CONTAINERISATION AND PORT REQUIREMENTS

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.1 Introduction

The maritime transport industry has experienced several evolutionary periods which have brought radical changes to shipping technology and practices. The transition from wooden built ships to iron and then steel construction and the move from sail to steam were two such significant periods. Of similar impact has been the introduction of unitization, particulary containerization in the past two decades. From its early development this mode of carriage has grown at an unprecedented rate resulting in major changes in shipping and port practices. The change is summed up by Thomas,(1) Ashar (2) and Gilman(3) who wrote respectively that:

"The introduction of containerization on many of the world's major maritime trade routes has significantly altered the traditional landscape of ports and introduced new concepts in cargo handling."(1)

"Containerization, as this revolutionary technology of the late 1960's was called, has moved a long way since its emergence. The process of transformation and adaptation embraced all the various components of the chain of transformation: the cargo itself, the ships, the ports, and the inland carriers."(2)

> "The most dramatic changes occured when a large increase in size of unit, a radical simplification of port operations and integration with inland modes were simultaneously achieved by the conceptually simple expedient of taking the whole of a road trailer aboard ship."(3)

Containerization has been a feature of most of the major international seaborne trade routes for the past 15 years and is gradually being introduced in trades to and from developing countries. As a result, an extensive network of routes now links all corners of the world. The rate of growth in the change to containerization has far exceeded the early expectations of the shipping industry.[4] For example, world container traffic volumes increased five fold over the period 1970/1981, traffic rising rapidly from 47 million tonnes to over 225 million tonnes at an average annual growth rate of 18.8%.[5] This growth rate was also reflected in the size of the containership fleet. The overall capacity of the fleet expanded by some 18% annually in the period 1970/1983; the capacity of the fleet, measured on a TEU basis, rising from 195,000 TEU in 1970 to some 1,700,000 TEU in 1983.[6]

The number of containers in circulation has also developed in response to the prolific growth rate in the volume of cargo carried by this mode. The world's container population increased from 450,000 TEU in 1970 to 3,798,000 TEU in 1982, equivalent to an annual average growth rate of 21 percent.[7]

Containerization of the major liner trading routes between the Far East/USA, Far East/Europe and USA/Europe, comprising in total 70% of the global marine container transport capacity, is reaching saturation point. Since the volume of cargo carried on these routes represents only about 45% of the global total of potentially containerizable cargoes, the conclusion can be drawn that there is ample scope for further growth, particularly in the trades serving the southern hemisphere.(8) Krose(9) projects that:

> "The container system will forge ahead into all liner markets, and by the end of the century, perhaps earlier, it will have captured some 80% of the high-valued liner trade."

This is an indication of the potential growth rate of the future and is supported by the technical press. The Containerization International journal(10) reports that the growth rate of global container handling in ports was 17.4% per annum between 1970 and 1982 and reached 42.3 million TEU in 1982, which is 6 times the 1970 figure.

Since the demand for port services is a derived demand,any structual changes in trading patterns or technological developments in shipping practices have an immediate effect on the provision of port facilities and services. Vital to the success of any container service is the existence of an efficient, economical method of facilitating the loading and discharging of containers at the terminal ends of the voyage.(11) Hayut(12) pointed out this need by stating:

> "The demands that containerization places on the major segments of the system - ships, terminals, and inland carriers - leads to the establishment of the container terminal."

The anticipated growth of containerization represents a substantial increase in the potential flow of containers through the world's ports. The need for additional port capacity to meet this demand will require larger areas of land adjacent to deepwater on which to construct new terminals. This often involves large scale capital investment in infrastructure and major changes in operating and working procedures.

To enable ports to meet the demand placed upon them by the growth of containerization, adequate port capacity is essential to facilitate international trade and to ensure that the economy takes full advantage of improved shipping services. This is a highly important criterion for port policy makers. In this respect, it is of the utmost importance to monitor the efficiency of cargo handling and the costs involved. Ports should not forget that fast turnaround of vessels and quick and efficient loading, delivery and distribution of cargo is a first requirement of ship operators and cargo interests. Given the projected growth rate ports must ensure that they adopt sound planning and operating procedures in the future. The pre-requisite for this is a comprehensive knowledge of the developments likely to affect the maritime industry. It is important for ports to closely follow developments in shipping, industry and trade to ensure that they plan and adapt their facilities to meet these needs in good time.

2 The Characteristics of Containerization

An essential requirement for trade to flourish is the existence of transport which is a part of the value of every commodity and most services available in the economy.(13)(14) Couper described the importance of maritime transport stating:

> "Maritime transport constitutes part of the distributional sector, but it can equally well be considered as a factor in production."(15)

Efficient maritime transport, therefore, can lead to the promotion of international trade and improvements in the welfare of a particular nation, region or city.

Containerization as a major system in the transport of cargo had it's origins in the fact that conventional cargo handling operations, which were largely labour intensive, left little scope for improvement and were becoming increasingly more expensive.[16] Traditionally, conventional vessels were known to stay in port for 60-80% of the voyage time.[17][18] The cargo handling process was slow with a considerable amount of idle time and delays. Despite the objective of reducing the turn-round time in port and reducing costs per ton of cargo handled, output was often well below possible levels and costs higher than necessary. In the U.S.A, for example, stevedoring costs alone accounted for about 60% of the total cost of movement from port gate to port gate in 1960, and when ship time was taken into account the port sector accounted for 80% of total maritime transport costs.[19]

The advent of unitization brought with it a new mode of packaging or carriage-the container. Specially built ships were required of completely new design, intermodalism was introduced allowing containers to be moved from one mode of transport to another and allowing greater inland penetration. The rationale behind containerization is the movement of high volumes of cargo being handled by purpose built facilities to achieve high productivity.

The idea behind containerization and other methods of unitization of cargo is to consolidate items into one standard size unit which can be handled faster, stowed better, and moved more efficiently.[20] It has radically altered ocean transportation, ship design, cargo handling equipment at deep-sea terminals and at inland installations, port and inland connections, commercial and legal regimes and procedures, labour and social questions, trading and employment patterns.[21]

Containerization came first to the industrialised world. This was because the low output and high costs that existed in the developed world had made conventional stevedoring of liner cargoes wholly uneconomical. The benefits of containerization in the developed world are indisputable, its cost-effectiveness and its contribution to speedier handling and to greater cargo security are beyond doubt and this is confirmed by its continuous and rapid growth. The speedy loading and discharging of large numbers of packages simultaneously reduces the idle time of the ship and crew in port considerably, resulting in substantial additional savings for the carriers.

The container is unique in that it permits transport of goods from the shipper's door to an overseas destination, minimizing loss and damage, and other hazards inherent in the multiple handling of goods by various modes. The sealed boxes can be transported by ship, rail, highway or even by air. Containerization, and the consequent growth of intermodalism, has been phenomenal. Basically, however, the container revolution has resulted not from the aforementioned factors as much as that containers enable steamship lines and deep-sea terminals to handle large volumes of cargo very rapidly.[22] It has developed on traditional land and sea routes from "innovative" to "conventional" in only a quarter of a century and it is still growing, even on sea routes serving less developed countries.

There are strong criticisms from several sources concerning its suitability for some developing countries, which face completely different social, political and economic conditions.[23] However, even countries with an abundant supply of low cost labour are beginning to depart from age-old traditional labour-intensive methods of handling break-bulk cargo ships in favour of modern container terminals. They recognise the need to use the ubiquitous 'box' in order to maintain and increase trade with developed countries.

2.1 Merits of Containerisation

The rationale or major benefits behind the introduction of containerisation is the improved utilization of shipping space. The principal advantages offered by a fully containerised transport system is the ability to load and discharge cargo of various types and sizes encased in standard sized containers, thus avoiding the necessity of handling many small packages of irregular shape and size. It is this intermodal concept allowing a through transport movement which reduces considerably the need for manpower, changes the system into a capital intensive one, speeds up cargo movements, reduces risk of damage and pilferage, and allows increased productivity in the ports. It should, therefore, be possible to achieve cost savings compared with conventional cargo handling methods, which involve several stages in handling each of which can delay the consignment on its journey from origin to destination. However, these benefits will only be realised if the seaport terminals at the ends of the voyage are efficient, and handle the containers with a minimum of delays.

The turn-round time of container ships in port is critical to the operating efficiency and economics of shipowners. As mentioned eariler conventional general cargo ships typically spent 60-70% of their time in port discharging and loading their cargo.[24] This represented a high proportion of voyage time and one area where the major component of voyage costs, indirect or direct, were incurred. In the New-Zealand trade in the late 1960's it was reported that about 60 percent of total ships time was spent in port and, what is more important, only 15 percent of that was utilised for working cargo.[25] Today, fully-cellular container ships on deep-sea routes spend between 20% and 30% of their time in port.[26] Moreover, for two-thirds of their time in port cargo is actually being worked.[27]

The key to the success of containerisation is the rapid handling of containers in ports. Container terminals have a capacity of 7 to 8 times that of conventional berths.[28] Loading and discharging of ships at container terminals will be considerably accelerated whilst time spent in port will be correspondingly reduced. For the port, this means labour saving and for the ships a higher degree of utilization. Where before 160 men worked for five days, 50 men will be able to cope with the same work in

20 hours.[29] On the basis of united states experience, it is claimed that the turn-round time of container ship is a tenth of that of conventional ship.[30] The Mackinsey Report, for example, estimated in 1972 that a 3 day reduction in turn round times in Europe could reduce the costs of European container services by £ 3m. (1971 prices)[31]. Through the introduction of a new dee-sea container service cargo in port, it brought a massive cost reduction. One example cited was a reduction of terminal costs from U.S. $ 12 to less than U.S.$ 1 a ton through the use of containers.[32]

Conventional handling was labour intensive activity that was slow, and prone to delays and idle time. Output figures of 300 to 500 tonnes a day were common in ports operating a 2 shift system. By contrast, container vessels expect to spend hours in port and output figures of 10,000 tonnes/day are regularly achieved. The operation uses far fewer men but relies upon the use of more sophisticated and specialized mechanical handling techniques. For comparison, one man handles 750-1,000 tons a year of cargo at a conventional berth; the figure for containerised and roll-on freight is 5,000-10,000 tons per man per year.[33]

The NPC and McKinsey studies have shown that containerisation makes a major contribution towards reducing transport costs. The potential benefits of containerization were identified in a report commissioned by the U.K National Ports Council in 1967 and undertaken by Arthr D. Little Ltd. The report(34) contained a comparative analysis of port-to-port costs for break-bulk and container services on the North Atlantic. The conclusion was that container services would enjoy strong cost advantages on this route. A similar report commissioned by the BTDB on the economics of containerisation confirmed this view. The Mckinsey(35) Study concluded that containerisation is the key to low-cost transport.

2.2 Disadvantages of Containerisation

Changes in the operating practices in the port have a significant impact on port employment. The operation of loading or discharging container's and their handling on the quay side is performed mechanically. Twenty to thirty men are typically employed in a terminal operating 2 quayside cranes compared with 150 or more for 4 hatch working on a conventional berth. This has resulted in a change from labour intensive port operations. This means the handling of containers will require a comparatively small proportion of the available man-power. This has, inevitably, led to considerable unemployment among dock workers.(36) (37)

The impact of containerisation on employment opportunities in seaports is best illustrated by examining employment statistics in countries where this mode of carriage has been widely introduced. In 1966, the American seaport industry employed 89,000 longshoremen and 55,000 crew members on some 775 U.S flag ships totalling 11 million grt. By 1976 there were 60,000 longshoremen and 23,000 crew members on some 550 U.S flag ships totalling 13.6 million grt. Total ocean borne foreing trade had more than doubled during this period.(38)

In 1969, the number of U.K registered dock workers was 52,732 men handling 105.5 million tons (excluding fuel). By 1979 there were 25,731 men handling a traffic of 129.8 million tons. The total number of dock workers decreased by more than half during this period.(39) Today, only 13,500 registered dock worker are employed in scheme ports in the U.K.(40)

Busan port in Korea employed 4,322 Registered dock workers in 1970 with an ocean borne trade amounting to 4.4 million tonnes. By 1982 there were 3,117 workers handling a total traffic of 22.3 million tonnes. This shows traffic has grown 500% during this period whilst, by contrast, the number of dock workers has decreased by 28% in the same period.(41)

A parallel development to the decline in the number of dockworkers employed has been the increased status and earnings of dockworkers. Container terminal operators are now considered skilled/semi-skilled workers operating in a highly mechanized environment.(42) Through negotiating power, and industrial strength the terms and conditions of employment has been greatly improved and dockworkers feature in the top portion of the earnings league.

Despite the cost reduction attractions of containerisation, it neverthless presents major problems for many countries, particularly developing countries. One of the important problems of containerisation is the scale of new capital investment imposed on ports. For example, container berths are two or three times as expensive to construct as a break bulk berth,(43)(44) and equipment investment is very expensive. Further, institutional, organizational and administrative difficulties face stevedoring companies, trucking and transport operators and others involved in the movement of containers.

Primary amongst those are the scale of investment needed in port and its related transport facilities. These problems are compounded by the need to invest not only in transport equipment but also in ports and inland transport infrastructure to ensure the benefits of the through transport system are obtained. New deep water terminals with extensive land requirements are necessary; new roads and rail connections or the upgrading of existing infrastructure is essential; new skills to operate deep sea terminals and educating users are inevitable if containers are to move into the hinterland and achieve the benefits of door to door transport. New sophisticated and expensive equipment is necessary bringing further investment and maintenance problems. Superimposed upon this is the need for improved management information systems, better planning, both short and long term, and the need for new management and supervisory skills.

Whilst consultancy services and advice have been provided to developing countries to assist them in this transitional period, the permanent and long term solution must be for government or port authorities to control their own destiny. The key to this is the formulation of policies and plans to deal with future developments in the port industry. It is encumbrant upon government or port authorities to be continually monitoring technical and commercial developments in the field of containerisation to ensure that their future plans take this into account. The key to this is a knowledge of the production function of container terminals, and of the relationship between the supply and demand of facilities. If this trade is to be handled efficiently in the future and to the benefit of the country's shippers and receivers, the adequate terminal capacity and efficient operations are essential. Only if the operating characteristics of terminals are known can a reliable blueprint for future port development be completed. This is the objective of this research. There is a need for a comprehensive, and detailed investigation of the production function of container terminals, to obtain knowledge of the operating performance of container terminals to enable effective future investment decisions in capacity to be made.

3 Historical Development

Large containers of various kinds have been used in inland and overseas distribution for many years. Whether bags made of goatskin of Greek amphorae should be considered as the first containers ever used in intermodal transport can be left to historians to decide. They will certainly also mention that a Greek cargo ship of about 230 BC was discovered in the Mediterranean and that it held 8,000 amphorae, each carried in a specially designed rack.(45)

It seems, however, that the advertisement appearing in the American National Geographic magazine of April 1911 gives the first proof of an existing regular freight movement in containers. It announces that 'left-vans' can be provided for immediate loading in any city in the United States or in Europe and that their use insures a minimum of handling, security for small packages, and the least possible risk of damage. Literature reveals that it pictures a steel container of 18 x 8 x 8ft, hardly different from today's standard freight container dimensions.(46)

In 1926, the Midland and Scottish Railway first used containers and unit load systems have been a feature of the Great Britain-Ireland trade since World War I.

It is perhaps surprising that the 'revolution' has been so long delayed. The potentialities of containerization were recognized at least as long ago as 1931 when the Royal commission on transport reported:(47)

"The use of containers is another direction in which

> we think greater progress might be made. The great advantages of containers, particularly in minimising the risk of damage and in reducing the cost of handling, are so obvious that it is a matter of some surprise to us that they are not more generally used. And yet British Rail's freightliner service started some thirty-five years later."

However, containerization really started after the experiences obtained by the United States Army during World War II, when containers were used to speed up the transport of war materials to the front in Europe. Since the beginning of the 1950s, the CONEX containers, of which the United States Department of Defense had more than 100,000 in 1968, become of great importance.

In 1956 Sea-Land, which had its origins in road haulage, started its containership services between New York and Puerto Rico following experimental shipments the previous year between New York and Houston. Port handling costs and times were reduced drastically. But for almost a decade other shipping lines ignored or rejected the potential of containerization, even though by 1966 Sea-Land had nineteen containerships and Matson fourteen.(48) At the beginning of 1966 some 700 containers a month left U.S West coast ports bound for South East Asia: by the end of the year the monthly rate had risen to 1,500 by Sea-Land services.

From the late 1950's and early 1960's European shipowners were becoming more and more concerned with the stable output of their vessels in ports. Also the cost of cargo handling, the majority of which was labour, were rising rapidly. It was obvious that something had to be done. Initially, studies were made to evaluate alternative systems such as palletisation. Given the risk attached to these developments, it was not surprising that the shipowners were reluctant to take the plunge. Eventually they did.

Since 1966 the growth of container services has been explosive. Container services in ocean trades were inaugurated on the North Atlantic trade in 1966. By January of 1967 it had risen dramatically to 38 lines sailing from the U.S. East and West coast and Great Lakes ports to over 100 ports in Europe, Latin America, Asia, Africa and Australia. Table 1 provides a chronological list of the introduction of purpose-built full container and of ro-ro services world wide.

4 The World Fleet of Container Carrying Ships

Corresponding to the increase in container traffic demand, worldwide containership capacity has dramatically increased from 195,372 TEU in 1970 to 1,698,371 TEU in 1983.

Table .2 shows the details of the growth in the TEU capacity of the world containership fleet. The overall

(Table 1)

Full Container and Ro/Ro Services Chronology of Service Inauguration of Purpose built Ships

1955	United States coastal services
1958	North America-Hawaii
1959	Australian coastal services
early 60's	New Zealand coastal services
1963	North American East Coast-Puerto Rico
1964	North American West Coast-Anchorage
	Australia/New Zealand
mid-60's	European coastal services
1966	North American East Coast-North Europe
1968	North American West Coast-Far East
	Canadian Atlantic-North Europe
1969	Australia-Europe
	Australia-North American East Coast
	Australia-Far East
	North American West Coast-North Europe
	North America/Atlantic-Mediterranean
1971	Australia/New Zealand-North American West Coast
	Mediterranean-North American West Coast
1972	Europe-Far East
	North Europe-United States-Gulf
1973	North America-Indian Subcontinent
	Mediterranean-Far East
1975	Europe-South Pacific
	Europe-Middle East
	North America-Middle East
	Europe-Morocco
1976	Far East-South Pacific
	North Europe-Caribbean/Central America East Coast
	North American Atlantic-West Africa
	Miami/Ecuador
1977	North America/Far East-Panama/Venezuela
	Australia/New Zealand-Middle East
	Australia-Sri Lanka
	Australia/New Zealand-South East Asia
	Europe-South Africa
1977	Europe-West Africa
	Europe-Indian Subcontinent/Indonesia
	Europe-New Zealand
	Far East-Middle East
	Australia-South East Asia
	Australia-Papua New Guinea
	Mediterrancan/Caribbean
	South American East Coast-Coastal services
1978	North American Atlantic-South American East Coast
	Brazil-West Africa
	North American West Coast-South Pacific
	North Europe-Central American West Coast
	North American West Coast-Central American West Coast
1979	North Europe-Mexican Atlantic
	Mediterranean-Venezuela/Mexican Atlantic
	Europe-Mozambique
	North American Atlantic-Colombian Atlantic
1980	North Europe-South American East Coast
	Far East-Indonesia
	Australia-South Africa
	China-Austrlia
	China-Europe
	Black Sea-India
	North Europe-Sri Lanka/India
	Australia/New/Zealand-(South American West Coast) Venezuela/Caribbean
	Mediterranean-East Africa
1981-82	Far East- South Africa
	Europe-Indonesia
1982	Europe-South American West Coast

Sources: The advance of deep-sea, fully cellular container shipping H.P. Drewry, London. 1978.

capacity of the ships expanded by 18.6% annually over the period 1970/83; rapid growth was apparent between 1971 and 1973 when the fleet expanded by an average 35% annually. The main reasons for this rapid growth were firstly the introduction of new trade routes i.e Europe-Far East and the international economic boom before the oil price crisis.

In the period 1977/1979, a growth rate of 22% per annum was experienced. This was caused by the new route expansion to the African, Middle East and South American regions from Europe and North America.

Table . .2

Cumulative World Containership Capacity

Year	TEU	Annual(%) increase	Year	TEU	Annual(%) increase
1970	195,372	-	1977	782,219	22.8
71	258,186	32.2	78	971,657	24.2
72	382,428	48.1	79	1,178,293	21.3
73	478,492	25.1	80	1,342,483	13.9
74	518,944	8.5	81	1,438,258	7.1
75	567,363	9.3	82	1,527,948	6.2
76	636,909	12.3	83	1,698,371	11.2

Source : Containerization International,Jan. 1983. p 39

Further examination of the growth of total container shipping capacity shows that the growth rate of annual slot capacity amounted to 20.5% in the period 1976-80 compared to 18.6% during the 13 years from 1970 to 1983.

The increase in carrying capacity has had a profound effect on the size and design of container terminals. In effect it increases the potential number of containers moves per ship call and the consequent demand for port storage. Other factors affecting this are the frequency of service and more importantly the itinerary of the vessel. If a 3rd generation vessel calls at 4/5 ports at the end of voyage then the number of units discharged and loaded in each port could be 500 units. However, if the shipowner concentrates on 1 or 2 ports the number handled increases dramatically, particulary if a large number of these are handled again to feeder vessels.

Container carrying ships can be divided into several types or classes as shown in Table .3. Forty-six percent of the world's slot capacity falls into the non-fully cellular category.

Table .3

World Container Fleet by Ship Type 1982

Type of Ship	No of Fleet	GT	Proportion(%)
Fully cellular (FC)	675	672,800	44%
Converted to fully cellular (CC)	156	126,300	8.3
Ro-Ro cellular (RC)	94	57,800	3.8
Ro-Ro (RR)	344	180,500	11.8
Semi-container (SC)	1,136	373,600	24.4
Bulk/container (BC)	143	106,900	7.0
Bargecarrier (BA)	17	10,000	0.7
Total	2,565	1,527,900	100.00

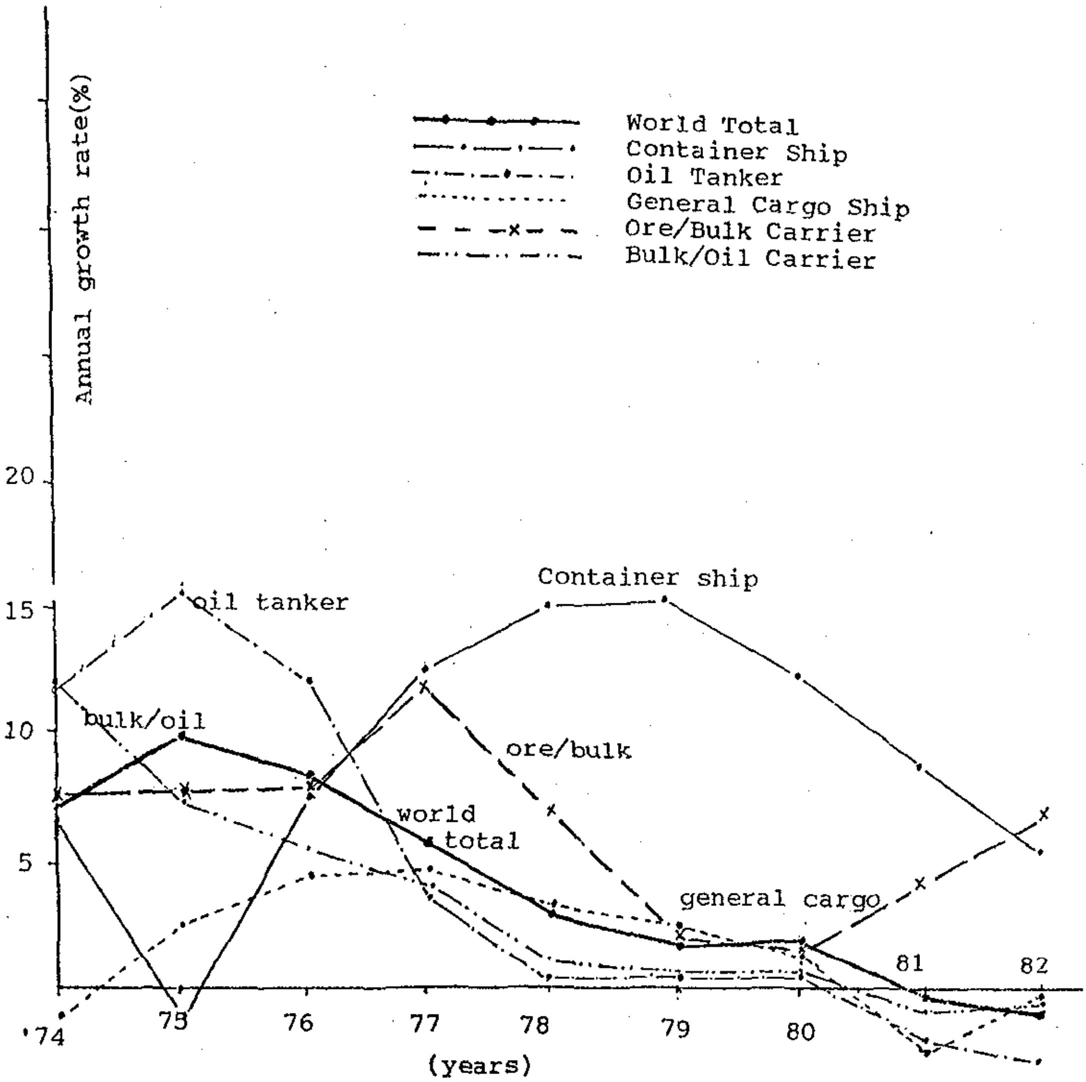
Source : Containerisation International, Year Book. 1983.

Comparison between the growth of the world merchant fleet and of fully cellular container vessels measured in GRT illustrates the prolific growth rate in the capacity of the latter. Table 4 gives the composition of the world fleet by vessel type in GRT'(000) at mid-1982 with the average annual growth rate shown in parenthesis. The average annual growth rate of the fully cellular containerships as a whole in GRT, was 15.6% while that of the world merchant fleet was 2.3% during the 6 years between 1976 and 1982. Figure 1 plots the data contained in Table 1.4, showing the significant differences, trends, and changes in the world fleet by ship type.

Containerships are generally classified by type and size and in common with computers, the industry now refers to the different capacities of vessels as generations. In general, the term refers to the carrying capacity of the vessel measured in the common denominator of TEU's.[49] There is some confusion in the use of this term since some shipping companies refer to each successive class of vessel constructed as the next generation in their fleet irrespective of size. Using the TEU capacity as the basis of the measurement the first generation of cellular vessels (constructed about 1966-1968) applies to those ships which have a capacity of up to about 800 TEU. The second generation ships, built first in the 1969 to 1970 period, were around 1,500 TEU. In the early 1970's the third generation

Figure 1

Growth Trend of Merchant Fleet by Ships Types



(Table .4)

Development of the Merchant Fleet by Types of Ship

(000 GT)

years / Types of ship	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
Oil Tankers	105,129	115,365	129,491	150,057	168,161	174,124	175,035	174,213	175,004	171,696	166,828
(annual growth rate)		9.7	12.2	15.9	12.1	3.6	0.5	0.5	0.5	- 1.9	- 2.8
Liquefield Gas Carriers.	1,887	2,276	2,415	2,999	3,377	4,411	5,530	6,674	7,393	7,958	8,785
(")		20.6	6.1	24.2	12.6	30.6	25.4	20.7	10.8	7.6	10.4
Chemical Tankers	551	652	748	967	1,274	1,755	1,930	2,079	2,249	2,614	2,964
(")		18.3	14.7	29.3	31.7	37.8	10.0	7.7	8.2	16.2	13.4
Bulk/Oil Carriers	15,073	19,539	22,035	23,716	25,023	26,089	26,372	26,496	26,241	25,838	26,030
(")		29.6	12.8	7.6	5.6	4.3	1.1	0.5	1.0	- 1.5	- 0.7
Ore/Bulk Carriers	48,415	53,110	57,403	61,832	66,714	74,832	80,173	81,827	83,355	87,246	93,268
(")		9.7	8.1	7.7	7.9	12.2	7.1	2.1	1.9	4.6	6.9
General Cargo	70,591	49,506	68,674	70,399	73,608	77,088	79,675	81,678	82,610	80,826	80,542
(")		1.5	1.2	2.5	4.6	4.7	3.4	2.5	1.1	-2.1	- 0.3
Container Ship	4,310	5,899	6,291	6,224	6,685	7,543	8,674	9,996	11,274	12,292	12,942
(")		36.9	6.7	1.0	7.4	12.8	15.0	15.2	12.8	9.0	5.3
Other Vessel	1,720	1,688	1,722	1,988	2,157	1,773	2,376	2,832	3,121	3,706	3,945
(")											
Total	247,676	268,035	288,780	318,201	347,000	367,616	379,764	385,796	391,247	392,177	395,304
(")		8.2	7.7	10.2	9.1	5.9	3.3	1.9	1.4	- 0.2	- 0.8
Non-Trading Types	20,664	21,892	22,542	23,961	25,000	26,062	26,238	27,224	28,663	28,658	29,438
(")											
World Total	268,340	289,027	311,323	342,961	372,000	393,678	406,002	413,021	419,911	420,835	424,742
(")		8.0	7.4	10.2	8.5	5.8	3.1	1.9	1.7	- 0.2	- 0.9

Sources: Lloyd's Register of Shipping, Statistical Tables, London
from 1972 to 1982 (12).

ships made their debut with box capacities of 1,500 TEU plus.(50)(51) Since the early 1970's the size of the largest container vessels has remained relatively constant because of trading demands and beam restrictions imposed by the major canals. The third generation of fully cellular ships has culminated with the Hapag-Lloyd Frankfurt Express of 3,045 TEU,(52) built in 1981.

Initial rapid growth in ship size took place between 1967 and 1972 when the capacity of the largest vessels increased from 800 to 3,000 TEU. Then a consolidation period set in when the maximum ship size was re-examined to construct. Now we are on the threshold of the appearance of the 4th generation vessels. U.S. Lines plan to build fourteen 4,148 TEU capacity ships for world wide operation.(53)

Where will ship size go in the future. This is a very important development for ports. F Avierinos(54) suggested that;

> "Ships of 5,000 to 6,000 TEU might be built in the future, remarking that the USL concept for large 4,000-4,500 TEU vessels is a good one; however, it is far ahead of its time considering present port capabilities."

In addition, the Scan Dutch consortium is understood to be showing an interest in the fourth generation vessels of super-panamax ro-ro/cellular type.(55) However, this super size vessel is restricted to calling at very few ports in the world. Many operators in the industry suggest that many of today's 3rd generation vessels are already too large for the volume of trade and frequency of service on some routes.

Williamson investigated, in his preliminary study, the feasibility of 4th generation super-panamax ships with sizes up to 6,000 TEU. He concluded that the feasibility of such ships is governed not by technical factors but operational and commercial considerations.[56]

The growth process has come to a halt with shipowners reluctant to exceed the Panama Canal beam limitations or because of the difficulty of consolidating and lifting such large quantities of units per voyage. The present recession is also a contributory factor. Opinion in the industry is that 4,000 TEU ships would be disruptive, both commercially and operationally. Gilman,[57] in evaluating the prospect of fourth generation ships concluded that:

> "A new fourth generation of super-panamax ships is clearly technically feasible and neither the loss of ability to transit the canal nor port constraints seem to present insuperable barriers to operations. However, the economic and operational barriers still appear formidable and for this reason it is not very likely that such ships will be built in the near future. Possibly only a radical change like a switch to new fuels and engines could create a realistic prospect for their development."

It was believed, in the late 1960's, that there were very large economies of scale in container ships and terminal operations. However, economies of scale of large container ships were not as powerful as expected because container handling rates in port were below what was expected on simple port itineraries, ship time in port was considerably greater, and size economics were further weakened.[58]

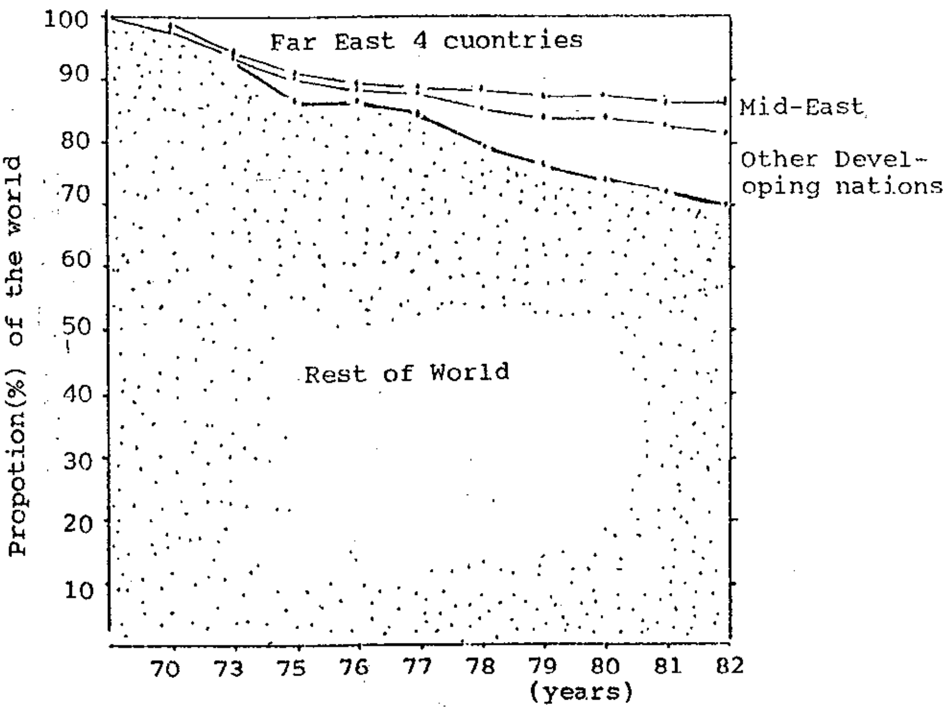
The need to realise economies of scale will remain and will strongly influence the size of ships in the future, But the physical restrictions of canal breadth and depth, of quay lengths as well as width of locks and also operational restriction of cargo handling will have to be taken into consideration.

5 The Growth of Container Handling in Port

Table 5 shows that the volume of container traffic handled in the worlds' ports has risen by around 600% since 1970 from 7.1 million TEUs to over 42.3 million TEU in 1982. This is an average compound growth rate of over 16.4% annually since 1970. Even if the rate of traffic expansion slowed down to one third that of the level experienced in 1982, world wide port container traffic would still exceed 63 million TEU by the early 1990's. This underlines the scale of problems facing ports in the future, particularly in developing countries where much of this expansion will take place.

Figure 2

Distribution of World Container Handling by Region



(Figure 5)

WORLD CONTAINER PORT HANDLING TRAFFIC DEVELOPMENT

Countries	70	73	75	76	77	78	79	80	81	82
Far East 4 cont's (South Korea, Singapore, Hong-Kong, Taiwan)	147 (2.0)	1,000 (6.7)	1,685 (9.3)	2,377 (11.1)	2,883 (11.6)	3,366 (11.6)	4,026 (12.1)	4,715 (12.5)	5,325 (13.0)	5,544 (13.1)
Mid- East			82 (0.4)	172 (0.8)	527 (2.1)	952 (3.2)	1,329 (4.0)	1,637 (4.4)	1,928 (4.7)	2,580 (6.1)
Other Developing Nations	10 (0.3)	138 (0.9)	687 (3.8)	1,020 (4.7)	1,382 (5.6)	1,929 (6.6)	2,607 (7.8)	3,463 (9.2)	4,238 (10.4)	4,566 (10.8)
Sub - Total	157 (2.3)	1,138 (7.6)	2,454 (13.5)	3,569 (16.6)	4,792 (19.3)	6,247 (21.4)	7,963 (23.9)	9,815 (26.1)	11,491 (28.1)	12,690 (30.0)
Rest of World	6,914 (97.7)	13,798 (92.4)	15,656 (86.5)	17,978 (83.4)	20,074 (80.7)	22,965 (78.6)	25,315 (76.1)	27,785 (73.9)	29,409 (71.9)	29,610 (70.0)
Total	7,071 (100)	14,936 (100)	18,110 (100)	21,547 (100)	24,866 (100)	29,212 (100)	33,278 (100)	37,600 (100)	40,900 (100)	42,300 (100.0)

Sources : Containerization International Year Books(1980-1984)
Containerization International(Monthly) : December & September, 1983. p.57

A distinctive feature of the world container handling statistics is the growth of the developing countries share of container movements. Reference to Figure 2 shows the percentage shares of world traffic handled by developed and developing countries. Developing countries reached 30% in 1982 from only 2.3% in 1970. As containerization expands in the 1980's it is anticipated that the proportion of trade to and from developing countries will increase significantly.(59)

Figure 2 gives some indication of how fast the areas of the developing countries have progressed when compared with established port ranges in the rest of world, mainly Europe and N. America. During the period 1970-1982 container moves through the ports of the 4 major Far East container countries of Korea, Taiwan, Singapore and Hong Kong grew at a rate of 35.3% annually, as against the world average of 16.1% over the 12 year period.

These 4 countries have been treated as a special group because of the phenomenal growth rates experienced and because this study is concerned with containerization in Korea. These 4 countries accounted for 55.4% absolute growth during 1973-1982. However, since 1977 the annual growth rate has slowed to an average of just over 16%; is explained by the fact that the transition from conventional to unitized trades had been completed. The 4 countries, newly industrialised countries,(60)(61) handled 13.1% of the world traffic in 1982 emphasising their importance in these trades.

During the past 15 years, the proportion of container traffic on routes linking ports in the North Atlantic has declined and there has been a concentration on trade routes to the Pacific and Far East. Table 6 contains data to support this view and shows the throughput for the world's top 20 container ports in 1982. Half of the 20 top ports are situated in the Far East and Asian region.

The growth of fully cellular container services on routes to the Middle East suggests that containerisation can be profitable, even with chronic trade imbalances, if other conditions are right. However, there are still limits to containerization. Cargo type and conditions of carriage restrict the movement of some cargoes by container. Innovatious the industry has made, however, means that new types of containers have been developed with features which include temperature control, ventilation, etc. enabling an increasing range of cargoes to be carried by this mode.

Initially, the industry thought that many cargo types were unsuitable for containerization notably because of temperature and atmospheric controls. Research and

Table 6

The World's Top 20 Container Ports in 1982

Position 1982	(1981)	Port	1982 TEU	1981 TEU	%Gain (Loss)
1	(1)	Rotterdam	2,158,699	2,049,148	5.3
2	(2)	New York	1,909,000	1,860,000	2.6
3	(4)	HongKong	1,659,943	1,559,819	6.4
4	(3)	Kobe	1,504,374	1,576,651	(4.6)
5	(5)	Kaohsiung	1,197,998	1,124,707	6.2
6	(6)	Singapore	1,116,288	1,064,504	4.9
7	(8)	San Juan	916,857	841,933	8.9
8	(7)	Hamburg	889,252	906,874	(1.9)
9	(12)	Antwerp	846,029	794,611	6.5
10	(9)	Yokohama	843,249	812,502	3.8
11	(13)	Oakland	820,218	775,300	5.8
12	(11)	Seattle	803,893	805,084	(0.1)
13	(10)	Bremen/ Bremerhaven	795,728	811,875	(2.0)
14	(14)	Busan	786,653	743,968	5.8
15	(21)	Long Beach	714,636	553,709	29.1
16	(16)	Keelung	702,922	655,441	7.2
17	(18)	Jeddah	688,398	618,012	11.4
18	(15)	Tokyo	654,547	695,162	(5.8)
19	(22)	Felixstowe	628,837	523,395	20.1
20	(17)	Los Angeles	594,939	620,988	(4.2)

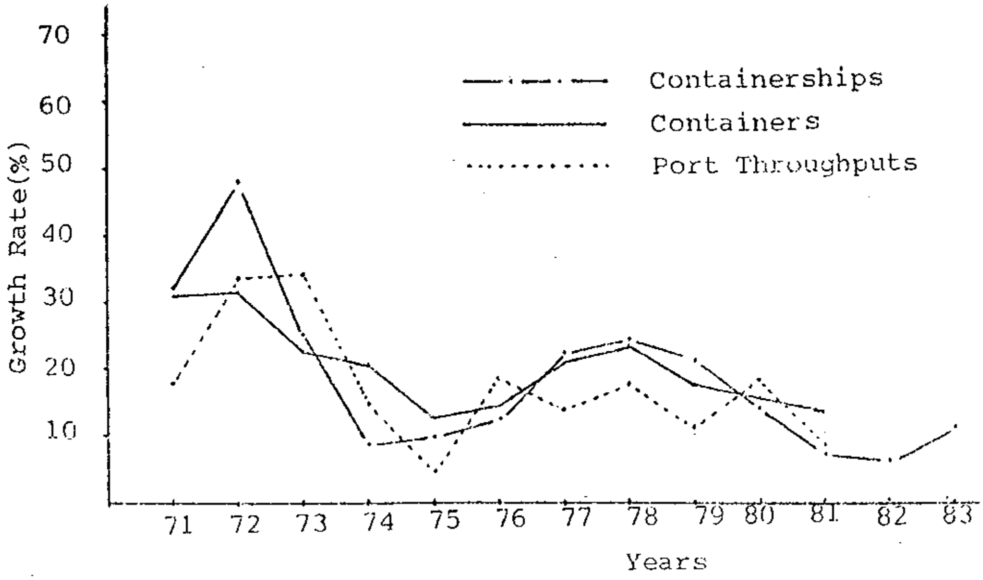
Source : Containerisation International Year Book, 1983 development has proven, however, that their carriage problems can be overcome. Innovation in the industry has seen the development of a wide range of container types to meet the needs of specialised cargoes. Today, coffee, tea, bananas, cocoa and rubber are regularly shipped although years ago these were considered totally unsuited for container carriage. With the growth and changing commodity composition of developing countries trade the scope for containerisation will gradually increase.[62]

The principal conclusion to emerge from sections 3 to 6 is that the container revolution is far from over. Future expansion is likely to shift geograpically with developing countries handling an increasing proportion of total container routes. Growth rates are already impressive in three developing country regions in particular the Far East and South East Asia, the Middle East and West Africa.

Figure 3 summarises the chronological growth of the container carrying ship, container fleet and container port throughput. Not suprisingly, Figure 3 shows a high degree of positive correlation between the growth rates of container ship capacity, number of containers in circulation and the ports' throughputs. There are notable periods of high growth rates but the underlining trend is continuous growth.

Figure 3

Container Growth Rates, Containership Capacity and Port Throughputs



6. DEVELOPMENT OF CONTAINERISATION IN KOREA PORT

6.1 Container traffic development

6.1.1 Present traffic

The total number of containers handled in the port has increased rapidly in recent years, from 87,683 TEU in 1973 to 962,000 TEU in 1983. Busan has maintained a dominant position in the trade during these years, with Incheon handling less than 8.1% of the national total.

Container traffic, by import/export at the two ports is shown in Table 7. Busan handled 884,000 TEU or 91.9% of the national total in 1983, consisting of 375,000 TEU imports and 509,000 TEU exports.

Table 7

Development of Container Traffic

('000 TEU)

Year	Busan			Incheon			Total		
	Import	Export	Total	Import	Export	Total	Import	Export	Total
'73	45	37	82	4	2	6	49	39	88
74	70	62	132	5	1	6	75	63	138
75	82	91	173	6	6	12	88	97	185
76	164	186	350	15	18	33	179	204	383
77	214	240	453	22	21	43	236	261	497
78	234	273	507	26	22	48	260	295	555
79	267	330	597	24	19	43	291	349	640
80	256	377	633	34	26	70	290	403	693
81	315	429	744	35	35	70	350	464	814
82	348	418	786	35	29	64	383	467	850
83	375	509	884	45	33	78	420	542	962

Source : KMPA Statistics

Table 8 and Figure 4 show the growth of container traffic handled in the port of Busan. The outstanding growth of container traffic is illustrated by the 10.8 fold increase in throughput in the period between 1973 and 1983.

Figure 4

The Trends of Busan Traffic Structure

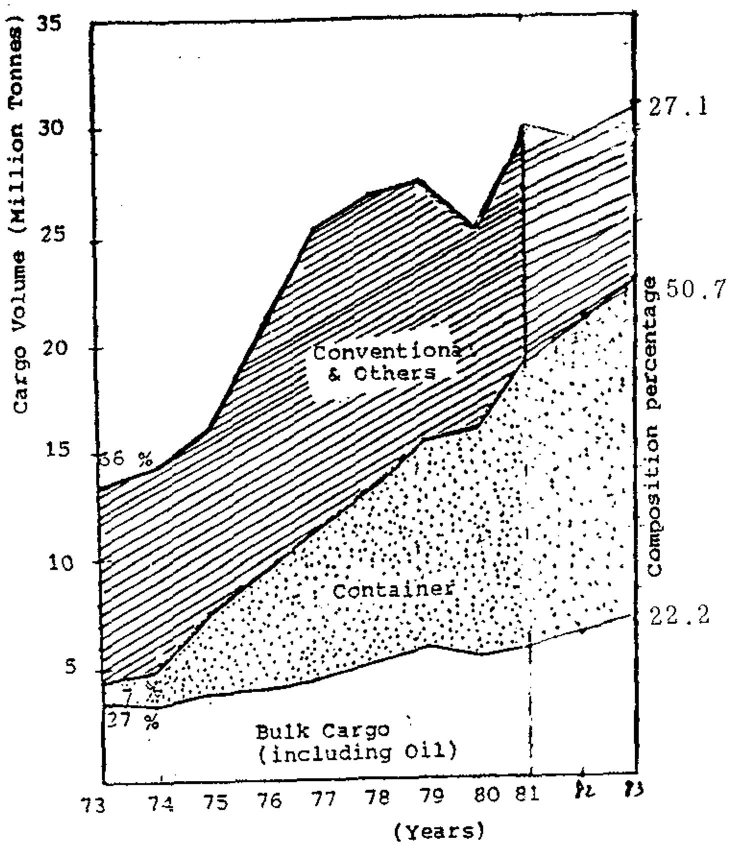


Table 8

Development of Busan Port Traffic

(000 tonnes)

Traffic Year	Container(%)	Bulk-Carco(%)	Conventional & others(%)	Total(%)
1973	942 (7.0)	3,670(27.1)	8,910(65.9)	13,522(100)
74	1,529 (10.8)	3,443(24.3)	9,192(64.9)	14,164(100)
75	3,511 (21.0)	3,989(23.8)	9,238(55.2)	16,738(100)
76	5,198 (24.0)	4,193(19.3)	12,282(56.7)	21,673(100)
77	6,653 (25.9)	4,652(18.2)	14,362(55.9)	25,667(100)
78	7,893 (29.0)	5,268(19.4)	14,052(51.6)	27,213(100)
79	9,243 (33.0)	6,170(22.1)	12,550(44.9)	27,963(100)
80	10,414 (40.5)	5,522(21.5)	9,763(38.0)	25,699(100)
81	13,478 (45.4)	6,028(20.3)	10,209(33.3)	29,715(100)
82	14,529 (49.9)	6,398(22.0)	8,186(28.1)	29,112(100)
83	15,962 (50.7)	6,989(22.2)	8,555(27.1)	31,506(100)

Source : KMPA Statistics

6.1.2 Future Traffic Growth

It is clearly essential, given the time required to plan, construct and commission port facilities, that future port capacity requirements be kept under constant review. A pre-requisite for this is the existence of comprehensive and reliable traffic forecasts upon which the future development plans of the port can be based. This is particularly relevant to Korea since traffic growth, particularly in the container field, has been so dramatic in the 1970's.

Several studies of future seaborne traffic of Korea have been undertaken using different techniques and levels of sophistication. These have ranged from the simple extrapolation of past data to a commodity by commodity analysis utilizing economic models.[63][64][65][66][67][68][69]

The studies referred to have adopted a procedure of forecasting both the medium and long term traffic forecasts. Medium term projections, for the next 5 to 10 years, have been complemented by longer range estimates of traffic growth for time horizons of 15 to 25 years ahead. As part of its development plans for the Korean ports the KMPA commissioned KAIST (Korea Advanced Institute of science and Technology), with the assistance of the consultancy company Lyon Associates, to conduct a future port traffic forecast up to the year 1991. This study[70] adopted a micro approach investigating the plans and production targets of individual industries and taking into account the government's aspirations in its fifth 5 year plan. This study included preparation of future traffic forecasts for the number of container's to be handled at Incheon and Busan. Table 9 summarises the results of this exercise.

Table 9

Container Actual Traffic and Forecasts

('000 TEU)

Ports	'76	79	81	82	83	86	88	91
Incheon	33	43	80	109	115	194	220	327
Busan	351	597	744	795	875	1166	1402	1849
Total	384	640	825	904	990	1360	1602	2176

* '76 - 83 :actual traffic

Reference to Table 2.12 shows that container throughput in the port of Busan is expected to increase 2.5 times in the next 10 years to a total of 1,849,000 TEU by 1991 which represents approximately 85% of the national total. If the port is to keep pace with these developments early commencement of the port development must be made to match supply and demand.

6.2 Existing Container Handling Facilities

Container handling facilities in Korea are concentrated at Busan in the South and Incheon on the West coast. As was mentioned previously, the port of Busan is the major center handling more than 90% of all container traffic. It is somewhat ironical, therefore, that whilst Busan has severe problems of undercapacity, with all the resultant operating difficulties this imposes, Incheon has extensive facilities which are grossly underutilised. The Incheon terminal, which was inagurated in 1974, has a length of 1,160m, is equipped with 3 ship/shore gantry cranes and has a possible capacity of 225,000 TEU's. In 1981, the terminal handled 70,000 TEU containers representing less than 35% of the possible capacity.

Container cargo is presently handled at two locations in the Busm port. The pier 5 container terminal is a purpose built facility which was opened in late 1978 and consists of a 659 meter length of quay with all supporting services. Piers 1-4 which were predominantly used for general cargo in conventional form also handle significant numbers of containers. In 1983, the pier 5 quay was extented by a further 600 metres to provide the port with a modern terminal equipped with eight service points or quayside cranes. It is provided with an extensive operational back-up area (including land allocated for building, stacking areas, and an apron marshalling areas) of 69.5 hectares. Handling equipment at these facilities in support of the eight 30/40 ton capacity container cranes consists of an appropriate mix of rubber tyred gantries(RTG), and straddle carriers(S/C). The throughput of pier 5 in 1982 was 360,000 TEU with an average of 90,000 TEU handled per crane.

Piers 1 to 4, consisting of typical break bulk general cargo berths, accommodate those containers not handled at piers 5 and 6.Pier 3 has a 30 ton capacity rail-mounted container crane operated by a private shipping company. Container handling productivity at these berths is considerably less than that at pier 5. Further, all containers handled at these berths must be moved to off-dock container yards immediately because of the lack of container stacking space.

7. Conclusion with emphasis on the port requirements in Korea

This study has reviewed the historical developments of the container transport industry and its principal charateristics. What has emerged from this investigation is that containerisation of general cargo in seaborne trade has been growing much faster than was anticipated in the late 1960's and early 1970'. Containerisation has evolved into a sophisticated transportation system largely caused by the pressure of escalating labour costs and low productivity in the ports of developed countries and the need for more efficient cargo handling methods to cope with the growing tonnage of goods being transported. Containerisation makes possible greatly improved vessel port turn-round time, major cost saving , and it is also considerably reduce cargo handling costs.

Evidence has been produced to substantiate the rapid growth of containerisation, a phenomena which is expected to continue in the future. It is now imperative for developing countries to accommodate this mode of carriage for a foreign trade expansion. The benefits of containerisation can not be achieved without proper container handling facilities. This underlines the need for an efficient port development plan to provide efficient container handling as a stimulus to the promotion of the national economy and maritime industry.

Korea has experienced problems in this era of steady expansion of containerisation: shortage of funds for investment; unemployment; poor inland infrastructure and distribution systems; failure to formulate policies and long term plans for containerisation to mention a few. Problems have also emerged in response to improved management information system, better planning both short and long term and need for new management and supervisour skills. The key to the solution of these is the formulation of policies and plans to deal with future developments in this industry. This enforces upon government or port authority to monitor continually developments of this industry to meet demands.

The rapid development of the Korean economy was accompanied by a considerable increase in both ocean-going and coastal trades between 1973-1981;[71] the total volume of seaborne trade increased from 60 million to 149 million freight tonnes (F/T) with an average rate of increase of 13.5% per annum. Excluding oil traffic, which increased from 31 million to 102 million F/T in this period, the remaining trade grew at an annual rate of 17%.

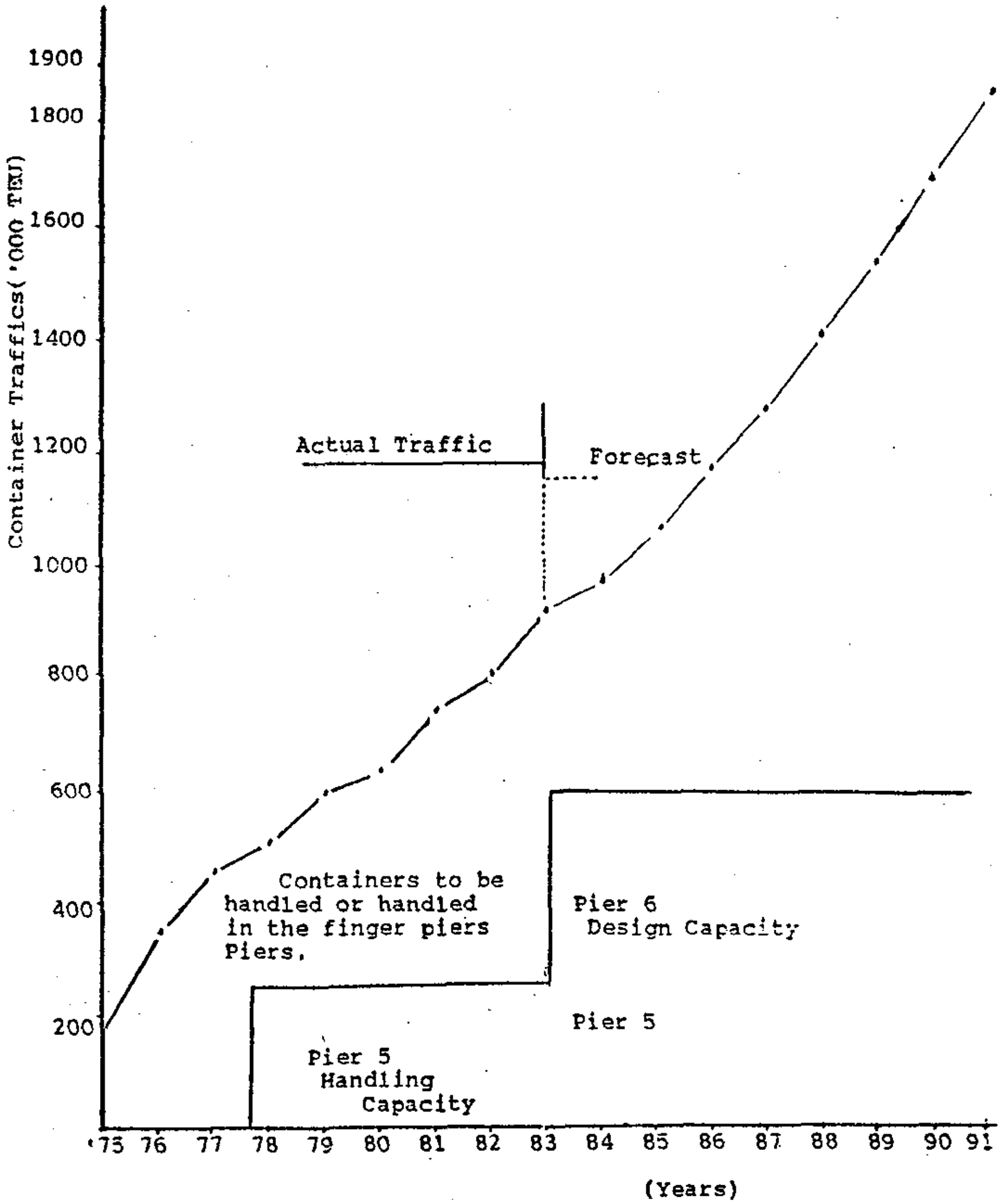
The obvious pressures that this enormous increase in demand has placed on Korea seaports was compounded by the impact of technological change in the shipping industry. Containerisation emerged as the major mode of carriage in general cargo trades and expanded rapidly. As a consequence, the ports, particularly the premier port of Busan, was forced to respond to meet the needs of new technology and to ensure that expansion in facilities did not inhibit or restrict trade. Regrettably, the events of this period created severe policy, planning and operational problems since the ports were not equipped to deal with the scale and nature of the expansion in trade.

With respect to containerisation, Korean seaports currently face major policy and planning issues. At the centre of the problem is the inability of the industry to expand facilities in line with demand. As a result, container terminal capacity is well below the existing and projected traffic figures. For example, Busan container traffic has been increasing at an average annual rate of 26.8% from 82,000 TEUs in 1973 to 884,000 TEU's in 1983. But container terminal capacity has not kept pace with the growth of traffic, leading to less efficient methods of handling containers and resulting in higher maritime transport costs. Korean studies[72] [73] have shown that the failure to equate the supply and demand of container terminal facilities has caused extra transport costs which have been immediately passed on to shippers.

Figure 5 contains a comparison between existing container terminal design capacity, actual traffic volumes and future traffic projections. Container traffic through

Figure 5

Comparisons Between Traffic and Modern Container Handling Capacity at Busan



the port of Busan reached a half million TEU before the specialised pier 5 container terminal was opened in 1978. Prior to this, containers were handled at the old finger piers by ships lifting gear and immediately moved to off-dock CY/CFS facilities located in the Busan area. Since the pier 5 terminal was commissioned approximately 50% of the traffic is being handled at this modern purpose built terminal. However, because of an acute shortage of land, containers were restricted from being stored in the stacking areas provided at the terminal. Most of the containers handled at pier 5 are moved to off-dock CY/CFS facilities within 2-3 days of discharge. Most of the export containers are routed through off-dock CY/CFS facilities and arrive 2-3 days before ship arrival.

The pier 6 terminal opened in early 1983 and was constructed to alleviate the under-capacity problem. In 1983, the traffic volume reached 884,000 TEUs but the design capacity of both piers 5 and 6 is approximately 600,000 TEUs. This illustrates the extent to which container terminal capacity lags behind the present demand. As a result approximately 300,000 TEUs per annum have to be handled across the old finger piers.

The failure to ensure adequate provision of specialised capacity to handle the projected throughput of containers is an indictment of present policy and planning procedures. It raises serious questions of both a planning and institutional nature. Failure to plan for adequate capacity has resulted in serious financial penalties being imposed on importers and exporters and to less competitive trades. The failure to construct facilities means that large numbers of containers still have to be handled at conventional facilities, an operation which is slow and costly.

There are other potentially more serious consequences of this policy. Failure to provide sufficient specialised facilities has encouraged shipowners to rely on feeder services, primarily between Kobe and Busan and to avoid calling directly with large trunk line vessels. This involves additional handling and transhipment costs and creates less efficient terminal operating practices since large numbers of vessels, transferring comparatively few containers per ship call, are handled. Evidence of this is supported by the fact that shippers have to pay an additional approximately $ 190 (1979 value) per TEU for containers shipped by feeder services instead of the mother vessel.(74)

Failure to prepare a long term development plan at the appropriate time means that with an increasing volume of containers being forecast (see Figure 5), that the discrepancy between supply and demand will increase significantly. An urgent plan of action is needed to ensure that capacity expands in line with demand.

The Korean Phase Three Port Development Study, which is primarily concentrated on container terminal development, was commenced in 1979. This study, published in 1981, recommended the development of a new container terminal, to be operational in 1986, to cope with the future growth of container traffic in Busan. This study had a number of inherent weaknesses. First, the study failed to undertake a detailed capacity study of container handling facilities. This took no account of the production function of container terminals and the complexity of the operation. Attempts to determine existing terminal throughputs were crude, using average annual crane handling rates, based on secondary data sources.

Second, unrealistic assumptions were made on future operating practices (dwell time, container flow patterns etc.) which raise serious doubts about the validity of the conclusions reached. Further, policy and institutional factors were made with respect to the future role of off dock CY/CFS operators; a role which will specifically affect terminal operating performance.

A fundamental weakness is that the study accepts that capacity will lag well behind demand for the foreseeable future and proposes an investment timetable which will perpetuate this unacceptable situation. At the present time, the study is still under consideration and the conclusions are still being vigorously debated in government circles.

Given the urgency of the need to construct additional container capacity in Busan this further illustrates the weaknesses of present port planning procedures in Korea.

Throughput the investigation of this study it was observed that the problem for Korea is one of large scale investment in facilities to meet the new transport technology used in containerisation. However, Korea without these basics can not utilise the containerisation method. This indicates that a pre-requsite for Korea is to have adequate port development and management policy.

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要 約

海運産業은 第2次 大戰후 急速한 發展이 있었다. 發展 양상은 海上物動量의 계속적인 增加, 規模經濟의 효과를 기대하는 船舶크기의 增加, 技術發展과 需要에 부응하는 特殊船化(specialisation)등으로 집약할 수 있다. 이러한 發展은 多方面에서 있었지만 두드러진 것은 一般貨物(general cargo)에 대한 단위화(unitization)가 港灣에 크나큰 影響을 미쳤다. 貨物의 단위화 특히 콘테이너화를 開發途上國에서 수용하는데 야기되는 문제들은 技術 및 資本投資의 缺乏과 기타 經驗 및 資原의 不足 등이다. 또한 이러한 開發은 고용, 내륙수송 및 관리통제 씨스템 등에 큰 影響을 미치고 있다.

特히 開發途上國들은 콘테이너화를 수용하는 過程에서 겪고있는 港灣施設의 不足과 非合理的인 內陸輸送 씨스템 등으로 一括輸送의 長點을 살리지 못하고 있다. 韓國도 그 例外는 아니며 콘테이너化에 따른 港灣施設不足 및 輸送씨스템의 在來性 등이 現 與件上 解決되어야 할 重要한 부분이다.

上記의 背景속에서 論文은 콘테이너化가 出現하여 發展하여온 過程과, 이것이 港灣에 미치는 影響과 동 씨스템의 出現背景을 經濟的인 측면과 運營的인 측면에서 硏究되었다. 또한 콘테이너化에 관한 關聯文獻을 中心으로 硏究되었으며 開發途上國을 中心으로 해서 한국입장과 與件등을 分析했다. 結論的으로 效果的인 港灣開發計劃이 必要하며 港灣開發計劃이 包括的이고 科學的이며 合理的인 측면에서 樹立되어 港灣開發運營政策이 유도되어야 한다는 結論이다.