeed this is what is found in bulk terminals.

[24/] P. Hanappe and M. Savy, Industrial Ports and Economic Transformations. (The IAPH Head Office Maintenance Foundation Tokyo 1980) pp. 48 to 58.

[25/] Japan Maritime Research Institute Report No. 1. Tokyo. 1984. pp.15-17; "The case of Sines", paper presented to the World Port Conference 1984; "Batangas coal-blending terminal" Bulk System International, October 1983, pp.26-29.

E. An outlook

27. A recent forecast covering the period 1983 - 1995 indicates that the seaborne bulk trade will grow by only 26 per cent to reach 2,211.1 million of tonnes;26/ this suggests that the growth will be moderately higher than that achieved during the period 1970-1983. The forecast trade volumes for different commodities are shown in table 9. The crude oil trade will increase only slightly as a consequence of the diminished rôle of crude oil in covering the energy needs of developed countries.27/ Some developed countries expect that less than half of their energy demand will be covered by crude oil in the future.28/

28. For drybulks the economic growth in the developed countries, which is vital for the performance of the industrial sector, will be decisive since that sector accounts for much of the trade. However the trends, such as the industrial redeployment in cost advantageous countries and agreements such as the one reported recently to produce aluminium using Jamaican bauxite and Colombian coal,29/ may prove to be more important than anticipated.

29. In the grain trade, it seems that developing countries will continue to increase their share of imports because their expected grain consumption will double by the end of the century. These countries already raised their share of the trade, from 27 to 38 per cent in a ten-year period.30/ Lack of adequate port facilities and transport logistic management may continue to pose difficulties in this trade.

30. The employment of specialized and bigger vessels in the drybulk trades will continue as is shown in table 10; further it has been suggested that, in order to cope with draft-restricted routes, wide-beam shallow-draft vessels up to 150,000 dwt could be economically used.31/ Another plausible development could be the introduction of self discharging ships on suitable routes32/and the transport of coal in slurry form.33/

26/"Medium to long-term analysis of the shipping market (1984-95)", JAMRI, Tokyo, 1984.

27/Crude oil is seen as the energy resource of last resort in eight northwestern European countries. Further, the major threat to their indigenous North Sea oil production will seem to come from the cheap gas from USSR and petroleum products from OPEC refineries. Source: "Les hydrocarbures en Europe du Nord" Petrole et entreprise No. 13, August 1984, pp. 21-25.

28/Crude oil will account for 42 per cent of Japan energy needs by the end of the century (Source: JAMRI Report No.1 Tokyo, 1984. p.18); similarly 43 per cent of the EEC energy needs by the year 1990 will be accounted for by crude oil. (Source: Pétrole et entreprise No.17, December 1984, pp. 13-16).

29/Bulk System International, November 1984, p.61.

30/International Bulk Journal, December 1984, pp.76-79.

31/Ports and Harbors, January/February 1984, p.33.

32/Bulk Handling and Transport, vol. IV, pp. 56-61.

33/Betchel and B.P. announced plans to develop slurry technology for coal up to 2" size. Source: International Bulk Journal, November 1984, p.89.

Table 9: Forecast volume of bulk seaborne trade by 1995 and its comparison with 1983 trade volume

Commodity	Forecast 1995 (million of tonnes)	Actual 1983 (million of tonnes)
Crude oil	1130	1020
Iron ore	348.5	257.4
Coal	361.1	197.0
Grain	270.5	199.4
Bauxite/alumina	42	35.8
Rock phosphate	59	43.3

Source: "Medium to Long Term Analysis of the Shipping Market (1984-95)" JAMRI, Tokyo, October 1984 and World Bulk Trades 1983. Fearnleys, Oslo, Norway.

Table 10: Percentage of the trade measured by weight expected to be carried by specialized ships in 1990

Commodity	Per cent of the trade to be carried by all specialized ships	Per cent of the trade to be carried by large specialized ships a/
Iron ore	97	95
Coal	90	76
Grain	93	53
Bauxite/alumina	91	32
Rock phosphate	80	19

Source: Elaborated from Dry Bulk Commodity Seaborne Trade Development 1970/90 CSR Consultants - London 1983.

a/ Greater than 50000 dwt.

Chapter II

PHYSICAL CHARACTERISTICS OF BULK TERMINALS

A. The influence of ships and cargoes

31. A bulk terminal comprises a berthing facility for loading or discharging ships, marine works for the safe access and operation of ships, and land based facilities for transit storage and the execution of related activities such as cleaning, blending, etc.

32. Ship size determines the major features of a bulk terminal. The basic ship dimensions, which are shown in table 11, have a direct influence on marine works; for instance, dredging is directly related to draught. In many cases the berthing facility is located offshore to minimize dredging costs which are high and have to be borne by commodities of relatively low value. Similarly, the ship deadweight is a major factor in assessing the size of transit storage facilities. The quick turnaround time required for these large and expensive vessels dictates the rating for the discharging or loading equipment.

33. The major physical characteristics of bulk terminals are determined by the degree of cargo fluidity. Liquid cargoes can be handled through flexible pipes allowing the ships to transfer their cargoes in relatively unsheltered waters. In fact, this is the reason for exporting such cargoes as iron sands in the form of slurry[34/]. Liquid cargoes also call for pipes, pumps, tanks and ponds, which give the terminal a distinct shape. On the other hand the ship transfer of drybulks is more likely to need calm waters, usually provided by breakwaters. Since the breakwaters are expensive, berthing facilities tend to be located onshore.

Table 11: Basic ship dimensions as function of ship type and size

Type	Size (dwt)	Length (m)	Breadth (m)	Draught (m)
Bulk carrier	21,000	162	22.8	10.4
Tanker	50,000	230	31	12.0
Bulk carrier	62,000	238	32.2	12.2
Bulk/oil carrier	102,000	256	39	15.1
Ore/oil carrier	224,000	314	50	20.4
Tanker	300,000	350	58	22
Tanker	550,000	410	63	30

Source: Elaborated from "Technological change in shipping and its effects on ports: the impact of technological developments in bulk traffics on port facilities" (TD/B/C.4/129/Supp. 5).

34/ Bulk Handling and Transport, vol. I, pp. 29-34.

34. The annual throughput is the third factor which influences the physical characteristics of a terminal. For high throughput terminals, normally handling one or, at most, two commodities, one inland transport mode tends to predominate while ship size determines the speed of the discharging or loading equipment and the storage requirements. For less specialized terminals, flexibility is paramount, and the use of multipurpose cranes with grabs is widespread. Different types of storage coexist side by side and reception or delivery facilities for several inland transport modes, are provided. Finally, at the lower end of the scale, there are facilities which are not even exclusively devoted to bulk cargoes, the reason for mentioning them here is the limited bulk handling capabilities they provide by means of mobile equipment. Grain discharging is one example.

35. Ships and cargoes also exercise a more localised influence upon the physical characteristics of bulk terminals. First, simpler berthing facilities, intended to cope basically with the berthing ship, are used in some circumstances. For instance, the availability of on board cargo handling equipment for discharging liquid and dry bulks35/ allows the use of buoys or dolphins. Although shore based equipment is used in the loading of crude oil, the berthing facility is kept simple because oil is pumped from afar.

36. Secondly, the nature of the cargo and its interaction with the environment exercises a definite influence upon the storage facilities and cargo handling equipment. As shown in table 12, for some commodities such as iron ore and coal, open storage is all that is needed, whereas enclosed or covered storage is needed for grain. There have been instances where, in order to protect the environment enclosed storage has been used even for coal.36/

37. The method of handling the various bulk cargoes is indicated in table 12. The commodities must be handled without their undue degradation, which can be a problem for drybulks due to the friction which develops between commodity and equipment. Certain easy flowing commodities, such as grain and alumina, can be transported upwards and horizontally pneumatically; by conveying them in an air stream like a fluid. More abrasive materials, such as iron ore, are lifted with grabs and transported horizontally by belt conveyors. To avoid dust, sealed grabs and enclosed belt conveyor transfer points may have to be used.

38. Thirdly, activities required by specific commodity trades such as cleaning, classifying and blending also influence landside facilities. For instance, since Canadian grain export regulations insist on clean grain, cleaning machines are prominent in the new silo complex at Port Rupert.37/ In the same facility the strict classification of the incoming grain is maintained throughout because reception and shipping elements of the complex are so arranged that they are able to handle 20 different incoming grades of grain while simultaneously shipping out six grades.

35/The buoy mooring system used in the crude oil trade is a well known example: a lesser known one is the two dolphin facility for discharging grain in Tampico. Source: Bulk Handling and Transport, vol. IV. p.58.

36/Three coal storage silos of 13,000 tons capacity each were built at the Saijo Power station, Japan. Source: Bulk Handling and Transport, vol. IV. Day 2. pp. 10/1.

37/World Grain, vol. 3 No. 1, (November/December 1984) pp. 7-26.

Table 12 Basic data on bulk commodities

Commodity	Physical characteristics stowage factors m^3/tonne	Handling characteristics and method for				Special requirements
		Loading	Unloading	Transfer	Storage	
Crude oil	1.2	Pump	Pump	Pipeline	Tank	-
Iron ore	0.4	Gravity loader	Grab equipped unloader	Belt conveyor	Open yards	Dust filter for certain grades
Coal	1.4	Gravity loader	Grab equipped unloader	Belt conveyor	Open yards	Fire precaution for certain grades
Bauxite	0.8	Gravity loader	Grab equipped unloader	Conveyor	Covered	Dust filter and cleaning necessary if aluminia is handled later
Alumina	0.6	Gravity loader	Pneumatic and mechanical unloader	Conveyor	Covered	-
Phosphate rock	1.0	Gravity loader	Grab equipped un- loader continuous mechanical unloader	Conveyor	Open or closed	Dust filter
Wheat Maize Soyabeans Barley	1.3 1.4 1.2 1.5	Gravity loader	Pneumatic or continuous mechanical unloader; grab equipped unloader	Conveyor	Closed	Protection from vermin and weevils

39. A broad classification of bulk terminals according to their physical characteristics is given in table 13. In order to produce this table the first criteria considered was the location of the berthing facility; the nature of the facility provided the second criteria, while additional factors, such as equipment, commodity etc., were brought in so as to obtain a reasonable picture of the situation.

B. Dredging

40. Whether a bulk terminal is located offshore or onshore some dredging will almost certainly be required. Capital dredging is often performed, by specialized dredging companies. The cost of such dredging, reflects the demand and supply situation for dredging works rather than the actual cost to the dredging companies. The three Australian bulk ports of Port Hedland, Port Walcott and Dampier, for example, benefited from international competition which almost halved dredging prices to A$4.50 per m3.[38/]

41. The cost of dredging depends on the depth at which it is carried out and the soil characteristics. Winds, waves, current and tides influence the cost too, but to a lesser degree. The increase in water depth causes a more than proportional increase in dredging costs, since there is more than a proportional increase in the total volume to be dredged. This arises from lengthened access channels to reach the required water depth on the natural seabed profile and from the need for a widened access channel due to slope stability or for navigational reasons. In addition, the raising of dredged materials from much greater depths, their disposal much further away, the risk of finding unexpected soil layers, the removal of wrecks, etc, all increase the cost of the dredging operation.

42. The huge costs of large dredging projects merit the undertaking of extensive studies in order to balance dredging needs and navigational safety standards. Computer simulation techniques, in which experienced pilots assessed navigational risks posed by different channel configurations, have been used in the examination of the proposed deepening of Hampton Roads to 16.70m.[39/]

43. Difficulties are now being experienced with dredging activities since the sea disposal of dredged materials is now the concern of environmental Government agencies.[40/] This stems from the London Dumping Convention which classified substances in two groups according to their potential for harm to marine ecosystems. The development of numerical standards for such classification and the study of the effect of those substances in pure and dredged form is presently under review at the International Maritime Organization (IMO) with the International Association of Ports and Harbors (IAPH) taking an active role in this respect.[41/]

38/ The Dock and Harbour Authority, vol. LXV No. 763, July 1984, p. 60.

39/ The Dock and Harbour Authority, vol. LXV No. 763, July 1984. pp.54-56.

40/ A dispute, which arose in Hamburg because of insufficient water depth, was caused by disagreement on the classification of the dredged material. Lloyds List, issues of 24 and 29 April 1984.

41/ Ports and Harbors, May 1984, p.8.

Table 13: Classification of bulk terminals according to their physical characteristics

Berthing facility		Complementary features	Examples
Location	Nature		
Offshore	suitable anchorage	Floating equipment for loading/ unloading	Floating transfer equipment placed alongside seagoing ship sometimes working in conjunction with river barges i.e. loading grain in the Mississippi and iron ore at Mormugao; discharging grain at Rotterdam
		on board equipment for unloading	seagoing vessel discharging into barges i.e. discharging grain with mobile pneumatic equipment into barges at Chittagong
	buoys	ashore equipment for loading and onboard equipment for discharging	discharging crude oil at S.B.M. loading crude oil and slurries at S.B.M.
	fixed berthing structure (dolphins)	landside facilities offshore	i.e. 20 Ha.man-made island at the end of 5 Km causeway: Robert Bank facility near Vancouver for coal exports
		land side facilities onshore	sea islands for loading/discharging crude oil i.e. loading at Mina al-Ahmadi: discharging at Multedo (Genoa)
Onshore	"finger" type berth or dolphin arrangement	fixed storage layout for one (or very few) commodities; landside equipment moves on a fixed pattern	i.e. dolphin arrangement with quadrant loaders for iron ore exports at Tubarao; Pier No. 6 with travelling loaders for coal exports at Hampton Roads; GEM Europort jetty for discharging grain at Rotterdam
	"marginal" type berth	idem	i.e. quaywall with crane and grab system up to 85t capacity for discharging coal at Maasvlakte-Rotterdam; quaywall with travelling loader for rock phosphate at Casablanca
		fixed multicommodity storage layout; landside equipment moves on a fixed pattern	i.e. quaywall with crane and grab system for discharging several drybulks to covered/uncovered storage at St Laurenhaveen - Rotterdam
		flexible multicommodity storage layout: landside equipment moves on a flexible pattern	i.e. quaywall with crane and grab system supplemented by mobile hoppers for discharging several drybulks; stacking by means of mobile belt conveyors at Bassens-aval Bordeaux
	general cargo berth	storage may be available; mobile equipment available	i.e. any general cargo berth handling drybulks by means of mobile equipment (grabs with hoppers, pneumatic) on temporary or permanent basis

C. Offshore terminals

44. Those offshore facilities which are found at both ends of crude oil trades have been discussed in detail in an earlier secretariat report[42] where it was explained that berthing facilities fell into two types: floating buoys and fixed dolphin structures. Therefore this section will focus on the relationship between the berthing facility and the site's natural conditions as well as the implications for the loading and unloading equipment if any.

45. Since the berthing facility is usually exposed to waves, currents and winds, its utilisation depends on the allowable ship movements during the loading or unloading operations. Clearly, flexible connections, such as those used in the handling of liquids, allow some latitude in those movements; this is also the case for loading drybulks for which the force of gravity is used and therefore there is no contact between the ship and the shore based loading equipment. Thus, the utilisation of the offshore terminal is mostly restricted to liquid trades and loading drybulks.

46. The crucial question for offshore terminals is their availability, i.e. the number of days in which wind and wave conditions allow the terminal to be operated. Single buoy moorings, for example, cannot operate above the 2-3m wave range.[43] So every effort is made to raise the availability, as exemplified by the variable orientation fixed berth for loading iron ore at Punta Colorada.[44] In this case, availability was raised from 255 to 330 days by using a dolphin arrangement which provides three different dock faces.

47. The loading of drybulks calls for equipment, such as slewing bridge loaders, to be installed on the berthing facility which comprises a suitable layout of jetty and dolphins. The loading element of this type of loader is supported at two points - at one end and at half its length - by platforms. The end support is the fixed point of the slewable system with the latter running over a curve or straight path, a wide coverage of ship's holds can be reached in this way. The two alternatives available for this type of loaders are shown in figure 1. Civil and mechanical engineering aspects are normally well integrated in the design and execution of these facilities which are relatively cheap. The only drawback is their inability to cope with any ship, in fact they are conceived to serve a certain range of ship size. This type of facility is found in the iron ore, coal and bauxite/alumina trades.

48. The loading of grain and coal in the lower Mississippi provides another example of this type of terminal. There, the ships can stay at anchor or alternatively can be secured also by buoys in order to allow a better loading operation. The essential element is the floating crane which discharges river barges and loads seagoing ships by means of grabs. It has been reported that the system will be used for exporting coal on a temporary basis from Bahia Portete[45] and the same system is probably envisaged for the export

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42/ TD/B/C.4/129 Supp. 5.

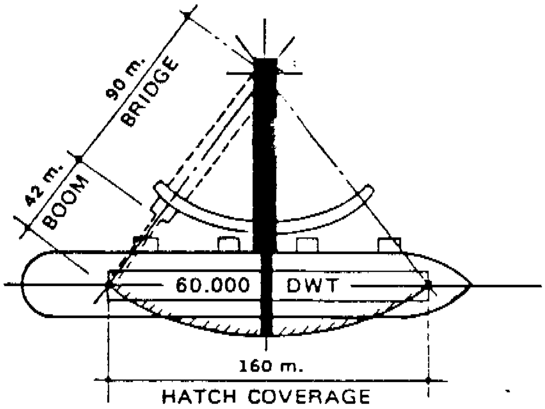
43/ TD/B/C.4/129 Supp. 5.

44/ Ports and Harbors, February 1978.

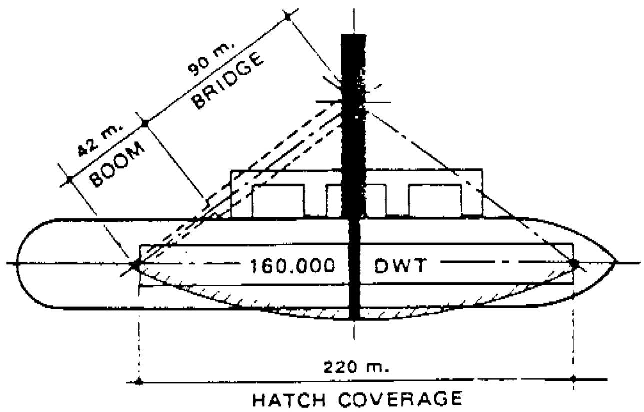
45/ International Bulk Journal, March 1984. p.17.

transhipment facility at Paranaguá in which grain will be transferred from 30,000 dwt bulkers, able to go up the River Plate, to Panamax ships.46/

FIGURE 1
Slewing bridge loaders



Radial loader



Linear loader

49. The exposed location of most berthing facilities has led to the development of better techniques for the safe mooring of vessels.47/ The use of breasting dolphins covered with large fenders to receive the impact of the berthing ship has emphasized the inconvenience of the recoiling proprieties of most fenders. Recently, the need for a joint approach to both mooring and fendering as a means to avoid excessive ship movements has been advocated.48/

46/ The Dock and Harbour Authority, April 1984. p.273.

47/ See for instance: "Guidelines and recommendations for the safe mooring of large ships at piers and sea islands", Oil Companies International Marine Forum 1978, Witherby and Co. Ltd., London.

48/ The Dock and Harbour Authority, February 1984, pp. 209-212.

D. Onshore terminals

50. Onshore terminals, which predominate at both ends of drybulk trades, are associated with large breakwaters, huge locks and extensive land requirements. Berthing facilities are generally pier type for loading terminals and marginal type for discharging terminals.

51. Breakwaters, both those which reflect wave energy and those which dissipate it, are very common marine structures. However, the cost of building breakwaters in deeper and deeper waters and more exposed locations[49/] has prompted the extensive use of multi-legged armour blocks, instead of the compact conventional ones, in the protective outer layer of new breakwaters. Recently, some of these newly built breakwaters have been severely damaged by the sea.

52. Subsequent investigations have provided a better understanding of breakwater behaviour and indicate that their failure is a chain process. The use of large numbers of multi-legged blocks, which rely on interlocking as well as weight to resist wave attack, causes the failure of the whole breakwater soon after the failure of a few individual units has occurred. New integral design methods,[50/] derived from these experiences and including hydraulic, soil and materials parameters, are now under development but they will not replace the need for reliable field data to conduct useful laboratory tests during the design phase.

53. The provision of land is particularly relevant in the case of industrial ports.[51/] Harbours for these ports are built by reclamation or by excavation. Reclamation is recommended for seacoasts with relatively shallow and calm waters and as far as is feasible dredged materials are used. Excavation is used on open and exposed coasts with waste land or marshes at the back; in places with a considerable tidal range, the connection with the sea or river is made through locks.

54. Some drybulk loading terminals have similar features to those mentioned under section C, namely, jetty and dolphins for berthing ships and supporting quadrant loaders. Others use rail-mounted travelling loaders which move along a pier. Travelling loaders such as that shown in figure 2 can work with a variety of ships, sometimes with geared ones, and also trim them mechanically.

55. Drybulk discharging equipment is shore based and it is dominated by the grab-equipped crane such as that in figure 3. Although payload is roughly equal to the grab weight the flexibility for handling any bulk commodity by simply changing the grab may explain this preference. Discharging rates are improved by reducing the grab cycle, with gantry cranes discharging into a hopper located near to the quay edge being the most effective. Average

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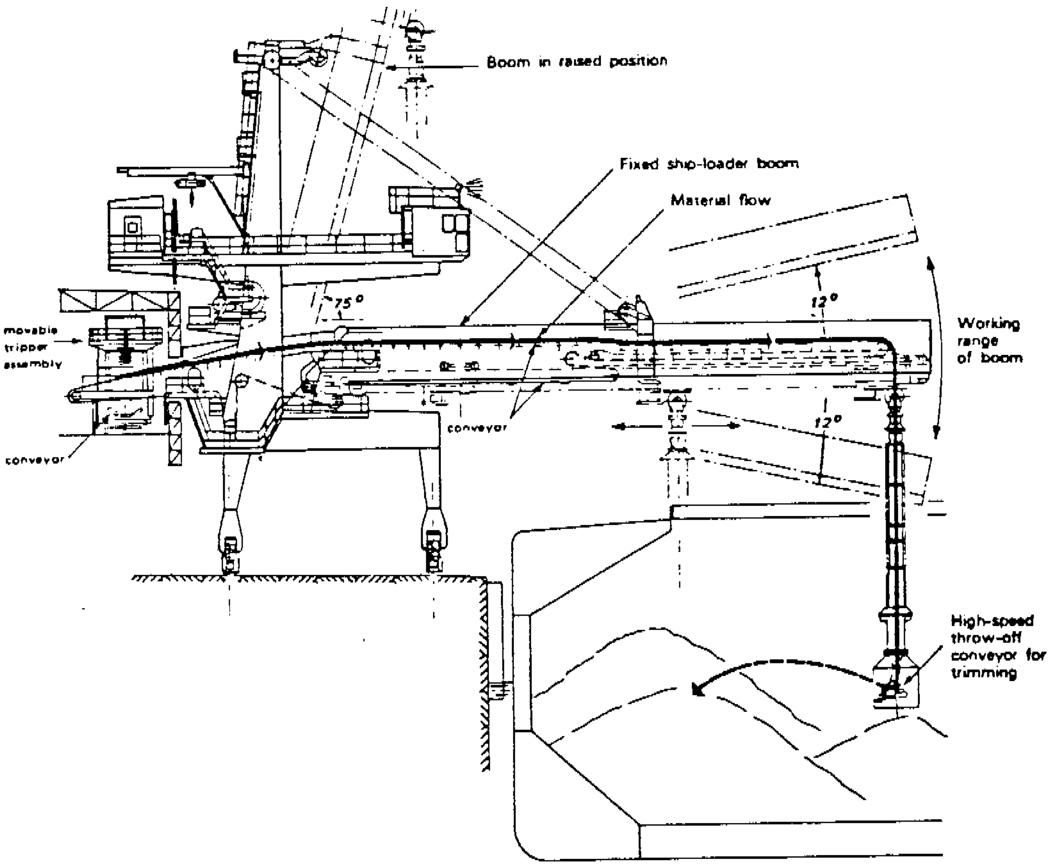
[49/] Up to $US150,000 per linear meter. Source: The Dock and Harbour Authority, September 1981.

[50/] The Dock and Harbour Authority, July 1984.

[51/] In Japan 477 km^2 were developed for this purpose in the period 1956-80. Source: Ports and Harbors. Ministry of Transport. 1981.

unloading rates tend to be about half the rated capacity.[52] Level luffing cranes are also used but their rated capacity is lower than that stated for gantries; the average unloading rate is further diminished if the rotation of the crane has to be executed during the grab cycle.

FIGURE 2
Example of travelling ship-loader



56. For free flowing commodities such as grain and alumina pneumatic equipment is used. This is usually made up of two suction lines mounted in a gantry with a combined capacity of about 1,000 t/h. The advantages of a dust free operation and efficient clean up of ship holds are somewhat reduced by the high energy consumption.[53]

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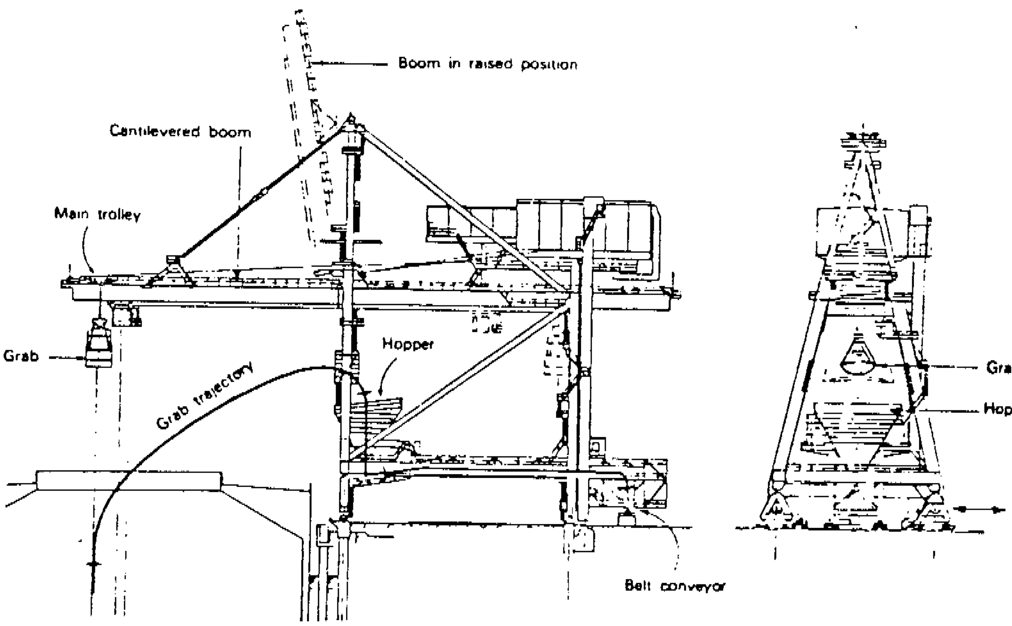
[52] For the 81 tonnes grab unloaders at Oita average discharging rates are between 50 to 60 per cent of their 2,500 t/h rated capacity. Source: Bulk Handling and Transport, vol. II, pp. 20-23.

[53] It is claimed it is above 0.6 kwh per tonne. Source: Bulk Handling and Transport, vol. I. p.135.

FIGURE 3
Travelling overhead trolley unloader grabbing crane



57. Recently a wide range of both vertical conveyors and bucket elevators have been introduced for the discharge of both free flowing commodities and coal. It seems that the environmental advantages - less noise and dust, the energy savings (consumption is claimed to be less than 0.4Kwh/t) and the reduced machine weight - have overcome the previous doubts about their reliability.

58. Landside facilities have evolved consistently with the practice for cargoes to follow the indirect route, that is ship to storage and from there to inland transport vehicles, or vice versa. In this way a slow ships' turnaround time due to the practice of direct reception or delivery of cargoes is avoided. The storage facility effectively disconnects the loading/discharging of ships and the receipt/delivery operations. For export terminals this trend which started in the mid-1960s, continues apace, as is showed by the completion of two coal terminals at Hampton Roads.54/

59. The storage of cargoes is either on the ground, as in open yards and warehouses, or vertically in silos. The selection of the type of stockpile is paramount for achieving a better land utilization in open yards and warehouses. In open yards, the windrow type stockpile, which is made up of a triangular transversal section running along a distance of perhaps 1,000 m. is frequently selected.

60. Belt conveyors which dominate in drybulk horizontal transport are also used for stacking and reclaiming operations. Stacking is made with a stacker, usually a railmounted machine, widely used when storing on the ground. This machine has a tower-like structure, receives the material by means of a tripper and stacks it out by means of a boom-mounted belt conveyor. Reclaiming is

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54/ Bulk Systems, August 1984, pp. 32-37.

made, from the top of the stockpile, by reclaimers which are similar in shape to stackers but have in addition a revolving wheel with buckets at the extreme end of the boom. Stacker-reclaimers which combine both functions in a single machine are often used. Rated capacities for these machines vary from 1,000 to 3,000 ton/hour with availabilities of as much as 90 per cent being mentioned.55/ Reclaiming is also possible from the bottom of the stock: in this case belt conveyors which normally run beneath the stockpile in a tunnel are directly employed. Material is fed to the conveyor via a variable opening and a chute. Typical stacker and stacker-reclaimer machines are shown in figure 4.

61. For large terminals, belt conveyors are fixed structures with their layout and stockpile types being carefully selected to achieve as continuous a flow of material as possible. This calls for the use of surge bins to cater for the time a shiploader takes in changing hatches. For low throughput terminals handling several commodities, the alternative is to use a mobile belt conveyor. In this way flexibility is achieved since changes in the storage layout and pile types in accordance with cargo requirements can be made at relatively short notice.56/

62. Rail and river transport are found to be the most common inland transport modes but road transport and long distance belt conveyors are also used. The extent and nature of the reception and delivery facilities of terminals depend on the type of inland transport. With a railway connection, for example, the reception or delivery facilities will depend on the railcar type, the number of railcars per train, and the planning of trains. Single and tandem rotary car dumpers with peak discharging capacities of between 4,500 to 7,000 tonnes/hour are found in export terminals.57/

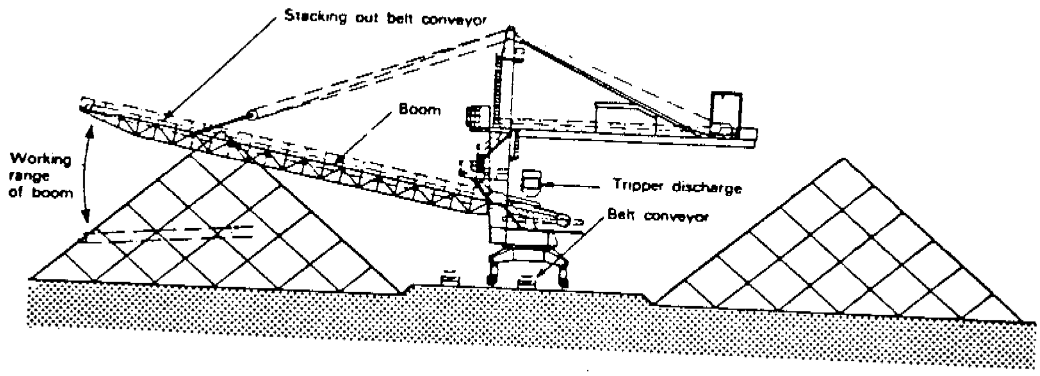
55/Bulk Handling and Transport, vol. IV, pp.28-29.

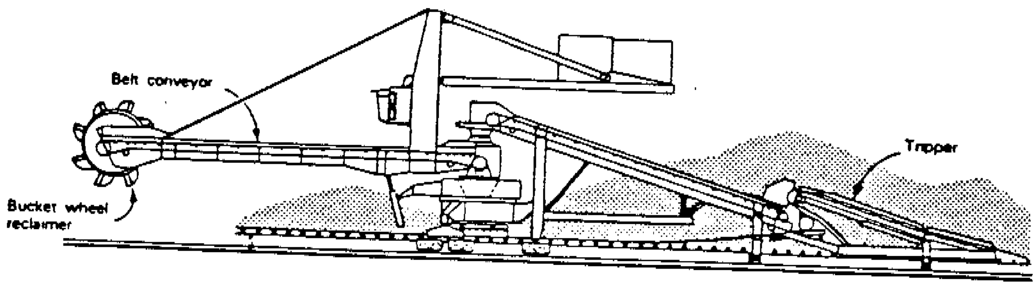
56/For example at the Bassens-aval multi-bulk terminal at Bordeaux. Source: Bulk Handling and Transport, vol. IV, pp. 8/1 to 8/6.

57/Bulk Handling and Transport, volume III, p.86.

FIGURE 4

Stacker and stacker-reclaimer





Chapter III

THE MANAGEMENT AND OPERATION OF BULK TERMINALS

A. Management

63. The management of a bulk terminal - that is, the organizational structure, procedures and policies - is influenced by two factors: the mechanisation of the cargo-handling activity and the owner-user relationship. Mechanisation causes the management of all bulk terminals to differ radically from the labour-intensive activities of the general cargo facilities, while the various owner-user relationships cause the management of bulk terminals to differ amongst themselves. Table 14 shows a typical terminal organization structure in which the management functions, goals and tasks are provided.

Table 14: Organization structure for a terminal

FUNCTIONS	Commercial	Operations	Technical Services	Finance	Personnel
GOALS	Maximize annual turn-over and income	Maximize service at minimum costs	Maximize availability of facilities at minimum costs	Financial control	Optimum allocation of skills
TASKS	. Acquisition of cargo and customers . Required level of services . Contracts . Market research	. Macro sche-duling of users and resources . Micro sche-duling of cargo hand-ling	. Maintenance and repair . Spare parts	. Cash flows . Budget . Salary . Financial reporting . Statistics . Tariff-structure	. Social con-tracts . Hiring of personnel

64. The high level of mechanisation of bulk terminals means that the maintenance department feature prominently in organisational charts. This department is responsible for the implementation of effective procurement and inventory procedures, and effective preventive maintenance to reduce the risk of breakdowns. Similarly, the personnel department will need to have policies that emphasize recruiting personnel with the right skills, providing stable employment, adequate training, and so forth.

65. The influence of the owner-user relationship stems from the degree of linkage that may exist between the two. A close owner-user relationship, which is the result of TNCs or/and government involvement in the logistics of some commodities, often causes terminals to be specially dedicated, that is, terminals not intended for public use because they are linked to a transport

chain. On the contrary, a loose or non existent link is characteristic of common-user terminals. Specially dedicated terminals are fairly common worldwide58/ in all trades with the exception of discharging facilities of the grain trade.

66. Whether a terminal is specially dedicated or common-user has implications for its management. For example, the marketing function which is unimportant in a specially dedicated terminal, is paramount in a common-user one, to the extent that even participation in schemes aiming to generate new cargoes could be envisaged.59/ Also the development of dedicated terminals is eased by the reduced uncertainties about ships and cargoes which lead to straightforward design and project management with the latter covering the period from inception to commissioning.

67. Specially dedicated terminals are operated by companies under different arrangements with port authorities, local or national governments. Leasing and concessions are often modalities of the arrangements which can be entered into. Although the majority of these terminals are devoted to cargo handling, some of them, particularly those located in remote places, can be considered as ports in their own right since they provide services to both ships and cargoes alike.

68. Since a dedicated terminal is normally attached to a specific trade, the development of a link between the TNC with interests in that trade and the terminal operating company is common. The linkage is provided by the finance which the TNC may make available to the company for commissioning the facility.

69. Dedicated terminals engaged in trades belonging to the mining and energy sectors are regarded by some developing countries as being remote from the scope of transport development.60/ The view that the participation of a TNC in a terminal operating company is not a substantive item in ventures belonging to these sectors is supported by the fact that only a fraction, ranging between 10 to 15 per cent,61/ of the total investment is devoted to port

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58/All surveyed iron ore and bauxita/aluminia loading terminals are dedicated terminals. Source: CSR Report op. cit.

59/A European grain terminal operator is believed to be involved in the planned development of export transhipment facilities at Paranagua. Source: International Bulk Journal, August 1984, p.19.

60/The development of coal export facilities at Puerto Bolivar (Colombia) is within the scope of a 33-year agreement between Intercor (Exxon subsidiary) and Carbocol (State company). Source: International Bulk Journal, March 1984, p.13.

61/Port investment amounted between 9 to 14 per cent in two recent coal projects in Colombia and Canada. (Source: Seatrade, April 1984, p. 19 and The Dock and Harbour Authority, June 1984, pp. 34-35) while it amounted to 12 per cent in an aluminium project in Indonesia (Source: Ports and Harbors, September 1982, pp. 21-25).

facilities. Further, even for the same trade, the TNCs share in total investment fluctuates widely from country to country.62/

70. Both common-user and dedicated terminals are also developed, or allowed to be developed, by countries within the context of their transport networks, usually under the umbrella of a port authority or similar body. As such, they can benefit from public funds for marine works. This is the case of terminals located in commercial and industrial ports. These terminals have two features in common: first, their planning and development is part of the master plan for the development of the port and second, the services they provide are restricted to cargoes.

71. There are some general issues concerning the management of all bulk terminals: first, the high cost of marine works particularly dredging; second, the impact of terminal costs on the landed value of commodities and third the adjustment of surplus labour.

72. An important concern of Governments or terminal companies developing facilities to serve bulk trades is the high cost of marine works, particularly dredging. In some cases, dredging programmes have been carried out progressively over the years to correspond to user's needs63/ but in other cases controversy has arisen and, as a result, the users have had to produce answers of their own.64/ For developing countries the problem is compounded by the financial difficulties of obtaining foreign funds to finance capital dredging programmes.

73. The direct impact that terminal costs may have upon the landed value of commodities is another source of concern for management. With average f.o.b. values for many commodities at around $US50 or less per tonne, as is the case with iron ore, coal, bauxite and rock phosphate, and freight rates amounting to about 30 per cent of that figure, all terminal costs need to be watched closely. For other commodities costing over $100 per tonne terminal costs are less critical. However, facilities for importing grain in many developing countries are rather rudimentary and this limits the size of vessels which can be employed, causing freight rates to be significantly higher than they need be65/ and the payment of demurrage.

To move a tonne of soyabeans through Santos costs 21 $. It is the highest in Brazil. Costs in Paranagua are only 7 $/tonne. (Seatrade Week April 14-20, 1989 page 10)

62/In two aluminium projects the Government participation was 10 per cent and 51 per cent of the total investment. Source: Ports and Harbors, September 1982, pp. 21-25 and The Dock and Harbours Authority, June 1984, pp. 31-33.

63/For instance, since 1st January 1985 the available draft at Rotterdam is 72'.

64/It has been suggested that the cost-effective solution of "topping off", that is completing a ship's cargo at sea by mean of a self discharging ship, could preclude the need for dredging in the coal trade of the United States. Source: WWS/World Wide Shipping, December 83/January 1984, pp. 19-29.

65/Savings of up to 50 per cent in freight rates can be made depending on routes, port facilities, tonnage imported etc. Source: Report for item 9. International Wheat Council, Session 101.

74. Another source of concern for Governments is the adjustment of the labour force to appropriate levels for the highly mechanised nature of the operation of bulk terminals. It may present a particular problem when the new terminal replaces previously used breakbulk facilities and thus requires only a fraction of the dockworkers previously employed. The difficulty is less serious, or even non-existent, in the case of newly built ports were a new work force must be recruited.

75. Finally, the development of each terminal is normally faced with a unique set of problems arising out of differences in site conditions, the nature of the commodity, the scope of the operation and whether or not major marine works are required. Representative figures for development costs and completion time are very difficult to come by. For example, large crude oil terminals, built at the beginning of the 1970s, cost well above $US100m.66/ A review of the technical press indicates that the development costs of some newly built dry bulk terminals were in the range of $US50m to $US150m. Furthermore there are considerable differences in the breakdown of the development cost; it has been reported that for some dry bulk terminals the cost of the civil works, that is excluding all equipment, varies from 12 to 52 per cent of the total cost.67/ Reference costs for some items of drybulk handling equipment are given in table 15. It seems that construction time is rarely less than two years, with 27 and 35 months being mentioned as the time taken to build two recently built coal export terminals.68/

B. Operation

76. The operation of bulk terminals is dominated by the need to minimize ship time in port by maintaining as continuous a flow of cargo as possible. Since the overall performance of the handling system is governed by the element having the lowest performance, all parts of the system should be designed to allow the ship loader or unloader to work at its full potential.

77. The movement of cargoes on a continuous basis allows a handling system to work at its full potential all the time. This is the case for liquids in which pipes and pumps are used. For drybulks, however, the execution of activities of an essentially discontinuous nature, such as the use of grabs, and sampling and weighing, will lead to spare capacity in some elements of the handling system for most of the time. For example, belt conveyors are designed to match the free digging handling rate of a grab, although that rate is achieved only during a fraction of the total time the grab is used.

66/ TD/B/C.4/124/Supp. 5. p.5.

67/ Bulk Shipping and Terminal Logistic, Report 5204, The World Bank. July 1984, p.242.

68/ Bulk Systems, August 1984, pp. 32-36.

Table 15: Selected Bulk Equipment Project Cost Data

Description	Capacity	Unit	Cost (US$)	Year
Ship Unloaders	600 tph	each	1.6 million	1979
"	540 "	"	2.0 "	1981
"	1,000 "	"	2.24 "	1979
"	1,800 "	"	3.47 "	"
Ship Loaders	500 "	"	0.54 "	1981
"	1,000 "	"	0.90 "	"
Conveyors	300 "	metre	816	1979
"	600 "	"	1,122	"
"	600 "	"	2,000	1981
"	1,000 "	"	1,530	1979
"	1,200 "	"	1,735	"
"	1,500 "	"	2,040	"
"	1,200 "	"	2,200	1981
"	1,500 "	"	2,500	"
"	1,800 "	"	2,347	1979
"	2,000 "	"	2,551	"
Stackers	600 "	each	0.61 million	"
"	1,000 "	"	0.73 "	"
"	1,800 "	"	0.97 "	"
Reclaimers	600 "	"	1.22 "	"
"	1,000 "	"	1.53 "	"
"	1,800 "	"	2.14 "	"
Stacker/Reclaimer (Rec. Cap)	1,000 "	"	1.8 "	1981
Tripper cars	-	"	0.13 "	1979
Wagon loading station	-	"	0.35 "	"
Truck loading station	-	"	0.30 "	"
Major surge bin	-	"	0.31 "	"
Minor surge bin	-	"	0.09 "	"
Transfer cars	-	"	0.27 "	"
Rail weigh bridge	-	"	0.055 "	1982
Road weigh bridge	-	"	0.055 "	1981
Electronic scales	-	"	0.011 "	"

Source: World Bank Project Files.
Quoted in Bulk Shipping and Terminal Logistic, Report 5204.
The World Bank, July 1984, p. 254.

78. Nevertheless, the achievement of a continuous flow of cargo calls for a dedicated operational management able to co-ordinate the different parties engaged in moving cargoes in or/and out of the terminal, to establish the actual flow of cargoes within the terminal, and to sustain it at the desired level during the specified time.

79. The task of co-ordinating different parties is complicated by the number of inland points and parties served, whether one or more inland transport modes are used, and the number of commodities and trades involved. Obviously, to have a programme of ship arrivals, as is found in vertically integrated trades, helps but even in such cases, due to the many variables involved, computers are often used to obtain a cost-effective operation. For example, at one bulk terminal[69/] a computer is used to allocate the amount and location of storage for each customer, and then keep track of their individual stocks. In addition, the computer is used to keep details of railcars to help different companies in their fleet management.

80. The establishment of the material flow pattern will take account of equipment and storage availability as well as the activities to be performed simultaneously. It could also be described as storage management. Whether cargoes are just stacked apart for shipping or with a view to blending the use of computers is again invaluable. Traditional control rooms, with large panels representing visually all items of terminal equipment and manual operations, are being replaced by terminals with visual display units and pre-programmed decisions are being made by the computer. Software computer programmes can advise on the best way to carry out a particular task, taking into account all factors involved, and thus restrict human error to a minimum. They can also monitor actual flows of cargoes within the terminal.

81. The sustaining of high handling rates over long periods is helped by automation and efficient preventive maintenance. Computer controlled machines can be remotely operated whilst for others, partial automation may be used. For instance, grab-equipped cranes at Oita[70/] allow the crane drivers to concentrate solely in the grabbing phase because other movements of the grab cycle are executed automatically. Even preventive maintenance can be computer assisted. In the most advanced systems, sensors, suitably located in the equipment, continually monitor its current state. The information is then compared with preset values and, when corrective action is needed, the computer will indicate the action required.

82. While the achievement of uninterrupted operations in large drybulk terminals is helped with state of the art technology, this is not the case for many terminals in developing countries geared to handle several bulk commodities with smaller throughputs. Nevertheless, management should prepare contingency plans and authorize on-the-spot decision making to establish a continuous flow of cargo through the terminal at levels commensurate with available facilities.

[69/] The Conneaut terminal located at the Great Lakes handles 19 m tonnes/year of coal, iron ore, concentrates and other bulk cargoes. Source: Bulk Handling and Transport, vol. I, pp. 41-52.

[70/] "Discharging berths of Nippon Steel Works", Bulk Handling and Transport, vol. II, pp. 20/1 to 20/5.

83. In general, weighing and sampling of drybulks conflicts with the principle of continuous flow because higher accuracies can be reached only through static methods. Since all loaders perform a continuous operation, the conflict occurs mainly at the loading end of the trade. For grain static weighing is universally done while for other commodities ship's draught is the most frequent method employed. Some terminals have recently introduced continuous weighing methods which, it is claimed, can improve the accuracy of the former method by 100 per cent.71/ Since manual sampling is not feasible above flow rates of 400 tons per hour, due to the danger of personnel injury, most terminals rely on mechanical sampling, with moisture determination being one of the most relevant items in the process. In all cases, the investments leading to a better accuracy in the performance of these activities have to be balanced against potential gains which depend on increased cargo throughput.

C. Utilisation

84. One measure of the utilisation of a bulk terminal is the occupancy rate of the berthing facility. Bulk terminals normally have lower occupancy rates than general cargo facilities. This stems from the fact that there are fewer berthing facilities and the unit cost of ships tend to be higher than those of berths. However, high berth occupancy values can be achieved,72/ although whether this is at the expense of ship waiting time will depend on the regularity of ship arrivals.

85. The level of service provided by a terminal is given by the ship turnaround time which, in the absence of congestion, is made up almost exclusively by the time taken in loading or discharging a ship. Therefore terminal operators, specially those working in a competitive environment, usually guarantee a minimum handling rate.

86. Handling rates are roughly the same at both ends of the crude oil trade.73/ However, as table 16 shows, for drybulks it takes longer to discharge a ship than to load it. This stems from the fact that the same rate can be maintained over the whole loading operation while the discharging rate tends to diminish as the operation progresses. In fact, the discharging rate is at its lowest at the end of the operation due to the need for cleaning the holds.

71/ Draught survey can be deemed to provide plus or minus 0.5 per cent accuracy (Source: Bulk Handling and Transport, vol. II. p.46) while at Narvik an accuracy plus or minus 0.2 per cent is claimed (Source: Ports and Harbors, February 1976, pp. 22-27).

72/ At Tubarao Pier No. 1 the average occupancy rate in 1980 was 78 per cent. Source: Anuário Estatístico Portuário 1980, Empresa de Portos do Brasil S.A.

73/ TD/B/C.4/129/Supp.5. p.74.

Table 16: Typical drybulk handling rates by commodity and type of terminal

Commodity	Type	Rate (tonnes per hour)
Iron ore	Load	4925
	Discharge	2155
Coal	Load	3230
	Discharge	1575
Grain	Load	1490
	Discharge	945
Bauxite/aluminia	Load	1850
	Discharge	1140
Phosphate rock	Load	2320
	Discharge	950

Source: CSR Report op.cit. p. 116.

87. A review of recent port information 74/ indicated that congestion exists in some bulk trades as well as pointed out some of the factors which hinder terminal performance. Congestion is more likely to occur in the grain trade because of its seasonal nature and the many extraneous factors affecting demand; recently, congestion has been particularly serious in a number of African countries experiencing pronounced food shortages due to insufficient facilities for handling grain in bulk. Elsewhere, weather conditions have adversely affected operations in several ports.

88. Safety is very important for the efficient utilisation of terminals because accidents may put facilities out of operation for long periods. 75/ The concern for safety in crude oil trades originated a set of rules 76/ for the safe operation of terminals. As for the grain trade, the explosions and fires which occurred to elevators in North America in the last decade led to the establishment of a Task Force to look into the matter. Its report 77/ suggested a series of measures to be taken in order to prevent dust explosions. Paramount among them was the recommendation that grain dust must not be recirculated in the grain stream once it has been removed.

74/ BIMCO Bulletin Weekly Circular. (November and December 1984).

75/ Recently, a grain terminal was out of operation for 16 months due to a fire which affected its installations. Source: ALAMAR Informativo No.471 p.6.

76/ International Safety Guide for Oil Tankers and Terminals (Published by Witherby and Co. Ltd., London).

77/ "Prevention of dust explosions in grain elevators - an achievable goal" Bulk Handling and Transport, vol. II.

Chapter IV

CONCLUSIONS AND RECOMMENDATIONS

89. Since the 1950s crude oil and "major" drybulks have been progressively handled through terminals which were developed to cope with progressively larger and more specialized vessels. The pace of development, however, has not been even. It was faster in terminals serving the industrial/energy sector than in those serving the grain trade.

90. Concentration characterises bulk terminals. Exporting terminals serving a given trade are concentrated in a few ports of one or two geographical regions. Importing terminals serving all trades, however, are concentrated in a few ports of two regions, namely, Western Europe and Japan; in both regions the majority of terminals are closely related to industrial port development.

91. Industrial ports are relevant to developing countries because the industrialization process has often been port based. Therefore, an area suggested for future research is the examination of the factors which have contributed to the establishment of industrial ports and the likelihood for similar developments spreading to other countries under different circumstances.

92. Ships and cargoes are major factors behind the physical characteristics of bulk terminals. Terminals trading in just one or two commodities have high capacity cargo handling equipment, which operates on a well defined pattern, with their berthing facilities being located offshore or onshore in accordance with the site's natural conditions. Other terminals handling several commodities require flexibility and therefore equipment and storage are so provided to serve in a variety of circumstances. The experiences of a few multibulk terminals may be of interest for those countries having the need to handle limited volumes of several bulk commodities in a single facility.

93. Many grain discharging facilities in developing countries simply consist of general cargo berths with some specialized mobile equipment. Since the share of grain imports in these countries will increase in the foreseeable future the development of more specialized grain discharging facilities will be needed.

94. Specially dedicated terminals, which are part of a commodity transport chain, are common in the industrial/energy sector, with developing countries being engaged as exporters in the majority of cases. Ventures in this sector require huge investments, of which terminal investment is only a part, and arrangements between TNCs and Governments for the development of such bulk terminals are common. Management and operation of bulk terminals is often carried out by a body completely different from that which manages and operates the commercial ports.

95. An assessment of the performance of bulk terminals in serving a trade on a world-wide basis calls for a detailed analysis of the main trade routes. Trades serving the industrial/energy sectors tend to be catered for by the activities of TNCs and Governments. It is suggested, therefore, that the grain trade is one in which such an exercise could be advantageously conducted since there is strong evidence to suggest that inadequate discharging storage and delivery facilities in many developing countries is costing these countries hundreds of millions of dollars a year in excess freight costs.