The Evaluation of Cost-Effectiveness of Intermodal Transport Systems in the Korean Container Trades

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Abstract

It was in 1976 when the Korean Shipping Corporation started the country's first containerised liner service which was on the trans pacific trade route. Since then Korea has experienced a continuous expansion in its container trades and it is now one of the major countries trading in containerised cargoes.

Korea is on the mainstream trades of the world and on its deep sea routes has access to the largest and most efficient ships in the world fleet. However, there are a number of issues relating to the structure of the transport networks serving Korea and the efficiency of operation of the inland modes.

The first issue is that the main container port of Busan is in the south of the country whilst the major cargo centres are in the north at Seoul. This means that cargo has to move relatively long inland distances over congested inland routes. The second problem is that inland transport systems are fragmented in their organisation and physical infrastructure and this makes for relatively inefficient operations. Finally, there is a very high degree of reliance on road transport, whilst rail or rail/road systems would be expected to be the most economic in serving the northern cargo centres from Busan.

In approaching these issues the thesis starts with a review of recent developments in containerisation and intermodalism. There is then a review of economic development and trade growth in Korea which is used to develop sets of forecasts of container growth. These are used to assess the port development strategy and to help provide cost and revenue estimates for inland modes. The next chapters describe the maritime, port and inland sectors and develop a set of cost models to evaluate alternative port calling and inland transport strategies.

By evaluating the trade off between marine, port and inland sectors the thesis confirmed that the southern region is the optimum location for Korea's deep sea port facilities for most conceivable circumstances. It also showed that port development plans will just keep pace with traffic growth. It found that the physical separation of inland facilities from the ports and poor organisation of inland transport represented serious problems made certain recommendations to improve the situation. It confirmed that the use of rail and rail/road methods of inland distribution would be economic for serving the north of the country and made a series of recommendations for improving the efficiency and market share of these systems. Finally, it recommended the Korean government pay more attention to the needs of efficient intermodal transport of containers.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1. INTRODUCTION

1.1 STUDY BACKGROUND

During the past 30 years, ocean transport has experienced rapid changes. Not only have the size and draft of ships increased significantly, making many older ports unusable and many conventional ships obsolete, but also cargo handling methods have been drastically modified. One of the most important developments in the transport industry was containerisation. The effect of containerisation is to consolidate items into a standard size unit which can be handled faster, stowed better and moved more efficiently.

Containerisation came first to the developed countries. The benefits in the developed world were indisputable, and the cost-effectiveness of container systems in terms of speedier cargo handling and greater cargo security are beyond doubt and this is evidenced by its continuous and rapid growth. In addition, the rapid loading and discharging of large numbers of packages simultaneously reduces the idle time of the ship in port considerably, resulting in substantial savings for carriers. Among the most important advantages of containerisation are the capability of door-to-door service, minimising loss and damage, and other hazards inherent in the multiple handling of cargoes by various transport modes. In this new concept of the cargo transport system, container movements are increasingly considered from a viewpoint of the total, integrated distribution system.

Initially there were doubts as to the suitability of containerisation for developing countries which face completely different political, economic and social conditions from the developed countries where containers started. In recent years, however, the criticism has been muted. Containerisation is no longer viewed as being capital intensive. It produces savings in labour but savings in capital are now also acknowledged (Graham and Hughes 1985). Even countries with an abundant supply of low cost labour have departed from the traditional labour-intensive methods of handling break-bulk cargoes. They recognise the need to use the dominant box with a view to maintaining and increasing trade with developed countries. Korea has not been an exception to this.

In Korea containerisation was introduced in the late 1960s and foreign carriers dominated the Korean liner market. It was 1976 when the Korean Shipping Corporation started the country's first containerised liner service on the trans-pacific trade route. Since then Korea has experienced a continuous expansion and is now an important force which people cannot ignore. The volume of containerised cargoes in Korea's liner trades increased rapidly from just 584.8 thousand TEUs in 1979 to over 1.9 million TEUs in 1988. These are quite remarkable figures when it is taken into account that they have been achieved in the short period of only about 10 years. It is clearly likely that container traffic in Korea will increase considerably in response to the growth of the economy and international trade. As Korea depends heavily on the external trade system where raw and semi-finished materials are imported and re-exported after processing, just-in-time and cost saving delivery arrangements play a great role in the promotion of competitiveness in the international trade sector.

Korea is on the mainstream trades, and on its deep sea routes has access to the largest and most efficient container ships in the world fleet. Busan, the major container hub centre located in Korea's southern area, fits in the standard itinerary on the mainstream trades, while Inchon located in the north, lies some way the mainline routes so that a call at Inchon requires a substantial additional distance on the major routes serving Korea's trades. Thus, rather than making direct calls to Inchon, most carriers serving Korea's container trades tend to call at Busan which is geographically close to the mainstream, leaving all distribution to the land modes.

Although Inchon port has the most industrialised hinterland area and the importance of the Seoul metropolitan region to Korea's international seaborne trade, it does not play a significant role as a gateway for Seoul. Most cargoes from the city use Busan port through around 300 mile-long inland transport routes. In 1989 Busan handled 95% of the total containerised cargoes while Inchon had just 5%. This has led to the port congestion at Busan which has created severe cargo and ship congestion.

Due to capacity limitations, of the container traffic handled at Busan, BCTOC(Busan Container Terminal Operating Company) only held about 60% in 1989. The rest was handled at the conventional berths. At conventional berths all containers are moved directly to the ODCYs (Off-Dock Container Yards) within Busan city because of the extreme shortage of storage space at the berths. At BCTOC a significant proportion of boxes are dependent upon road and only a few on rail. In 1989, 93% of boxes are moved on trunk haul by road and the remaining 7% by rail. Such a serious imbalance in the modal split may cause a lot of problems related to environment. The problem of congestion in the road network is serious and most highways are already at their saturation point. In addition, the excessive dependence on road causes environment and air pollution. However, the share of the rail in container movements is still very low because of the ineffectiveness of the rail system.

Korea is now facing quite severe problems in its container port and inland transport systems. The major cause of this is the failure of policy makers to respond to technological change and the growth of container cargoes and to formulate a comprehensive policy. Problems of port congestion, coupled with poor inland transport systems have made the operation of container movements poor and inefficient, and thus inhibited economic development of the nation. A problem of this nature is probably further aggravated in view of the fact that there is no provision for a well-planned coordination between transport modes. These problems need to be rectified. There is also a need to identify the major problems in terms of the principal components of the transport system, viz. ocean transport, sea ports and inland transport in order to contribute to a better, more efficient transport system.

1.2 OBJECTIVES OF THE STUDY

Facing the intermodal era, the main objectives of this thesis are to examine thoroughly the fundamental problems confronting the industry, and identify and evaluate the optimum transport network in the total transport system in relation to the development of containerisation in Korea. This particular issues may be broken as follows:-

The main deep sea port is in the south of the country, whereas the main cargo centres are in the north. This imposes the need for long inland hauls. There is a general lack of port facilities which is being remedied by development in the south and tending to confirm the existing structure. There is a fundamental question as to whether this is economic and should continue, or whether an attempt should be made to develop for mainstream trades the northern port of Inchon.

Inland transport systems are fragmented both physically and commercially. We need a full understanding of the reasons for this and a policy for integration.

Road is the predominant inland mode, whilst for the long inland haul to Seoul rail/road is arguably the most efficient mode. We need to be able to find ways to improve this situation.

1.3 METHODOLOGY ADOPTED

In order to realise the study objectives set out in section 1.2, the study makes use of various tools. For forecasting Korea's seaborne container traffic up to the year 2000, a relationship is established with growth of Korea's GDP.

In the second part, estimates of TEU transport capacity are based on a broad analysis of the fleet using the NYK Registers and CIY, and an analysis of service frequency. NYK Registers and CIY cover ship size (TEU), service frequency and number of vessels in each fleet serving one itinerary and so on. Using this information, the aggregate annual transport capacity on a regular basis is estimated from the formula below:-

Capacity(TEU) per annum = Ship Size(TEU) X No. of oneway voyage Ship Year

The advantage of this method is that it is simple but reasonably accurate.

In the main methodology, the study is based on the through transport costing approach. The approach includes the inland transport costs at each end of the route as well as the voyage costs. In the intermodal transport system, the different links in the transport chain i.e. sea transport, port operation and inland transport are usually controlled by different and sometimes conflicting interests. A factor which has been optimised by the ship may not be optimal for the port and so on. From an independent viewpoint, it is this total transport cost which should be minimised. The advantage of using this method is that it explicitly recognises that additional inland transport can be used as a substitute for maritime transport and vice versa. This allows the ship operator to re-configure the itinerary to minimise overall through transport cost.

1.4 THE STRUCTURE OF THE THESIS

The thesis is arranged in eight chapters. Chapter 2 reviews the historical developments of containerisation and intermodalism. This starts with an analysis of container revolution in international transport, followed by the significant growth of containership capacity since containers were introduced into the three major deep sea routes of the world. The chapter ends with a discussion of the principal competition between ships and inland modes in intermodal transport.

Chapter 3 provides a comprehensive review of the Korean international trade developments under which the growth of Korea's container traffic is highlighted. Container traffic forecasts are then derived. Three different scenarios are assumed related to various international trade environments. They are used as a guideline towards the future development strategy of container ports and inland transport systems.

Chapter 4 deals with the development of five major container shipping routes serving Korea's trades and a regional breakdown of inland container traffics. It is shown that most carriers serving Korea's trades tend to call at Busan port which is geographically close to the mainstream trades, rather than making direct calls to Inchon. The regional shares of container traffic are used as an important parameter in calculating the distribution costs of moving container from the Busan and Inchon port, respectively (chapter 6).

Chapter 5 analyses the economics of port choice for the marine sector. The two route case studies (WCNA-FE and Europe-FE) are considered. On each route a call Busan alone is taken as the base case. This is compared with Inchon alone and Inchon plus Busan in the mainline service itinerary. The comparison is in terms of total costs at sea and in port. Having pictured the rapid increase of ship size in recent years, the issue of cost-efficiency of large ships is discussed. This is carried out by parametric studies. The study gives a detailed analysis of the build up of ship costs as far as possible.

Chapter 6 describes the inland transport network and estimates the costs of inland distribution. It starts with an investigation of the current situation of Korea's inland container distribution systems, followed by a calculation of the inland container transport costs by individual modes. Care is taken to derive precise costs because this paves the way for evaluating an efficient intermodal transport network in chapter 7. An analytical discussion of the major problems of the inland container transport systems is then made.

Chapter 7 sums up the marine sector costs estimated in chapter 5 and inland distribution costs analysed in chapter 6. The study is based on the through transport costing method which shows the best cost-effective network towards the development of Korea's intermodal transport system.

Finally, chapter 8 returns to the question raised in study objectives. Prior to answering these questions, we shall briefly summarise our findings. We shall then conclude with some recommendations on the strategic issues of the whole thesis and implications for future research.

1.5 DATA AVAILABILITY AND COLLECTION

As well as the review of the literature this thesis has utilised specialised literature statistics and field survey data. The statistical base for the analysis was compiled from a variety of official sources during the author's visits to Korea in the years 1989 and 1991. The data are relevant to Korea's economy and the container transport sector in general. The main sources are as follows:-

(a) Government records in various ministries and departments.
(b) Published statistical data from the centre of statistics of Korea and the central bank of Korea.
(c) The Ministry of transport.
(d) The Korean Shippers' Council.
(e) Documents from the Korean container lines.
(f) Data published from the international institutions and the United Nations.

In general official statistics and published documents may suffer from some inaccuracies but most are accurate and reliable. For the purpose of this thesis, in case of inadequate statistical data, comments on the quality of data sets are made when appropriate.

1.5.1 Field survey

Field surveys were carried out where there was lack of secondary data. The surveys conducted relate to the operational characteristics by road and rail of the journey to Bugok ICD, BCTOC and several ODCYs, etc. It was found desirable to pay visits to selected places to acquire first-hand knowledge of the nature of problems confronted by Korea's container transport systems.

1.5.2 Personal interview approach

The approach of the thesis is seldom complete unless interviews with officials involved in the total transport systems, i.e. ocean transport, ports and inland transport are conducted. Several discussions or interviews at various stages of the study were held. A number of distinguished members of the Korean transport institutions and government have offered authentic information from their personal knowledge and experience.

REFERENCE

Graham, M.G. and Hughes, D.O.(1985), Containerisation in Eighties, Lloyd's of London press, London.

CHAPTER 2. THE CONTAINER REVOLUTION AND DEVELOPMENT OF INTERMODAL TRANSPORT

2.1 INTRODUCTION

Growth in industry and trade and development in the field of transport have always interacted on one another to the benefit of both. As a service to trade, transport is very important to the trading process. Through speeding up the movement of the goods involved in trade, it contributes to the growth of the economy. It also helps specialisation to take place and thus assists in the realisation of economies of scale.

Technological advancement in the transport field helps efficiency thus promoting trade further. In recent decades technological innovation in transport has been a major factor in improving efficiency in the transport sector. In the general cargo sector this has been associated with the development of through transport systems simplifying the distribution system and increasing productivity. Containerisation was a physical change which facilitated door-to-door movement.

Containerisation and the development of intermodal transport systems have had a profound effect on the shipping industry, its structure and operation, seaports and inland transportation. The movement of goods in a single container by more than one mode of transportation from origin to final destination was an important development in the transport of general cargo. Although this development was pioneered in US trades, it has now spread throughout the world.

The principal aim of this chapter is to provide an overview of these developments. This analysis will encompass trade, transport, technological advancement and then containerisation. There will be also a review of the competition between transport modes in intermodal transport. The chapter is divided into three major sections. The first covers the evolution of containerisation in seaborne transport as a service to trade. In the second section the development of intermodalism in international transport is examined. This covers the interrelationship between containerisation and intermodalism. Following this, a brief review of the operation of the major international minibridge is developed.

2.2 TECHNOLOGICAL REVOLUTION IN INTERNATIONAL TRANSPORT

The maritime transport industry has experienced several revolutionary 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 unitisation, particularly containerisation, in the past three decades.

2.2.1 THE ADVENT OF CONTAINERISATION

Containerisation was initiated in the United States during the mid-50's and entered on the deep-sea trades in the mid-60's. 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 can be summed up by Gilman, S.(1983) and Thomas, B.J.(1976) who mentioned respectively as follows:-

> The most dramatic changes occurred when a large increase in size of unit, a radical simplication 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.

> The introduction of containerisation 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.

Containerisation as a major system in the transport of general cargo had its origin in the fact that conventional cargo handling operations, which were highly labour intensive, left little scope for improvement and were becoming sharply more expensive (Graham, M.G. and Hughes, D.O. 1985). Traditionally, conventional vessels were known to stay in port for 60-80% of the voyage time (Hoyle, B.S. and Hilling, D. 1983). The cargo handling process was slow with a considerable amount of idle time and delays. In spite of the objective of reducing the turn-round time in port and costs per ton of cargo handled, output was often well below possible levels and the costs higher than necessary. For instance, in the U.S.A, in case of using conventional break bulk methods of cargo handling, direct labour costs including crew as well as dockers accounted for 50-60% of the total costs of sea transport in 1960 and that between 60% and 70% of total costs accumulated in the port, and when ship time was taken into account the port sector accounted for 80% of the total (Gilman, S. 1983).

In addition, containerisation brought about an increase in the size of cargo handling unit from a maximum of about 3 tons under the conventional system, up to the largest size compatible with direct use in the inland modes. More precisely a 20ft container provides a capacity of around 22 tonnes of cargo in thirty cubic metres of space, whilst a 40ft box will carry a similar weight but has over 60 cubic metres of capacity (Gilman, S. 1991). This increase in size of cargo handling unit was combined with, greater damage and pilferage resistance, very fast, efficient and low cost cargo handling and a very large increase in vessel size. At the same time the implementation of unit handling methods provided the physical basis for integration along the transport chain from the manufacturer to the consignee and thus for the development of through transport.

Seaborne container transport began with the containerised coastal services around the US from 1956 onwards by Matson Naviation and Sea-Land. However, the most significant step in the advance of world deep-sea container shipping was taken in 1965 when Sea-Land announced its intention to bring containerships into the transatlantic trade, which was quickly followed by United States Lines' plans for a container service on the North Atlantic in 1966 (Drewry 1986). Since then the growth of container service has been explosive and over the past 30 years expansion of containerisation has been irresistible. The development of container system can be divided into epochs as follows (Marine Transport Centre 1981):-

1. 1950 to 1965:
   The gestation of the cellular container system mainly in the US.

2. 1965 to 1972:
   The container revolution: A rapid takeover of the major routes between developed countries. An increase of some six times in ship size to 3,000 TEUs. The early developments of integrated intermodal networks.

3. 1972 to 1983:
   (a) The further technological evolution of container systems chiefly in terminals and in the developments of intermodal networks.
   (b) The beginnings of container penetration in developing countries including the transformation of routes to OPEC countries on the mid-1970's.

4. 1983 to date:
   The growth of the fleet of very large containerships.

As can be seen in the epochs, from the mid-1960's there was a period of explosive growth when containers were introduced into the three major routes of the world, the Atlantic, the Pacific and the Europe/Far East route (now commonly known as the mainstream routes) as well as some subsidiary routes, notably Europe/Australia. Since the early 1970's container services have been introduced into developing countries and thus containerisation has been a feature of most of the major international seaborne trade routes for the past twenty years.

2.2.2 THE GROWTH OF THE CONTAINER CARRYING FLEET

Corresponding to the increase in container traffic on the major routes of the world, containership capacity has dramatically increased from 195,372 TEU in 1970 to 3,021,289 TEU at November 1, 1989 (CIY 1990). Tables

2-1 and 2-2 show the details of the growth in the TEU capacity of the world containership fleet.

Container carrying ships can be divided into several types or classes, viz, fully cellular containerships, semi-containerships and other, which includes Ro-Ro/Container, Ro-Ro and Bulk-Containerships. As shown in the tables, the predominant ship type is the fully cellular containership. This type, including ships converted to fully cellular, dominated with 50.3% of the total world container fleet of 1,753,802 TEUs in 1983 and this increased slightly the share to 53.7% in 1989. The cellular sector also had 257,837 TEUs out of 314,427 slots on order which has further increased its share. Over fifty percent of the world's slot capacity falls into the fully cellular category but this sector contains most of the large vessels which sail on the deep sea trades.

Table 2-3 shows the development of the world cellular container fleet in terms of slots between January 1984 and November 1990. It includes a wide range of vessel sizes covering all routes, short as well as deep-sea. From the table it can be seen clearly that the high rate of growth was concentrated on the very large vessels of over 2,500 TEUs with almost 700% over the period. Other sectors grew between 28% to 64%. Large ships also dominated the capacity on order.

Table 2-1. World Containership Fleet and Orderbook by Size and Type at November 1, 1983

	Under 500	500-999	1000-1499	1500-1999	2000-2499	Over 2500	Total TEUs
FULLY CELLULAR							
Present slots	70586	101454	175297	228829	96747	83589	756502
No of ships	253	137	141	132	43	30	736
Slots on order	7886	18227	25465	31744	6670	115404	205396
No of ships	20	26	19	18	3	36	122
CONVERTED TO CELLULAR							
Present slots	8204	50372	59818	7840	0	0	126234
No of ships	30	72	53	4	0	0	159
RO-RO/CONTAINER							
Present slots	17264	18170	26919	0	0	0	62353
No of ships	57	27	22	0	0	0	106
Slots on order	780	2078	0	3600	10500	0	16958
No of ships	3	3	0	2	5	0	13
RO-RO							
Present slots	69022	47005	60335	22423	8100	0	206885
No of ships	256	70	48	13	4	0	391
Slots on order	10246	4960	6504	0	7320	0	29030
No of ships	34	8	5	0	3	0	50
SEMI-CONTAINER							
Present slots	310066	128185	11167	0	0	0	449418
No of ships	1167	195	10	0	0	0	1372
Slots on order	22750	17553	6291	0	0	0	46594
No of ships	63	26	5	0	0	0	95
BULK/CONTAINER							
Present slots	16962	61016	44592	17000	0	0	139570
No of ships	49	84	34	11	0	0	178
Slots on order	504	6186	11427	13002	0	0	31164
No of ships	4	9	9	8	0	0	30
BARGE CARRIER							
Present slots	2301	7435	0	3104	0	0	12840
No of ships	7	10	0	2	0	0	19
Slots on order	0	1026	1480	0	0	0	2506
No of ships	0	2	1	0	0	0	3
TOTAL							
Present slots	494405	413637	378128	279196	104847	83589	1753802
No of ships	1819	595	308	162	47	30	2961
Slots on order	42166	50030	51212	48346	24490	115404	331648
No of ships	124	74	40	28	11	36	313

Source: CIY(1984).

Table 2-2. World Containership Fleet and Orderbook by Size and Type at November1, 1989

	Under 500	500-999	1000-1499	1500-1999	2000-2499	Over 2500	Total TEUs
Fully CELLULAR							
Present slots	113700	154557	236382	267435	148591	589873	1510538
No of ships	391	214	194	152	67	198	1216
Slots on order	1586	11687	42566	35139	19214	147645	257837
No of ships	5	16	39	20	8	45	133
CONVERTED TO CELLULAR							
Present slots	10248	40597	49428	4712	8000	0	112985
No of ships	40	57	41	3	4	0	145
RO-RO/CONTAINER							
Present slots	18845	18475	24465	20631	8400	14559	105375
No of ships	61	30	20	12	4	5	132
Slots on order	698	0	0	0	0	0	698
No of ships	2	0	0	0	0	0	2
RO-RO							
Present slots	102919	75350	53002	13898	14300	8250	267719
No of ships	411	117	42	9	7	3	589
Slots on order	3223	11065	2474	0	0	0	16762
No of ships	11	17	2	0	0	0	30
SEMI-CONTAINER							
Present slots	420955	206585	11839	0	0	0	639379
No of ships	1596	316	11	0	0	0	1923
Slots on order	20974	11524	5064	0	0	0	37562
No of ships	85	17	5	0	0	0	107
BREAK BULK							
Present slots	48212	503	0	0	0	0	48715
No of ships	271	1	0	0	0	0	272
BULK/CONTAINER							
Present slots	21132	77624	132199	64950	20821	0	316726
No of ships	64	107	105	39	10	0	325
Slots on order	0	700	0	0	0	0	700
No of ships	0	1	0	0	0	0	1
BARGE CARRIER							
Present slots	1981	9004	5763	3104	0	0	19852
No of ships	6	14	4	2	0	0	26
Slots on order	0	868	0	0	0	0	868
No of ships	0	1	0	0	0	0	1
TOTAL							
Present slots	737992	582695	513078	374730	200112	612682	3021289
No of ships	2840	856	417	217	92	206	4628
Slots on order	26481	35844	50104	35139	19214	147645	314427
No of ships	103	52	46	20	8	45	274

Source: CIY(1990).

Table 2-3. The Development of World Fully Cellular Fleet 1984-1990

	Under 500	500-999	1000-1499	1500-1999	2000-2499	Over 2500	Total TEUs
SLOTS							
Jan-84	78790	151826	235115	236669	96747	83589	756502
Jan-88	115815	188914	265463	255580	180915	409463	1416110
Nov-90	129216	194375	314457	295511	158438	663370	1755367
GROWTH %	64	28	34	25	64	694	132
On order	4449	22241	48028	25196	36052	201615	337581
% of 1990	3	11	15	9	23	30	19
SHIPS							
Jan-84	283	209	194	136	43	30	895
Jan-88	409	262	218	148	80	137	1254
Nov-90	447	266	261	168	72	221	1435
On order	12	28	44	15	17	61	177

Source: Containerisation International (1990).

Initial rapid growth in ship size took place between 1965 and 1972 when the capacity of the largest vessels increased from 800 to 3000 TEUs. Then a consolidation period set in when the maximum ship size did not increase. As shown in the table large vessels have figured in a very large burst of recent ordering for mainstream routes, and they are now the dominant class. A modern Panamax containership has a capacity of between 3,400 TEUs (53,000 d.w.t.) and 4,300 TEUs (60,600 d.w.t.). These ships have distinctive features compared to the standard general cargo liners of the conventional era. Firstly, they are almost five to six times larger in both space and d.w.t carrying capacity. Secondly, they are rather faster at between 19 and 24 knots compared to the 16 to 18 knots of most conventional liners. Thirdly, they spend only between about 20% and 25% of their time in port compared to the 50% to 60% in the conventional era. Fourthly, they handle cargo from ship to shore at rates in excess of 8,000 tonnes per day compared to the 300 to 500 tonnes per day of the conventional era.

Now a new generation has been designed and built. APL, breaking the Panama canal size barrier, operates five 4,300 TEUs capacity ships for the Pacific service whilst Maersk Line and Hapag-Lloyd plan to deploy twelve 4,000 TEUs and five 4,400 TEUs capacity ships respectively for worldwide operation by 1993 (CIY 1990). In the near future, ships of 5,000 TEUs to 6,000 TEUs might be deployed into the major seaborne routes. As Gilman (1991) indicated the post Panamax ships have very effective design, good stability and substantial capacity as well as good speed and fuel economy. Accordingly, there are already further orders and major ports all over the world are preparing themselves for the post Panamax era.

2.2.3 THE LEADING CONTAINER OPERATORS AND AN INCREASE IN THEIR MARKET SHARE IN THE MAINSTREAM TRADES

According to Containerisation International (1990 June), by the end of March 1990 a total of 4,614 full containerships with a total capacity of 3.03 million TEUs were in operation on the world major deep sea routes. By 1990, Evergreen of Taiwan was the world's largest containership operator controlling a fleet of 67 vessels with an aggregate capacity of 130,916 TEUs slots. Sea-Land of the Unites States ranked the second with 115,367 TEU slots, followed by Maersk (Denmark), NYK (Japan), MOL (Japan), APL (USA), OOCL (Hong Kong), K-Line (Japan), COSCO (China) and Hapag Lloyd (Germany). Hanjin ranked the eleventh with 27 containerships of about 50,000 TEUs slot capacity. In 1993, Evergreen will take the second place, slipping down the league while Maersk will grow to 132,703 TEUs slots holding first place. Following this there are 12 operators in the 50,000 to

80,000 TEU range. The smallest carrier will still have 34,428 TEUs, which would have placed it seventeenth in the league in 1990. Table 2-4 shows the detail.

Table 2-4. TEU slots of the top 20 container operators 1990 to 1993

Operators		Operated Mar-1990	Contracted Newbuildings	Projected 1993	Ranking 1993
Evergreen	Taiwan	130,916		130,916	2
Sea Land	US	115,367		115,367	3
Maersk	Denmark	94,703	38,000	132,703	1
NYK	Japan	78,148	14,418	92,556	4
MOL	Japan	70,334	7,226	77,560	6
APL	US	66,380		66,380	7
OOCL	Hong Kong	58,117		58,117	12
K-Line	Japan	55,462	1,700	57,162	14
COSCO	China	54,505	5,460	59,965	11
Hapag Lloyd	Germany	53,178	24,537	77,715	5
Hanjin	Korea	49,621	16,468	66,089	8
P & O	UK	49,368	2,400	51,768	16
Yangming	Taiwan	46,817	10,500	57,317	13
Zim	Israel	44,918	16,814	61,730	10
Nedlloyd	Netherlands	40,335	23,400	63,735	9
BSC	USSR	36,760	15,124	51,884	15
NOL	Singapore	35,294	1,526	36,820	19
ScanDutch		32,948	11,625	44,573	17
SNCDV	France	31,204	6,600	37,804	18
CGM	France	29,040	5,388	34,428	20
TOTAL		1,173,413	201,186	1,374,599	
World Total		3,026,180	367,033	3,393,213	
Top 20 Share		39	55	41	

Source: Containerisation International June 1990.

In terms of TEU slot capacity the top twenty had 39% of the world container fleet in 1990 and this is expected to rise to around 41% by 1993. As can be seen in table 2-4, Asian carriers dominate the rankings. They occupy nine of the top 20 carriers and account for almost half (579,215 TEU) of all the slots in service in March 1990. The Asian group's share of the contracted newbuildings in 1993, however, has slowed somewhat and its share of the top 20 fleet is projected to fall from 49.4% in 1990 to 46.3% in

1993. A loss of market share is also expected for the American carriers. Neither Sea-Land or APL have tonnage booked for the year 1993. Their overall share of the league will fall from 15.5% in 1990 to 13.2% in 1993. In contrast to this situation, carriers from Europe show a strong orderbook. A total of 111,950 TEU is projected for delivery over the next three years, almost twice that contracted by Asian operators. As a result the European share of the league will increase from 28.2% in 1990 to 32.2% three years hence.

Especially noticeable is the clear trend by the top 20 carriers to operate large ships in the major deep sea trades of the world. Table 2-5 lists the shares of the top 20 by ship size of March 1990. In 1990, the top twenty had 96.4% of the fleet of ships of 3,000 TEUs and over, just over 80% of those between 2,500 and 3,000 TEUs and 60% of the ships between 2,000 and 2,500 TEUs. Taking the three sectors together they had 81% of the TEU capacity and this is expected to rise to about 85% by 1993. These statistics show predominance in the mainstream trades, together with a considerable participation in the rest of the deep sea sector (see table 2-6).

Table 2-5. Shares of the Top 20 Container Service Operators by Ship Size(TEUs), March 1990

	Under 1000TEU	1000-1499	1500-1999	2000-2499	2500-2999	Over 3000	Total
Evergreen	15,876	11,912	10,960		54,560	37,708	130,916
Sea-Land	11,065	18,040	1,924	12,746	30,120	41,472	115,367
Maersk	10,073	3,666	6,900	18,964	5,100	50,000	94,703
NYK	16,500	7,385	15,837	11,349	16,223	10,854	78,148
MOL	17,700	3,594	12,437	6,480	26,510	3,613	70,334
APL	5,980	5,600		8,000	25,300	21,500	66,380
OOCL	5,279		6,103	11,180	12,705	22,850	58,117
K-Line	8,590	1,139	1,830	13,392	20,143	10,368	55,462
COSCO	14,414	20,704	8,435		10,952		54,505
Hapag Lloyd	4,628	6,019	4,849	9,020	22,176	6,486	53,178
Hanjin	760	6,944	9,883		32,034		49,621
P & O	2,217	5,075	14,638		20,212	7,226	49,368
Yangming	757		21,340			24,720	46,817
Zim	14,178	7,045	12,097	11,596			44,916
Nedlloyd	13,871	10,516	13,186		2,762		40,335
BSC	23,148	10,522	3,090				36,760
NOL	2,936	1,281	6,682	8,482	5,932	9,981	35,294
ScanDutch	2,670	1,452	4,866	6,705	17,255		32,948
SNCDV	14,617	8,610	7,977				31,204
CGM	1,608	14,243	10,664	2,525			29,040
TOTAL	186867	143747	173598	120439	301984	246778	1173413
World Total	1309336	510391	375127	200112	375340	255874	3026180
Top 20 Share	14.3	28.2	46.2	60.2	80.5	96.4	38.8

Source: Containerisation International June 1990.

As can be seen in table 2-5, in the league only four carriers, i.e. Zim, BSC, SNCDV and CGM do not operate vessels loading upwards of 2,500 TEUs. In the case of BSC and SNCDV, the whole fleet is now confined to ships less than 2,000 TEUs. Within three years, however, this situation is likely to change. BSC has already announced five ships loading 2,668 TEUs while SNCDV has ordered three 2,200 TEUs ships (CI 1990). Then, the share of the large ships of the top twenty in the mainstream routes is projected to increase further in the near future.

Table 2-6. Top 20 container operators and their slots distribution(TEUs)
1990

Operator	Slots (TEUs)	Ships No.	FE/NA	FE/E.Med	NA/E.Med	FE/AuNz	E/Aunz	Other	Total
			Slots distribution						
Evegreen	130916	67	95732	95052	79520			11868	282172
Sea-Land	115367	63	39767	6460	41472			27518	115217
Maersk	94703	53	66980	84190	62888			7367	221425
NYK	78148	56	35757	29741		4150		15920	85568
MOL	70334	55	29677	24363		6644		19344	80028
APL	66380	35	45000	11200				10180	66380
OOCL	58117	30	30685	11632	11937	2266		3095	59615
K-Line	55462	35	31417	18030	1554	5087		7211	63299
COSCO	54505	55	12491	18240		4910		10599	46240
Hapag-Lloyd	53178	32		30977	18085	978	4222	8561	62823
Hanjin	49621	26	37637	11224				760	49621
P & O	49368	26		32064	3456	8866	9959	372	54717
Yangming	46817	20	44120	44120		2697			90937
Zim	44916	46	23693	36564	25319	8882	8882	7827	111167
Nedlloyd	40335	42	1228	20317		6881		19474	47900
BSC	36760	59		8348	4944		5322	18146	36760
NOL	35294	18	18034	11929		2999		3431	36393
ScanDutch	32948	20		43028				443	43471
SCNDV	31204	40							
CGM	29040	27		6397	7132		2537	12974	29040
Total	1173413	805	512218	543876	256307	54360	30922	185090	1582773
Percentage(%)			32.4	34.4	16.2	3.4	2.0	11.6	100.0

Source: CIY(1990).

Table 2-6 shows the slot distribution by mainstream route of the top twenty operators. Evident in the table is the major deployment in the mainstream trades with large vessels. Based on the table, in 1990 the FE/Europe & Mediterranean route is obviously the busiest one with a slots capacity of 543,876 TEUs or 34.4% out of a total capacity of 1,582,773 TEUs, followed by the transpacific route (32.4.%), the transatlantic route (16.2%) and FE/Australasia (3.4%), etc. The FE/Europe & Mediterranean route has the largest share of slots beating the FE/NA route by a modest margin. However, the FE/Europe route length is much greater than FE to the West coast and in terms of cargo volumes FE/NA is easily the most important. The table shows that the other routes (the African, South American and NA/Australia & New Zealand) have relatively small shares of the total slots capacity.

2.2.4 THE GROWTH OF HUB CENTRES AND FEEDER NETWORKS

As noted above, nowadays the trend on the world mainstream container routes is to deploy larger and larger ships. The massive increase in ship size has an important effect on the network strategies of the carriers and the choice of calling ports. In the intermodal age, the condition of the port itself is a major factor which influences ship operators' choice. Those ports with efficient container handling system, adequate container stowage yard and excellent geographic location are in a superior competitive position.

In the early stages of containerisation it was generally believed that container service would become highly concentrated with very large ships plying between a very limited number of super-ports, wider distribution being achieved by feeder service or inland transport. Theoretically, it is possible for the lines to absorb some inland costs from the sea freight so that shippers can deliver their container goods to such super-ports with no extra inland haulage costs as if they are moving the goods to the nearest traditional ports. In fact, however, this kind of very highly concentrated service has not materialised and the idea of super-ports itself has been critised (Gilman, S. 1991).

In reality there is an intermediate level of concentration. Mainline ship itineraries are still based on multi port operations[1] while there is also an increasing amount of feeding for outlying areas. This trend has now become universal in deep sea routes, particularly in the Asian region which has a number of major hubs. Singapore, Hong Kong and Kaohsiung are the large hub centres although other main line ports also take part in feeder activity on a smaller scale. These ports are particularly favoured geographically to act as feeder centres. They tend to become bankers and to crop up in almost every itinerary[2]. This situation can be identified by two examples of major carriers, i.e. Ace Group for the Far East, Japan/Europe route and APL for the PSW/Japan, Far East route.

The Ace Group calls at four European ports (*Le Havre, Felixstowe, Rotterdam and Hamburg*) and goes straight through to the Far East with no stop at the Mediterranean or the Middle East. In the Far East it calls at *Singapore, Hong Kong, Kaohsiung, Busan, Osaka and Tokyo*. Wider spread of cargo is achieved by a series of feeder networks. Hong Kong feeds PRC ports while Kaohsiung feeds Keelung and the Philippines. The Southeastern Asian ports of Kelang, Jakarta and Bangkok are fed via Singapore.

The American President Lines, on the PSW-Japan/Far East service, calls at *San Pedro, Oakland, Yokohama, Kobe, Hong Kong and Kaohsiung*. US East/Gulf coast and the Mid-West are served via Oakland using

[1] The main reasons are that the large modern deep sea container ship is by far the most efficient means ever devised for moving large quantities of general cargo and the substitution of inland transport or feeder service for diversion of the deep-sea ships is not necessarily a cheap option.

[2] The main reasons are that they have large advantages of market strength in the various parts of the trading region, operational strategies and varying preferences among the ports within a closely competing set.

mini/microbridge. Hong Kong acts as a transshipment centre for cargoes to/from China mainland. Philippines, SE Asia, Mid-East and India are served by feeder linkes from Kaohsiung.

Most major carriers base their operating strategies on similar ideas (see chapter 4 for more examples). Almost all mainline itineraries serving the Asian region go direct from Singapore to Hong Kong. The Philippines, Indonesia, Thailand and Vietnam are dependent upon a substantial feed of cargo. For mainline ships on the present itineraries direct calls in most of these countries represent a significant diversion, so that most carriers still leaves a considerable amount of feeding to a local centre, adopting basically the multi port operations. So far as Korea is concerned, Busan involves only a modest diversion on routes between Japan and South Asia and receives a direct call on many itineraries.

2.3 THE DEVELOPMENT OF INTERMODAL TRANSPORT

Containerisation has been a feature of the major international seaborne general cargo trade routes over the last thirty years and in the past two decades has taken over trades to and from developing countries. Containerisation brought with it new technological improvements in ships and ports and at the same time provided the basis for intermodal transport. This greatly increased the number of possible routings for intercontinental transport, allowing containers to be moved from one mode of transport to another and allowing greater inland penetration.

The idea behind containerisation is to consolidate items into one standard size unit which can be handled faster, stowed safer and transported more efficiently. It has radically altered ocean transportation system, cargo-handling equipment at deep-sea terminals and inland installations, port and inland connections, commercial and legal regimes and procedures, and trading patterns, etc (Collinson, D.S. 1969). We will deal with these from the three points of view; *the relation between containerisation and intermodalism, the developments of intermodal transport, and port equalisation and intermodal rates.*

2.3.1 THE RELATION BETWEEN CONTAINERISATION AND INTERMODALISM

Intermodal transport is simply defined as the movement of cargo from shipper to consignee by at least two different modes of transport under a single rate, with a through bill of lading and through liability. The objective of intermodal transport is to transfer commodities in a continuous flow through the entire transport chain from origin to final destination in the most cost effective way. This means capitalising on the relative advantages of various transport modes in every element of the journey(UNCTAD 1981).

The container is unique in that it permits transport of general cargo from the shipper's door to the overseas final destination, minimising loss and damage, and the other hazards inherent in the multiple handling of commodities by various modes. Containerisation, and the consequent growth of intermodalism, has been phenomenal. Compared to containerisation, the new development, intermodality brought with it a shift in emphasis. The focus was on the organisation of the transport industry and the synchronisation of the distribution system. Table 2-7 clearly illustrates the distinction between the technological character of the benefits of containerisation and the commercial nature of intermodalism.

Table 2-7. The Key Elements in Containerisation and Intermodalism.

CONTAINERISATION	INTERMODALISM
1. Unitisation	1. System concept
2. Standardisation	2. Management and coordination
3. Cellular ships	3. Control over cargo
4. Roll-on/Roll-off vessels	4. Mergers
5. Gantry cranes	5. Multimodal companies
6. Straddle carriers	6. Modal integration
7. Specialised terminals	7. Through rates and billing
8. Ship-to-shore productivity	8. Information system
9. Terminal back-up land	9. Physical distribution
10. Multi-rate structure	10. Deregulation

Source: Hayuth, Y.(1987).

From the above table, it can be seen that containerisation is concerned with the technological feature of most of the key elements of the transport industry, while intermodalism deals with the organisation of the principal components of the newly developed distribution system. Included in such an intermodal system are producers, shippers, ocean and land carriers, ports and so on.

Intermodal transport provides the shipper and the line with major benefits. Hayuth(1987) wrote in his book **Intermodality:-**

1. Intermodal transport signifies a growing trend in international freight transportation, in which shippers can take a full range of transportation and distribution services under one company umbrella. It means that there is no need for the shippers to make seperate and multiple contracts in order to carry cargoes from the original to the final destination. This represents strong interest in the establishment and expansion of multimodal or total transport companies.

2. Compared with the task of a segmented transport mode, a multimodal company can distribute cargoes under its direct control with better coordination and efficiency among the various modes. By doing so, the company can cut duplicate administrative expenses. With the cooperation and consolidation of various modes under one corporate roof, the company can again take advantage of the relative benefits that individual mode brings from its own region, area of speciality and traditional customers.

2.3.2 THE DEVELOPMENT OF CONTAINER TRANSPORT AND INTERMODAL TRANSPORT WORLDWIDE

As noted previously, containerisation provides for common cargo units which enable cargo to be transferred efficiently between modes of transport and thus paves the way for the development of intermodal transport. At the time containerisation developed in deep sea trades there were regulatory and physical barriers to intermodalism. The main regulatory barriers were in the US.

In the United States, the Shipping Act of 1916 provided antitrust exemptions for conference agreements duly registered with the US Federal Maritime Commission(FMC). The main reason the US has introduced this special legistration on liner services was the practice of self-regulation frequently observed in liner shipping services. However, in the 1980s there were a series of regulatory reforms which have set free the forces of competition in the US transport sector. The deregulation of domestic transport in the Motor Carrier Act of 1980, the Staggers Act of 1981 and the

Shipping Act of 1984 have greatly contributed to the growth of intermodal services.

The Motor Carrier Act of 1980 removed all legal barriers to entry into the trucking industry and led to the proliferation of highway carriers, many of them low-cost carriers. Hard pressed by intensified competition, highway carriers had to cut costs and/or search for a market niche. Some of them offered international intermodal service by contracting with foreign carriers at the other end of the journey (Thuong, L.T. 1989).

Under the Staggers Act of 1981, the railroads also acquired the flexibility required to supply intermodal service. They are no longer regulated by the Interstate Commerce Commission with respect to the pricing of TOFC (Trailer on Flatcar)/ COFC (Container on Flatcar) service. Consequently, box car traffic has steadily declined while intermodal traffic has become a mainstay business (ibid).

The new US Shipping Act of 1984 (enacted on March 20, 1984) had a major impact on liner conference's operations in the US trades and on the world liner shipping, replacing significant portions of the US Shipping Act of 1916. The basic objectives of the Act were to reduce governmental regulations of operators to allow them greater freedom of action within the liner conference system and permit market forces to play a larger role in ratemaking and service regulation by increasing the negotiating posture of operators or conferences with shippers. It was an important point that the Act allowed carriers greater freedom to collaborate on through rates and through bills of lading, and also provided shippers with new leverage.

As a result, deregulation in the whole transport sector has made it possible for steamship lines, railroads and highway carriers to realign themselves and to make the necessary investments for more efficient provision of intermodal services. Liberated by deregulation, the major shipping lines have provided an international door-to-door service that links most of the USA/Canada. The pioneering company, APL owns the rail cars and manages the whole system (Eyre, J.L. 1987). Other shipping lines including Maersk, Yangming, Evergreen, the Japanese and European consortia, etc carry containers double stacked on rail, forming alliances with railroads.

This pattern has now found its way into many major trade routes. In particular the move towards integration on the main three deep-sea routes, viz, North America- Far East and Japan, North Europe- North America and Europe- Far East has developed in the last twenty years. However, full intermodalism is an ideal which is not always carried out in practice. From the early days of containerisation shippers have always been allowed to arrange their own inland transport under the merchant haulage option. For a variety of technical, logistical and legal reasons merchant haulage has been widely used in many countries and it has been important in Korea.

2.3.3 THE DEVELOPMENTS IN LINER PRICING STRUCTURES

The development of containerisation and the intermodal nature of the new business forced changes in traditional charging practices and led to the introduction of through rates. This caused the adaption of liner tariffs to container services. With the development of container service, all through transport operators gave the traders the option between Carrier Haulage[3] and Merchant Haulage.[4] If a trader opts for merchant haulage at each end, the minimum service purchased from the carrier is sea freight plus terminal handling. With regard to the Terminal Handling Charge (THC), in some trades, a three part tariff (*Inland transport* + *Sea freight* + *Inland transport*) was adopted, THCs being combined in the ocean freight rate. In the Far East trade where port conditions varied greatly in different areas, the five part tariff structure (*Inland* + *THC* + *Sea freight* + *THC* + *Inland*) was adopted in 1990 with separate THC at each end. In recent times the five part tariff structure has become a norm for many trades (Graham, M.G. and Hughes, D.O. 1985).

In most liner trades, the sea freight rate for a given type of cargo is the same from any main port in a range on one end of a vessel's route to any main port in a range on the other end (Gilman, S. 1981). Under conventional pricing the shipper is responsible for inland transport costs to and from ports, and will minimise his total transport costs (ocean and inland) by shipping his cargo out of the nearest port. With conventional pricing, other things being equal, the shipper tends to minimise his inland transport and thus his total costs by choosing a local port. This conventional pricing structure was a major factor contributing to the extensive multiport itineraries and the duplication of port calls by liner companies prior to containerisation. As a

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3 The shipping line arranges all the inland transport and the carrier would absorb inland costs.

4 Under this arrangement the shipper or consignee delivers or picks up the box at the container terminal and has to return the box to the terminal at his own expense.

result, ports developed natural hinterlands and lines needed to call at each port if they desired to obtain the cargo from each hinterland.

With the advent of containerisation, different route structures and networks were required for containership lines to take advantage of the cost economics of containership size at sea. In order to obtain these cost economics, relatively large port consignments are needed[5]. In container trades an absorption pricing structure was developed and applied in certain areas to promote efficient container networks.

Under absorption pricing the shipper is charged for inland transport as though the cargo is going to or from its nearest port, irrespective of the port from which the carrier actually serves. That is to say, the costs of inland transport can be absorbed to some extent so that the shipper pays the same irrespective of the choice of ports. This makes shippers and consignees much less concerned with the choice of port or even completely indifferent to it and brings inland modes into transport networks in a much more substantial way (Gilman, S. 1983).

Furthermore it allows all lines access to cargoes throughout the hinterland and the shipping company can serve the whole hinterland with a single load centre call. In theory, lines do not have to make a direct call to a port if inland transport can be used as a substitute for ship diversion. Under absorption pricing, the choice of port has changed from the shipper to carrier

[5] The number of ports in each itinerary is still between 7 and 12 but the area served is much longer extending catchment of individual port.

so that the decision to call at a port depends on the economic trade-off between diverting a mainline vessel and using alternative land transport modes (Chadwin, W.A., Pope, J.A. and Talley, W.K. 1990).

An inland haulage system for carrier haulage based on absorption was developed early on by the UK Australia conference. For the Australian route, the UK was divided into 50 km inland grids based on the cost of the cheapest of the traditional major ports called at in the conventional system. The shipping company absorbed certain inland transport costs, itself selected the port for the trade and stopped its service from some established ports.[6] Similar pricing systems were later adopted on UK/Far East, South African and on the North Atlantic routes (Gilman, S. 1983 and 1987). A form of absorption pricing may also apply to merchant haulage. Carriers may offer the Bill of Lading from a port close to a shipper, and receive the cargo at that port, and then move it at his own expense to another port where his ship actually calls. In the case of conferences both ports will usually be included in the conference tariff. These systems are not, however, universal and they have not been applied in the Korean situation.

2.4 COMPETITION BETWEEN SHIPS AND INLAND MODES IN INTERMODAL TRANSPORT

In the conventional era, the shipping lines' main concern and responsibility was normally limited to cargo handling and vessel steaming. With the development of intermodalism ocean carriers had to extend their

[6] The port of Liverpool is a typical case in point of this situation as is the port of Greenock.

traditional and functional operations beyond the conventional role into the inland freight transport system. The lines had to provide a door-to-door rather than a port-to-port service and offered the shippers a total distribution package. This caused an increase in the relative importance to liner operators of the use of inland modes such as railways and trucks. The development of national highway systems, particularly in the United States and Europe, the adaptation of long-distance truck haulage to the container system, the introduction of container unit trains and the double stack container rail cars have all acted to lower the unit costs of overland transport (Hayuth, Y.. 1987). This encouraged the development of inland modes in which trucks and railroads in overland movements could compete with the high daily operating cost of container vessels on short as well as long distance routes.

With the development of intermodal transport the choice as to whether a ship should divert to make a direct call at a particular port or should use the inland transport mode to distribute the cargoes is important. It depends on a number of parameters which control the economics of route itinersries.

Transport costs per TEU mile: Generally sea transport is much cheaper than the land modes, rail or road. The deep sea container ship is by far the most efficient means ever devised for moving large quantities of general cargo. It costs about US$ 3.0 per 100 TEU miles for a panamax vessel compared to US$ 32 per 100 TEU miles by rail and US$ 70 per 100 TEU miles by road (see tables 5-14 and 6-19). Thus sea transport costs are between one tenth and one twentieth of the land based modes. It would seem from this that the ideal way to carry a cargo to its destination is to get as close as possible to that destination by water, put the cargo on a railroad to the depot nearest the consignee's premises and then complete the intermodal move by truck to the shipper's door. This would be the case if routes were parallel and the ship was always travelling at full load. However, quite often the maritime and inland distances required to serve the hinterland of a diversion port are very different. Further to this the cargo for the diversion may be only a small part of the vessel total and this can bring the inland modes into more contention.

Transport convexity: This is termed as the ratio between marine and land miles. The ratio varies enormously in each particular case depending upon the exact shape of land masses and the alignment of the sea route in relation to the land mass (The University of Liverpool Marine Transport Centre 1981). It is an important factor which determines whether a ship should divert to make a direct call at a particular port or should use the inland transport mode. If the additional sailing distance required to serve a port is far in excess of inland distance, this favours the inland distribution system. However, if little additional maritime distance could save significant inland transport distance, the ship may be justified in making a diversion. The exact ratio, however, depends upon the precise spatial (and cost) relationships in each case. Figure 2-1 illustrates the points.

Figure 2-1. Transport convexity ratio between marine and land miles

```
Marine diversion distance
|
|    Greater than unity
|--- 10
|  |
|  |
|  |
|  |      Unity
|--|------
|  |     |
|  |     |
|  |     |                 Less than unity
|--|-----|---------| 0.2
|__|_____|_________|_______________________
                                       Additional inland
                                       haulage distance
```

Source: The University of Liverpool Marine Transport Centre (1981)

As shown in the figure above, with a convexity ratio greater than unity the additional marine diversion distance exceeds the additional inland transport distance. At less than unity the additional inland distance is greater than the marine diversion distance. In practice, however, due to the huge difference in the marine and inland transport costs per mile, a high convexity ratio in excess of at least 10:1 would be needed for a land based feed for a ship at full load. Any ratio less than 10 would support marine diversion.

consignment size: Another factor, which determines whether or not the mainline vessel will be diverted, or a feeder vessel or land modes will be employed, is the consignment size of cargo at the proposed diversion port. An additional call involves the whole ship as an indivisible unit while potential savings may relate to only a percentage of the cargo. The analysis conducted in later chapters will model inland transport costs more precisely in the Korean case, but the relationships outlined above, remain underlying influences with a major effect on the result.

2.5 THE DEVELOPMENT OF MINI BRIDGES

With the development of intermodal transport, the increased use of inland modes allows for the establishment of new transport patterns. Where the ratios described above are favourable carriers using mini bridge routes can often find an advantage in terms of total costs, especially when taking into account further savings in transit time and inventory costs. This can be seen in table 2-8 which compares the costs between the traditional all water route and the mini-bridge on the Far East(FE)-the United States East Coast(USEC) route. The results are expressed in terms of one 40ft container (FEU).

Direct costs for the USEC cargoes via the west coast mini bridge by rail are about 30-40% over those of the all water service. There are, however, a significant saving of inventory costs, decreasing from US$ 420 to US$ 47.8 in 3400 TEU ship and from US$ 367.4 to US$ 2.0 in 1700 TEU, respectively [see table 2-8 (3)]. This gives an overall reduction of shipper's and carrier's costs for intermodal transport through the minibridge. It provides a saving of transit time of 8 days as against using the sea route [see table 2-8 (4)].

Table 2-8. Comparison of the Costs/FEU and Transit Time between FE/USEC using the all water route and the double stack train

	3400 TEU (20.7 kn.)	1700 TEU (21 kn.)
FE/USEC via USWC plus Train		
Costs at sea		
ship costs only/FEU(US$)	382.8	420.2
ship + high inventory costs/FEU(US$)	1134.4	1125.4
Costs in landbridge		
estimation of costs/FEU(US$)	700	700
high inventory costs/FEU(US$)	134.8	134.8
(1) Total Costs		
ship costs only/FEU(US$)	1082.8	1120.2
ship+high inventory costs/FEU(US$)	1969.2	1960.2
FE/USEC by All Water Route		
(2) Total Costs		
ship costs only/FEU(US$)	662.8	752.8
ship+high inventory costs/FEU(US$)	1921.4	1958.2
(3) Costs Comparison		
carriers costs/FEU(US$)	420.0	367.4
carriers+shippers costs/FEU(US$)	47.8	2.0
(4) Transit Time Comparison(days)		
using the landbridge	20	19
using the sea route	28	27
Savings via the landbridge	8	8

Source: Liu, S.(1989).

As mentioned the greatest advantages of hauling containers through the minibridge have to do with distance and transit time. The route from Japan to New York via minibridge service is about 5,000 km shorter than the route via the Panama Canal and the transit time is also saving eight days.[7] Although trades with the US East Coast are still being served by ocean carriers, a further shift to minibridge service seems quite likely because of the

[7] The costs are already discussed in table 2-8.

large size of container vessels, expectations of higher panama canal charges and the limitation of the dimensions of the canal's locks, etc. Certainly the minibridge services have had a significant impact on traditional port hinterlands and transport itineraries.

2.6 CONCLUSION

This chapter has reviewed the major characteristics of containerisation and the developments of intermodal transport. Containerisation has evolved into a sophisticated transport system largely caused by the pressure of higher labour costs and low productivity in ports and the need for more efficient cargo handling methods to cope with the growing tonnage of cargoes being carried. Containerisation made possible door-to-door service, greatly improving vessel's turn-around time in port and reducing cargo handling costs.

Since the introduction of containerisation into deep-sea trades between the United States and Western Europe in the mid-1960s, the system has become almost universal. Corresponding to the increase in container traffic demand, worldwide containership capacity has dramatically increased from 195,372 TEU in 1970 to 3,021,289 TEU in 1989. Of container carrying ships, the fully cellular containership dominated with 54% of the total world container fleet in 1989. The number of large capacity vessels is also significantly increased. During the period 1984-1990, the fleet of large capacity ships of over 2500

TEU grew by 700% compared to small vessels with only 40%. The trend in size of vessel of the world container fleet is demonstrated by experience of the top 20 carriers. Since 1983 they figured in a very large burst of ordering for mainstream routes and are now dominant on deep sea routes. In 1990 they had 96.4% of the fleet of ships of 3,000 TEUs and over, just over 80% of those between 2,500 and 3,000 TEUs, and 60% of the ships between 2,000 and 2,500 TEUs.

The massive increase in ship size has a significant effect on the network strategies of the carriers. In the intermodal era the condition of the port itself is a major factor which affects container service operators' choice. Carriers tend to call at the ports equipped with efficient container handling system, adequate container stowage yard and geographical closeness to their main cargo generating hinterlands. They operate multiport itineraries to such ports and then use feeders to extend to outlying centres.

In addition containerisation forced changes in traditional charging practices and led to the introduction of through rates. With the development of the system, all through transport operators give the trader the option between carrier haulage and merchant haulage. The minimum part of a through container service is still be seafreight (including port charges). Inland transport may be either by carrier or merchant haulage.

With the development of container transport and intermodal transport worldwide, the competition between ships and the inland modes is intensified. The development of the highway systems, the introduction of container unit trains and double stack container rail cars encouraged the participation of inland modes. The ship is by far the cheapest mode when travelling at full load compared to rail and road. However, the land modes compete with the ship either when they can take a short cut, or when the ship has to make a diversion for a relatively small amount of cargo, or when there is a combination of these two factors.

The increased use of inland modes caused an increase in the relative importance to liner operators of the use of mini-bridges. The international intermodal minibridge, the American West Coast minibridge offers shippers significant savings in transit time and affords liner operators the means of reaching new market areas. The use of the mini bridges is expected to increase in the future, in areas where the network geography is suitable. Korean services via Busan to the Seoul region represent a form of mini bridge which is examined in detail later in this thesis.

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CHAPTER 3. THE DEVELOPMENT OF INTERNATIONAL TRADE AND FORECASTING OF CONTAINERISED CARGOES IN KOREA

3.1 INTRODUCTION

The previous chapter briefly examined the historical development and possible future trends in intermodalism based on the major characteristics of containerisation. This chapter reviews the importance of international trade to the economic development of Korea and subsequently, forecasts the demand of container traffics to the year 2000.

International trade in Korea has increased dramatically since 1962, when Korea implemented a system of economic development plans. Since then, the country has achieved significant economic growth due to the expansion of its manufacturing and industrial goods and the diversification of its overseas trade. As Korea is heavily dependent on the import of almost all raw materials and the export of its finished goods, foreign trade is crucial to its economic growth.

The principal aim of this chapter is to show the pattern of development of Korea's international trade from 1962 to 1989. The chapter is broken down into three major sections covering Korea's economic growth, development of its international trade and containerised cargoes and finally the forecasting of container traffic. The first section illustrates the trend in three kinds of economic policies the Korean government adopted from the year 1962. In the second section, the evolution of containerised cargo on Korea's major liner routes is presented. This analysis covers the share and the pattern of growth of container traffic moved on the individual subroute. Following this breakdown, the forecasting of container traffic by subroute to the year 2000 is determined in the third section. The analysis is based on Korea's seaborne trade data, Korean statistics of national economic growth and container traffic statistics moved through Korean ports from 1979 to 1988.

3.2 ECONOMIC GROWTH AND TRADE DEVELOPMENT IN KOREA

3.2.1 OVERVIEW OF ECONOMIC GROWTH

The Korean peninsula which is located at the south of Manchuria is about 1,000 km in length and lies in a north-south direction. The total area of the peninsula is approximately 230,000 sq km, nearly equivalent to the land area of Great Britain excluding "Northern Ireland". The land area is now divided into two areas, the Republic of Korea(R.O.K) and the *Communist Democratic People's Republic of Korea.* This resulted from the Korean war in 1950 which brought a tremendous disaster and suffering to the Korean people. From 1950 to 1953, during its three years, almost all the area was devastated by the aggression of the communists of North Korea. In 1953, an armistice was concluded by United Nations Peace Keeping Force. Since then, South and North Korea have been remained antagonistic separated by a Demilitarised Zone. There have been almost no official diplomatic relations between the two sides so far.

The total area of South Korea is about 99,143 sq km and its total population was roughly 43 million in 1989. Korea's economic growth has been managed under a series of Five-Year Economic Development Plans during the last three decades from 1962. Through the impressive success of these plans, Korea has recorded higher economic growth rate than any other country in the world (Financial Times 1989). In 1962, its per capita income was no more than US $87 while by 1989, this figure had risen to US $4,850. Further, the GNP of US$ 2.3 billion in 1962 grew to US$ 205.0 billions in 1989 (see: Table 3-1).

Table 3-1. Results (US$) of the Korean Economic Growth in Selected Years (1962-1989)

Class\Year	1962	1981	1989
GNP($ billion)	2.315	63.343	205.0
Export($ million)	55	21254	62299
Import($ million)	422	26130	61300
Per Capita Income	87	1636	4850
Population(million)	26.5	38.7	43.2

Source: EPB(Report on Korean Economic Trends 1989).

From the above table, it can be seen that the population has grown from 26.5 million to 43.2 million with an annual average rate of increase of 3.0%. Total exports increased from US$ 55 million to US$ 62.3 billion and imports also grew to US$ 61.3 billion from US$ 422 million in the same period. The proportion of exports to GNP increased from 2.3% to 30.4% and for imports it rose from 18% to 29.9%. No single factor can account for Korea's economic miracle over the last 30 years and the literature on Korean economic success mentions a number of factors, all of which no doubt played an important role. However, the main elements have been *the export-oriented strategy, the import-substituting strategy and the policy of diversification of international trade.*

3.2.2 STRUCTURE OF KOREA'S INTERNATIONAL TRADE

3.2.2.1 EXPORT-ORIENTED STRATEGY (1962-1971)

In Korea, the decade from 1962 to 1971 is that of the " export-oriented strategy". For Korea with a long dependence on imports, the change to export-orientation was indeed remarkable. The essence of the strategy was to promote labour-intensive manufacturing exports in which Korea had a comparative advantage. In order to successfully carry out this strategy, the government took a number of internal and external measures. Most important were a series of fiscal and monetary reforms, which were aimed at increasing saving deposits, and the introduction of a unified exchange rate system targeted to promote exports. For example, the government allowed commercial banks to raise interest rates on deposits from 12% to as high as 26.4%. For three years in a row after 1965, the year when interest rates were raised, savings deposits in banks nearly doubled each year and the annual rate of real increase recorded 34.1% from the year 1962 to 1971 (Table 3-2).

Table 3-2. Savings Deposits in Korea

Year	Nominal Amount (Million Won)	GNP Deflator (1980=100)	Real Amount (Million Won)	Rate of Increase(%)
1962	12163	4.34	280253	89.6
1963	12846	5.61	228984	-18.3
1964	14496	7.50	193280	-15.4
1965+	30573	7.75	394490	104.1
1966	70085	8.87	790135	100.3
1967	128901	10.26	1256345	59.0
1968	255938	11.91	2145575	70.8
1969	451527	13.67	3303050	53.9
1970	576313	15.80	3647551	10.4
1971	708688	18.00	3937156	7.9
1962-1971			Annual Increase Rate:34.1	

Note: + means the year when interest rates were raised.
Source: Kihwan Kim(1984).

In addition, the government continued to give its full support to the export-oriented growth strategy. This consisted of the provision of short-term export financing by the government, tariff rebates on materials imported for export production and the simplification of customs procedures. These measures allowed Korean exporters to implement their business as if they were operating under a system of free trade.

The strategy was highly successful in changing the emphasis of the economy from foodstuffs and raw materials to manufactured goods. As can be seen in Table 3-3, in 1960-1962 the share of manufactured products accounted for 16.6% of total exports, while by 1973-1975, it amounted to 83.4% of a much larger total volume, recording 26.5% of GDP. This trend to industralisation continued under the subsequent Five-Year Economic Development Plans.

Table 3-3. Commodity Composition of Exports, 1960-1975
(Unit: share in % based on US$ values)

Category(SITC code)	1960-1962	1973-1975
Food and beverage(0,1)	32.1	10.1
Crude materials(2,4)	44.0	4.3
Mineral fuels(3)	4.8	1.9
Chemicals(5)	1.5	1.7
Manufactures(6,8)	13.2	67.9
Machinery & transport equipment(7)	1.9	13.9
Unclassified(9)	2.5	0.2
Total	100	100
Food, fuel & raw materials(0-4)	80.9	16.3
Manufactures(5-8)	16.6	83.4
Commodity exports' share of GDP	1.6	26.5

Source: IMF(1982).

The following table 3-4 presents a breakdown of seaborne exports by main items during the period 1962-1971.

Table 3-4.Breakdown of the Seaborne Exports by Items in Korea, 1962-1971
(Unit: thousands metric tonnes)

Item/Year	1962	1966	1967	1971
Grains	64	57		
Fertilizer		6	10	80
Cement		18	27	910
Lumber and logs	7	36	62	248
Anthracite	294	152		
Minerals	253	842		
Machinery				3
Oil				340
Iron materials			4	112
Iron ore			608	478
Other ore			254	327
Total	618	1111	965	2498

Source: The Department of Transportation(Various issues).

During the period, the major cargoes in Korea's export trade were cement, iron ore, oil, and lumber and logs. In 1971, they amounted to 2.3 million metric tonnes, taking over 50% of the total. In particular, cement exports grew rapidly in this period. In 1966, they only amounted to 18,000 tonnes, while in 1971, they reached 910 thousand metric tonnes, constituting 36.4% of the Korea's export trade by volume.

In case of electronic parts, most of which were exported, more than 90% in terms of value went to the US, the other markets being Japan, West Germany, Canada and Hong Kong. The other commodities are composed of cotton fabric and raw silk etc. They were exclusively exported to the US during the early 1960s, markets then diversifying to Japan, Hong Kong, Italy and Nigeria.

The important feature to be observed between 1962-1971 is that Korea's exports were mainly conducted with two nations-the US and Japan. Throughout this period, these two trading partners accounted for approximately 70% of Korea's total export trade. The results of the export-oriented strategy surpassed all expectations and the annual growth rate of exports in real terms during the same period was more than 20.2%. Fuelled by growth of exports, real GNP increased at annual rate of 8.7%.

3.2.2.2 IMPORT-SUBSTITUTING STRATEGY (1972-1981)

The early 1970s introduced a new strategy emphasising import substitution, especially in heavy and chemical industries and in agriculture. This shift in strategy resulted from a number of external factors. First, in 1971, the Nixon Administration in the US reduced its troop level in Korea by one third. This caused Korea to develop its own defence industry. Mr Carter's presidential promise to withdraw all US troops in 1976 further strengthened Korea's resolve in this direction. Another economic reason resulted from the failure of the Bretton Woods System in 1971. Contrary to the general belief, this discouraged balance of payments adjustments via exchange rate modification and accelerated protectionism. Facing growing difficulties, the government was forced to restructure its commodity composition in favor of more sophisticated, high value-added industrial goods and diversify its trading pattern (Kihwan Kim 1984).

Through the introduction of import substitution, the growth of heavy industries including iron and steel, shipbuilding, machinery, electronics and petrochemicals was accelerated (Table 3-5). This strategy also contributed to the upgrading of exports, the share of heavy and chemical industrial products in total exports rising from 9.0% in 1970 to 30.9% in 1981.

Table 3-5. Share of Major Commodities in Total Exports in Selected Years (1970-1981; Unit(%))

SITC NO	1970	1975	1978	1981
7 Machinery	7.4	13.8	20.4	22.2
72 Electrical Machinery	5.3	8.7	9.8	10.2
73 Ships & transport equipment	1.1	3.6	8.8	9.7
7-(72+73) Other machinery	1.0	1.5	1.7	2.3
67 Iron and steel	1.6	4.6	4.5	8.7
* Subtotal *	9.0	18.4	24.9	30.9
65 & 84 Textiles and clothing	35.7	36.1	32.3	29.7
85 Footwear	2.1	3.8	5.4	4.8
3 Fishery products	4.9	7.1	5.0	3.9
Others	48.3	34.7	32.0	30.7
TOTAL	100	100	100	100

Source: Bank of Korea(various issues).

The export-oriented strategy brought an ever increasing demand for imports, whilst improved foreign earnings made the expansion of imports possible. The share of imports during 1960-1962 amounted to a mere 13% of GDP, rising steadily to about 48% of GDP by value in 1981 (Table 3-6).

Table 3-6. Commodity Share of Imports, 1960-1981(Unit: % based on US$)

SITC NO	Commodities	1960-62	1973-75	1979-81
(0,1)	Food & beverage	11.1	14.7	8.8
(2,4)	Crude materials	21.4	18.3	15.8
(3)	Mineral fuels	7.5	14.7	26.6
(5)	Chemicals	21.5	9.4	8.6
(6,8)	Manufactures	16.8	16.6	14.8
(7)	Machinery & transport equipment	14.1	26.2	25.0
	Others	7.6	0.1	0.3
	TOTAL	100	100	100
Food, fuel and raw materials(0-4)		40.0	42.7	51.3
Manufactures(5-8)		52.4	52.2	48.4
Import's share of GDP		13.2	38.0	48.1

Sources: K.S.Kim(1975) and IMF(1982).

It can be seen from the above table that fuels, food & raw materials, and manufactures had a roughly stable relationship over the period 1960-1981. Within those categories, mineral fuel increased its share significantly because of the growth of demand for raw material inputs. Imports of machinery and transport equipment also rose substantially in response to the increased share of investment in GDP. The following table 3-7 presents the seaborne import trade volume by major items during selected years, 1972-1981.

Table 3-7. Seaborne Import Trade Volume by Items, 1971-1981
(Unit: thousands metric tonnes)

Items/Years	1972	1976	1977	1981
Grains	3071	3131	4024	7300
Oil	12612	18546	21756	25421
Coals	13	1689	2036	12463
Logs	2957	5552	6804	5107
Iron ore	71	2635	3523	11804
Phosphate	680	893	1467	1130
Machinery	28	516	903	717
Iron materials	1605	2416	3739	3923
Others	3661	6068	7245	11158
TOTAL	24698	41446	51497	79023

Source: T.W.Lee(1989).

During this period, the largest import item was oil, increasing continuously from 12.6 million metric tonnes in 1972 to 25.4 million metric tonnes in 1981. Its share of the total imports, however, reduced to 32.2% in 1981 from 51% in 1972%. Iron ore imports also grew remarkably by about 160 times from 71 thousand metric tonnes in 1972 to 11.8 million metric tonnes in 1981. This resulted from the strategy of import substitution in heavy industry. Owing to the oil crisis during 1973-74, the import of coal was significantly accelerated as a substitute energy source. This amounted to 12.5 million metric tonnes in 1981, reaching 15.8% of total imports. Major cargoes including grains, oil, coal and iron ore reached 57 million metric tonnes in 1981 or 72% of the total seaborne trade. This implies that the composition of seaborne imports has changed during the period. Despite the increase of imports of those items, Korea's import trade was still heavily dependent upon the USA and Japan, amounting to 23.1% and 24.2% of total import volume in 1981, respectively (Table 3-8).

Table 3-8. Major Import Countries by Region, 1970-1981(Unit: %)

Regions	1970	1977	1981
USA	29.5	15.8	23.1
Japan	41.0	15.9	24.2
Southeast Asia	5.0	30.3	19.6
Europe	7.7	0.5	7.6
Others	16.8	37.5	25.5
TOTAL	100	100	100

Sources: EPB(1982) and T.W.Lee(1989).

3.2.2.3 PROMOTION AND DIVERSIFICATION OF INTERNATIONAL TRADE (1982-1989)

As noted previously, Korea's heavy and chemical industrial exports including iron and steel products, textiles and clothing products, and machinery rapidly increased during the period 1970-1981, and emerged as major export growth commodities. The share of heavy and chemical industrial goods in total exports increased from 9.0% in 1970 to 30.9% in 1981 as shown in table 3-5. This high growth and the structural change were, however, accompanied by some structural imbalances in the economy as follows:

1. over-investment in heavy industries and under-investment in light industries.
2. a high degree of inflation (between 1962-71 the average annual rate of inflation measured in wholesale prices was about 12%, while recorded nearly 18% between 1972-79).[8]
3. excessive dependence on US and Japan as trading partners.

[8] It is far worsened by the assassination of President Park on October, 1979. Since then, the country began to bring about many political instability and economic difficulties. Under these circumstances, employers could not resist demands for high wage increase by workers. To make matters worse, OPEC began to raise oil prices, almost doubling Korea's oil import bill.

These imbalances eventually weakened export competitiveness, thus slowing down the overall growth of the economy. To cope with these difficulties, in April 1979, the government introduced a programme of stabilisation and the diversification of trade to restructure the whole economy. To deal with over-investment in heavy and chemical industries and under-investment in light industries, the country temporarily suspended all new projects in the heavy and chemical industries and realigned credit priorities in favour of light industries. Further, to maintain price stability, the nation set lower targets for the growth of the money supply. With steady governmental support policy, the economy began to recover in 1981 with an annual growth rate of 6.2%, compared to the decline of 5.2% in 1980 the first in more than 20 years (see table 3-9).

Table 3-9. Macroeconomic Performance in Korea(1980-1987)

	Unit	1980	81	82	83	84	85	8 6	87
GNP growth rate	%	-5.2	6.2	5.6	9.5	7.5	5.4	12.3	12.0
Wholesale prices	%	38.9	20.4	4.7	0.3	0.8	1.2	-1.9	0.6
Consumer prices	%	28.7	21.3	8.8	4.4	3.1	3.4	4.0	4.3
Trade balances	billion dollars	-4.8	-4.9	-2.5	-1.8	-1.4	-0.9	3.1	6.3
Exports	"	17.5	21.2	21.8	24.4	29.2	30.2	34.7	47.3
Imports	"	22.3	26.1	24.3	26.2	30.6	31.1	31.6	41.0

Source: International Financial Statistics and Yearbook(1988).

Measured in terms of wholesale prices, inflation fell to 0.6% in 1987 from 38.9%in 1980 whilst in terms of consumer price, it was down to 4.3% in 1987 from 28.7% in 1980. The trade balance was also increased to a positive US $ 6.3 billion in 1987 from a negative US $ 4.8 billion in 1980, recording its first-ever surplus in 1986. With a rapid decline in inflation and price stability, Korea's balance of payments improved dramatically and annual average growth rate in GDP(1980-1987) recorded 8.7% in real terms. This price stability went far toward increasing Korea's export competitiveness (Financial Times 1989).

The country has also pursued a policy of expanding and diversifying its trading pattern. Up to the early 1970's, the main trading partners were the US and Japan. As shown in Table 3-10, the combined share of the total USA and Japan in Korea's export trade decreased from 75.6% in 1970 to 56.7% in 1987. However, the absolute amounts of those two trades has increased from US $ 631 million to $ 26.8billion. The most noticeable trading development made during this period is that the country opened up new export markets in the Middle East and Africa, recording US $ 2.0 billion and US $ 553 million in 1987, respectively.

Table 3-10. Major Importing Countries for Korean Products in Selected Years (1970-1987, Unit: US $ million)

1970			1981			1987		
Countries	Amount	%	Countries	Amount	%	Countries	Amount	%
USA	395	47.3	USA	5688	26.8	USA	18382	38.9
Japan	236	28.3	Japan	3503	16.5	Japan	8437	17.8
Hong Kong	28	3.3	Mid-East	2442	11.5	W.Germany	2002	4.2
W.Germany	27	3.3	Africa	579	2.7	U.K	1525	3.2
Canada	20	2.3	Hong Kong	1155	5.4	Canada	1451	3.1
U.K	13	1.6	W.Germany	805	3.8	Saudi Arab	1031	2.1
Others	116	13.9	U.K	705	3.3	Mid-East	1006	2.2
			Canada	484	2.3	Africa	553	1.2
			Netherland	328	1.5	Others	12894	27.3
			Others	5565	26.2			
TOTAL	835	100		21254	100		47281	100

Source: Direction of Trade Statistics(1988).

Furthermore, in 1970 imports were primarily restricted to the Japan and USA, but with the expansion and diversification of trading partners, the combined share of imports purchased from the Japan and USA reduced from 70.5% in 1970 to 54.7% in 1987. However, the amounts of imports from those trades has grown 16 times from US $ 1.4 billion to US $ 22.4 billion. Despite the percentage decline, they still remain Korea's most important trading partners (Table 3-11). Of significance is the emergence of Saudi Arabia and Malaysia as importing partners; sources of petroleum and lumber, respectively.

Table 3-11. Major Exporting Countries to Korea in Selected Years (1970-1987, Unit: US $ million)

1970			1981			1987		
Countries	Amount	%	Countries	Amount	%	Countries	Amount	%
Japan	813	41.0	Japan	6374	24.4	Japan	13657	33.3
USA	585	29.5	USA	6050	23.2	USA	8761	21.4
W.Cermany	67	3.4	Saudi Arab	3561	13.6	W.Germany	1799	4.4
Malaysia	58	2.9	Kuwait	1573	6.0	Saudi Arab	1117	2.7
France	52	2.6	W.Germany	672	2.6	Malaysia	1086	2.6
Philliphines	42	2.1	Malaysia	643	2.5	Canada	947	2.3
U.K	33	1.7	Austria	910	3.5	Indonesia	825	2.0
Others	335	16.8	U.K	398	1.5	France	784	1.9
			Canada	531	2.0	U.K	722	1.8
			Others	5419	20.7	Africa	207	0.5
						Others	11115	27.1
TOTAL	1985	100		26131	100		41020	100

Source: Direction of Trade Statistics(1988).

As a result of the foreign trade expansion and diversification strategy, total traffic grew 31.5 times in value during the period from US$ 2.8 billion in 1970 to US$ 88.3 billion in 1987. In 1987, Korea accounted for 2.0% of the world's total value of exports and 1.6% of imports, being 10th in the table of leading exporting countries and 14th in the list of importing countries (Direction of Trade Statistics 1988).

3.3 THE GROWTH OF CONTAINERISED CARGOES

We have so far reviewed the general development of Korea's international trade. This section now focuses on the growth of containerised cargoes. The field of containerised cargoes has increased more rapidly than that of other cargo sectors. Table 3-12 shows the development of Korea's container traffic over the period 1977-1987. The volume of foreign trade cargo increased by 9.9% annually while the volume of containerised cargoes grew by 17.3%. The ratio of the volume of containerised cargo to total dry cargoes has greatly increased from 10.5% to 20.1% during the same period. In 1987, approximately 35 million tonnes of Korea's annual import/export trade was containerised cargo, and this amounts to 20.1% of total foreign trade.

Table 3-12.The Ratio of Container Traffic to Total Dry Cargoes in Korea
(1977-87, Unit; thousand tonnes)

Years	Total dry cargoes(T)	Container Cargoes(C)	C/T ratio
1977	68312.4	7146.7	10.5
1978	77882.1	8335.4	10.7
1979	90819.6	9539.6	10.5
1980	94034.9	10798.1	11.5
1981	105320.9	14069.0	13.4
1982	108506.5	14998.0	13.8
1983	118184.9	16551.6	14.0
1984	125736.2	19854.0	15.8
1985	133010.4	21647.0	16.3
1986	153823.4	28556.7	18.6
1987	175480.0	35192.0	20.1
1988		40992.0	
ANNUAL INCREASE (1977- 1987)	9.9%	17.3%	

Source: KMI(1988).

Korea's container trades may be broken down into six, viz. North America, Europe, Australian and New Zealand, Japan, Southeast Asia, Middle East and others. The volume of containers moved in those services is described in Table 3-13.

Table 3-13. Breakdown of Korean Container Traffic by Region,1979-1988
(Unit: 1,000 TEUs)

Region/Year	1979	1981	1983	1986	1988
Korean Exports					
North America	128.7(41.9)	154.4(37.3)	207.9(46.8)	344.6(45.7)	424.0(37.1)
Japan	69.3(22.6)	70.5(17.0)	58.7(13.4)	98.7(13.1)	201.0(17.6)
Europe	56.0(18.3)	63.2(15.3)	52.5(11.9)	92.4(12.3)	153.1(13.4)
S.E Asia	16.2(5.3)	41.1(9.9)	45.1(10.2)	103.5(13.7)	200.6(17.5)
Australia *	6.6(2.2)	8.8(2.1)	10.2(2.3)	20.7(2.7)	34.1 (2.9)
Middle East	10.7(3.5)	25.8(6.2)	29.8(6.7)	68.4(9.1)	98.2 (8.6)
Others	19.1(6.2)	50.3(12.2)	38.3(8.7)	25.8(3.4)	32.2 (2.9)
TOTAL	306.6(100)	414.0(100)	442.5(100)	754.1(100)	1143.2(100)
Korean Imports					
North America	161.2(57.9)	157.5(57.6)	178.7(52.5)	255.9(50.8)	362.0(47.8)
Japan	56.9(20.5)	52.5(19.2)	61.3(18.0)	82.1(16.3)	121.2(16.0)
Europe	30.4(10.9)	29.3(10.7)	40.4(11.9)	57.5(11.4)	91.8(12.1)
S.E Asia	8.1(2.9)	16.6(6.1)	26.5(7.8)	57.5(11.4)	111.8(14.8)
Australia *	9.9(3.6)	8.3(3.0)	11.1(3.3)	25.5(5.1)	24.7(3.3)
Middle East	na	na	na	19.4(3.9)	29.6(3.8)
Others	11.8(4.2)	9.3(3.4)	22.3(6.5)	5.4(1.1)	16.4(2.2)
TOTAL	278.2(100)	273.7(100)	340.3(100)	503.3(100)	757.5(100)

Notes: i) na implies non available
ii) * includes New Zealand
iii) ( ) is the percentage of each route over total container traffics.
Source: KMI(various issues).

In 1988, about 37% of Korea's container exports went to the North America. Other major markets were Japan (18%), S.E Asia (17.5%), Europe (13%) and Middle East (9%). In terms of container imports, around 48% of the total came from the North America. Japan, S.E Asia and Europe were the other big suppliers holding 43% of the total. Rate of growth by region ranged from 11% to 33% per annum. North America and Japan had a moderate decline compared with the others. The fastest growing trades during the period were those with S.E Asia and the Middle East (17% and 7% in 1988, respectively)- both starting from relatively small shares (about 4%) in 1979. This is a reflection of rapid development of the newly industrial countries(NICS) between Asian nations.

3.4 THE FORECASTING OF CONTAINER TRAFFIC TO THE YEAR 2000

The volume of containerised cargoes in Korea's trade increased rapidly from just 584.8 thousand TEUs in 1979 to over 1.9 million TEUs in 1988. These figures are quite significant if we take into consideration that they have been achieved in the twelve years since Korea started the country's first containerised liner service in 1976. The growth rate in this period was 14% per annum. It is likely that container traffic in Korea will continue to increase due to continuing high rates of economic growth and the growth in the ratio of containerisable cargo to total cargoes (see table 3-12). There are a number of questions concerning the future of the market. Facing the actively increasing containerised cargoes, it is the aim of this section to analyse the development of containerised goods and forecast the demand of container traffic in Korea's trades. In making this forecast, the main sources are Korea's seaborne trade data, container movements statistics through Korean ports and Korean statistics of national economic growth.

3.4.1 THE FORECASTING OF CONTAINER TRAFFIC

During the period 1977-1988 Korean Gross Domestic Product (GDP) increased from 17859 bn, won to 127962 bn. won at current prices, the average annual rate of growth in these terms being some 17.2%. This was also associated with a high rate of growth of trade in value terms and with a growth in the rate of containerised cargoes in weight terms of 18% per annum.

During the period the rate of inflation was of the order of 8% per annum suggesting a real rate of growth of the economy of some 9% per annum. In these terms the rate of growth of containerised cargoes would appear to be about twice that of the rate of growth of the economy as a whole. However, the early growth was from a low base and some of it would have been a result of take over from conventional handling systems rather than growth in the cargo base itself.

In an analysis of the relationship between world GDP growth in real terms and the growth of general cargoes in weight terms, covering the period 1972 to 1980 Gilman estimated a relationship of 1:1.4. This relationship has also been found for the growth of a number of individual countries, although there is some variation between them. For Korean cargoes this thesis will take a very cautious approach and use a ratio of 1:1, assuming growth only in line with GDP growth.

Table 3-14. Korea's GDP and Trade Data in Value(Billion Won)

Year	Export Value	Import Value	Total Value	GDP (current price)	Containerised cargoes(000 tonnes)
1977				17859	7146.7
1978				24017	8335.4
1979	7287	9844	17131	31215	9539.6
1980	10633	13541	24174	37830	10798.1
1981	14475	17796	32271	46799	14069.0
1982	15976	17730	33706	52878	14998.0
1983	18963	20318	39281	59603	16551.6
1984	23570	24690	48260	68867	19854.0
1985	26347	27089	53436	75511	21647.0
1986	30600	27840	58440	86653	28556.7
1987	38892	33742	72634	99790	35192.0
1988	44398	37898	82296	127962	40992.0

Source: IMF(1985, 1988 and 1990).

Having determined the relationship between Korea's economic growth and its container trade development, we can forecast Korea's seaborne container traffic. The first question relates to the figures of Korea's economic growth up to the year 2000. To forecast Korea's economic growth is quite complex and beyond the scope of the study. Fortunately, the Korean Development Institute (KDI) provides useful forecasting data from which figures for Korea's economy may be derived. According to KDI estimates, the Korean economy is forecast to have a growth potential of 7.2% per annum to the year 2000 from 1991 (Table 3-15).

Table 3-15. Sources of Average Annual Percentage Change of Korea's Economic Growth, 1972-2000

	Actual Growth Rate (1972-1983)	Potential Growth Rate (1991-2000)
Economic Growth Rate	8.2	7.2
Labor	3.2	1.3
(employment)	(1.9)	(0.9)
(education)	(0.4)	(0.5)
Capital	2.0	2.3
(non-residential structures and equipment)	(2.4)	(1.6)
(dwellings)	(0.1)	(0.2)
Productivity	3.0	3.6
(economies of scale)	(1.6)	(1.5)
(technology progress)	(0.6)	(2.0)

Source: KDI(1986).

However, the profile of Korea's development up to 2000 presented here is derived from the mixture of projected trends of past growth and considered as a somewhat optimistic forecast compared to that of table 3-16. Tables 3-15 and 3-16 show quite marked differences in Korea's economic growth rates.

As can be seen in table 3-16, developing country economics are expected to grow at slightly over 4.6% per annum. Korea's average annual growth rate is about 2-3% higher than this average. The higher estimate is based on several optimistic assumptions as follows:

Table 3-16. Average Annual Growth Change of the World, 1985-2000
(in 1980 constant US $ billion,%)

Countries/Year	1985	2000	Average Annual Rate of Growth 1986-91	1992-2000
WORLD	12750(100.0)	20563(100.0)	3.2	3.3
Advanced countries(a)	7917(62.1)	12156(59.1)	2.9	2.9
Developing countries	2185(17.1)	4245(20.6)	4.4	4.6
oil-producing countries	655(5.1)	1294(6.3)	4.7	4.6
non-oil-producing countries(b)	1530(12.0)	2951(14.3)	4.3	4.6
Communist countries(c)	2648(20.8)	4162(20.3)	3.0	3.1

Source: Ibid.
Notes: (a) 24 OECD member countries.
(b) Algeria, Indonesia, Iran, Iraq, Kuwait, Libya, Nigeria, Oman, Katar, Saudi Arabia, United Arab Emirates and Venezuela.
(c) Bulgaria, China, Czéchoslovakia, E. Germany, Hungary, Poland, Rumania, USSR, Yugoslavia.

1. Most countries will continue to pursue a free trade policy and thereby allow increases in the volumes of international trade.
2. Within the foreseeable future, technological innovation in Korea is expected to be significant enough to catch up with technology of advanced countries.
3. Abundant, hard-working and well-educated human resources will continue to sustain Korea's potential for growth.
4. The national savings rate will maintain a positive high growth, which can enhance the capabilities of new investment for social overhead and fixed capital, and technological innovation.

If the above-mentioned assumptions are not fully carried out or the international trade environment, including both internal and external conditions, deteriorates further, Korea's economic growth rate would be reduced. In fact, the past historic statistical data of Korea's economic growth do not coincide with the traditional development pattern of a developing countries other than the NICs. During the period 1974-84, the average annual economic growth rate for the developing countries was around 5% (Gilman, S. 1986) while Korea's economy has been 8% or above, this being 3-4% higher than the average for developing countries. Therefore, it is expected that the Korean economy will continue to grow at a rate higher than that of developing countries, generally.

To deal with forecasting uncertainties, three different scenarios (optimistic, intermediate and pessimistic) are assumed for Korea's annual economic growth rate up to the year 2000 for the purpose of the thesis. These are as follows:

1. Optimistic scenario: Due to the historic and recent economic growth rate, an average annual rate of 10% is anticipated.
2. Intermediate scenario: KDI's data is adopted as this case, a rate of growth of 7.0% per annum is assumed.
3. Pessimistic scenario: An average annual growth rate of 4.6% for developing countries is applied as this scenario for the Korean economy.

Following this approach and using the ratio 1:1, Korea's seaborne container traffic is expected to grow at 10% (optimistic scenario), 7.0% (intermediate scenario) and 4.6% (pessimistic scenario) per annum, respectively. The estimated volumes for Korea's seaborne container traffic up to 2000 based on the growth of Korea's output are presented in tables 3-17, 3-18 and 3-19. Based on estimates in the above-tables, figure 3-1 shows more clearly Korea's container traffic volumes up to the year 2000 for the scenarios.

Table 3-17. Forecasts of Korea's Seaborne Container Traffic to 2000
(Optimistic Scenario, unit:TEUs)

Year	Imports	Exports	Total
1988*	757500	1143200	1900700
1989	833250	1257520	2090770
1990	916575	1383272	2299847
1991	1008233	1521599	2529832
1992	1109056	1673759	2782815
1993	1219962	1841135	3061097
1994	1341958	2025248	3367206
1995	1476154	2227772	3703926
1996	1623769	2450549	4074318
1997	1786146	2695604	4481750
1998	1964761	2965164	4929925
1999	2161237	3261680	5422917
2000	2377361	3587848	5965209

* means real container traffic.

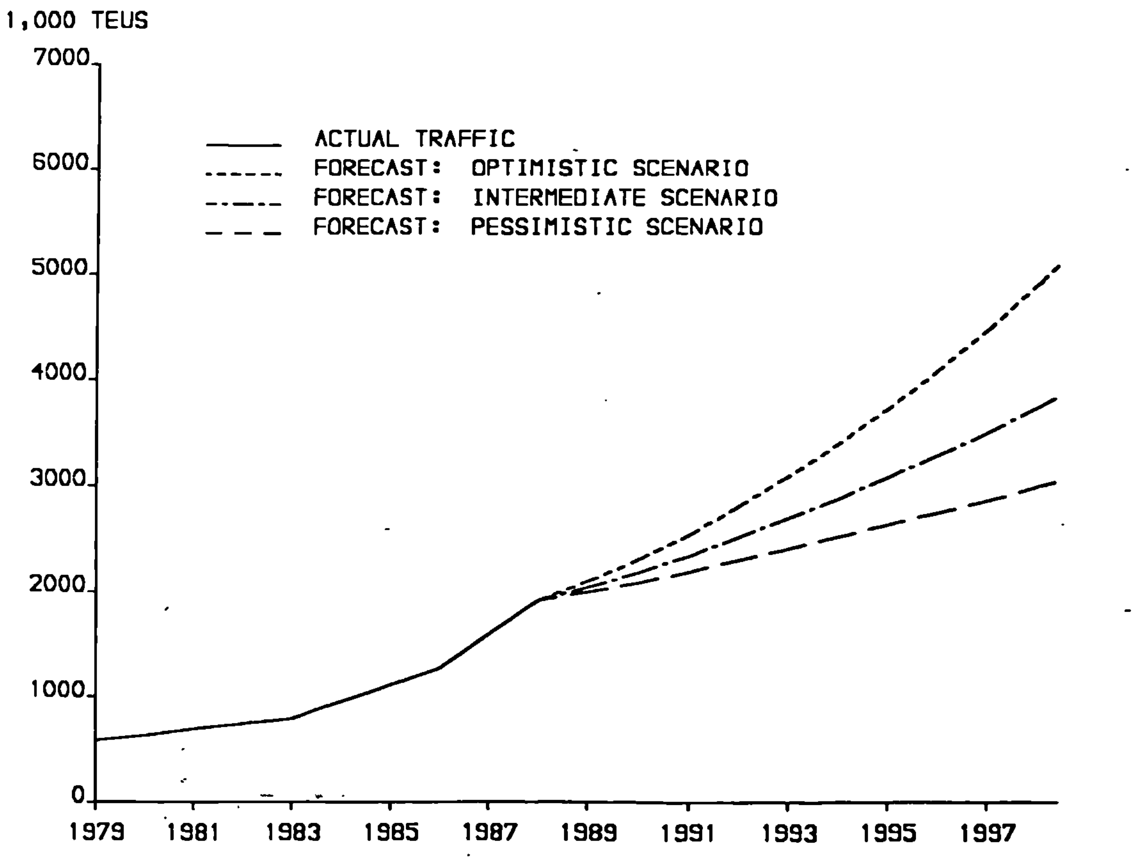
Table 3-18. Forecasts of Korea's Seaborne Container Traffic to 2000
(Intermediate Scenario, unit: TEUs)

Year	Imports	Exports	Total
1988*	757500	1143200	1900700
1989	810525	1223224	2033749
1990	867262	1308850	2176112
1991	927970	1400469	2328439
1992	992928	1498502	2491430
1993	1062432	1603397	2665829
1994	1136802	1715635	2852437
1995	1216378	1835729	3052107
1996	1301524	1964230	3265754
1997	1392631	2101726	3494357
1998	1490115	2248847	3738962
1999	1594423	2406266	4000689
2000	1706033	2574705	4280738

Table 3-19. Forecasts of Korea's Seaborne Container Traffic to 2000
(Pessimistic Scenario, unit: TEUs)

Year	Imports	Exports	Total
1988*	757500	1143200	1900700
1989	792345	1195787	1988132
1990	828793	1250793	2079586
1991	866917	1308329	2175246
1992	906795	1368512	2275307
1993	948508	1431464	2379972
1994	992139	1497311	2489450
1995	1037777	1566187	2603964
1996	1085515	1638232	2723747
1997	1135449	1713591	2849040
1998	1187680	1792416	2980096
1999	1242313	1874867	3117180
2000	1299459	1961111	3260570

Figure 3-1. Forecasted Container Traffic up to 2000 for Three Scenarios



Source: i) Real traffic is derived from Table 3-13.
ii) Forecasted traffic is derived from Tables 3-17, 3-18 and 3-19.

3.4.2 PROJECTED CONTAINER TRAFFIC IN THE YEAR 2000 BY REGIONS

As can be seen in Tables 3-17, 3-18 and 3-19, Korea's seaborne container traffic for three different cases in the year 2000 has been forecast as 5965209 TEUs (3587848(exports)+2377361(imports)) in the optimistic scenario, 4280738 TEUs (2574705(exports)+1706033(imports)) in the intermediate scenario and 3260570 TEUs (1961111(exports)+ 1299459(imports)) in the pessimistic scenario, respectively. Using the projected traffic, we can estimate trade volumes by 2000 on each individual route by regions. Turning to each individual trading route, on the basis of table 3-13, we can estimate the market share and volume of Korea's export and import container traffic in the year 2000 (see tables 3-20 and 3-21).

As indicated in table 3-13, North America and Japan have for many years been the primary trading partners for Korea's containerised cargoes.It is anticipated that in 2000 North America will remain as Korea's largest export and import market for containerisable cargoes, accounting for 33.1% of the total export and 40% of the total import. The container movement is heavily imbalanced in favour of Korea and this situation is likely to continue up to the year 2000 (table 3-21). Japan has been the second largest market for Korea but the market share is likely to have a moderate decline due to the diversification of international trade and the serious trade imbalance which is presently in favour of Japan.

Table 3-20. Market Share of Korea's Container Traffic in the Year 2000 by Regions(unit: %)

Region/Year	1979	1981	1983	1986	1988	2000(est)
EXPORTS						
North America	41.9	37.3	46.8	45.7	37.1	33.1
Japan	22.6	17.0	13.4	13.1	17.6	15.0
Europe	18.3	15.3	11.9	12.3	13.4	14.0
S.E Asia	5.3	9.9	10.2	13.7	17.5	22.5
Australia*	2.2	2.1	2.3	2.7	2.9	3.4
Middle East	3.5	6.2	6.7	9.1	8.6	10.0
Others	6.2	12.2	8.7	3.4	2.9	2.0
TOTAL	100	100	100	100	100	100
IMPORTS						
North America	57.9	57.6	52.5	50.8	47.8	40.0
Japan	20.5	19.2	18.0	16.3	16.0	15.5
Europe	10.9	10.7	11.9	11.4	12.1	12.5
S.E Asia	2.9	6.1	7.8	11.4	14.8	20.5
Australia*	3.6	3.0	3.3	5.1	3.3	4.0
Middle East	n.a	n.a	n.a	3.9	3.8	5.0
Others	4.2	3.4	6.5	1.1	2.2	2.5
TOTAL	100	100	100	100	100	100

Notes. * includes New Zealand.
Source: Derived from Table 3-13.

Nevertheless, Japan will still remain Korea's third largest market, just behind the Southeast Asian region, with a market share of around 21% by 2000. Despite the decline of the market share, North America and Japan will be Korea's major trading partners. Probably of importance is the emergence of South East Asian regions as major trading partners with a market share of 22.5% of the containerised exports and 20.5% of the imports by 2000. As the trading volumes between Korea and the NICs including Singapore, Taiwan, Malaysia and Indonesia, etc continue to increase, the future trading prospects with them appear to be significant. These nations have many advantages; Indonesia and Malaysia having ample natural resources and all of them being very near to Korea.

Table 3-21. Forecast Volume of Korea's Seaborne Container Traffic in the Year 2000 by Regions(unit: TEUs)

Region/Year	1988*	2000(estimate)**		
		optimistic	intermediate	pessimistic
EXPORTS				
North America	424000	1187578	852227	649128
Japan	201000	538177	386206	294167
Europe	153100	502299	360459	274556
S.E Asia	200600	807266	579309	441250
Australia	34100	121987	87540	66678
Middle East	98200	358785	257471	196111
Others	32200	71756	51493	39221
TOTAL	1143200	3587848	2574705	1961111
IMPORTS				
North America	362000	950944	682413	519784
Japan	121200	368491	264435	201416
Europe	91800	297170	213254	162432
S.E Asia	111800	487359	349737	266389
Australia	24700	95094	68241	51978
Middle East	29600	118868	85302	64973
Others	16400	59435	42651	32487
TOTAL	757500	2377360	1706033	1299459

Source: * is derived from Table 3-13.
** is derived from Table 3-20.

It is expected that Europe will still be a steady market for Korea's containerisable cargoes, with a share of 14% of Korea's exports and 13% of imports by 2000. In the container trade with Australia and New Zealand, due to the increasing personal and household income, and changing tastes in food in Korea, the containerised imports of Australian and New Zealand meat, and fresh fruit goods are likely to increase to about 4% of total imports. The remaining regions are relatively insignificant.

3.5 CONCLUSION

This chapter has reviewed the patterns of development of Korean trade over the period 1962-1989 and then forecast Korea's container traffic by subroute to the year 2000. During the period 1962-1989, three kinds of international trade policies, i.e. the export-oriented strategy, the import-substituting strategy and the policy of diversification of international trade were adopted. Due to the success of these policies, Korea's international trade volumes grew rapidly; total exports increased from US$ 55.0 million in 1962 to US$ 62.3 billion in 1989 and imports grew to US$ 61.3 billion from US$ 422.0 million during the same period. As a result, Korea was ranked as the 10th in the list of importing and exporting countries at the end of 1989. Further, the GNP US$ 2.3 billion in 1962 grew to US$ 205.0 billions in 1989. During the same period, its per capita income was nothing but US$ 87 in 1962 while by 1989, this rose to US$ 4850.

Especially, noticeable was the rapid growth of seaborne container traffic in Korea's international trade. During the year 1977-1987, the volume of foreign trade cargo grew by 9.9% per annum while the volume of containerised cargoes has been increased by around 18%. The ratio of the volume of containerised cargo to total dry cargo grew remarkably from 10.5% in 1977 to 20.1% in 1987 when 35 million tonnes of Korea's annual import/export trade was containerised cargo.

Following this review, based on statistical and empirical sources, i.e. Korea's seaborne trade data, seaborne container movements and Korean statistics of national economic growth, estimates of containerised cargoes movements in the long term were generated. For an outlook for the growth of Korea's seaborne container traffic to the year 2000, three cases of scenarios (optimistic, intermediate and pessimistic) were adopted. The estimated volumes of Korea's seaborne container traffic for the three scenarios in the year 2000 has been expected as 5965209 TEUs in the optimistic scenario, 4280738 TEUs in the intermediate scenario and 3260570 TEUs in the pessimistic scenario, respectively. With regard to regional shares by the year 2000, it is anticipated that North America, Europe, Southeast Asia and Japan will remain as Korea's major import and export markets for containersiable cargoes, losing just a little of their present share, but still accounting for 88% of the total import and 85% of the total export.

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CHAPTER 4. TRANSPORT GEOGRAPHY IN KOREAN CONTAINER TRADES

4.1 INTRODUCTION

The previous chapter investigated the growth of international trade and container traffics over the long period covered by Korean economic development plans. It then forecast Korea's seaborne container traffic by route up to the year 2000. The analysis now focuses on route structures in Korean container trades, this being based on data for 1989.

The chapter is broken into two major sections: the first dealing with *route structures of the ocean carriers* and the second with *a detailed regional breakdown of inland container traffics.* The first section is concerned with the five major container shipping routes serving Korean trades; North America, Europe, Australia-New Zealand, Intra-Asian and Japan. In 1988 these routes accounted for 94% and 92% respectively of total containerised cargo coming from or destined for countries overseas. The routes are analysed in terms of carriers and their market shares, transport capacity per annum, service frequency, service speed, round trip time and itineraries (see appendices).

The analysis is based on data provided by the *NYK Register 1990 and the Containerisation International Yearbook 1990* which cover shipboard slots (TEU), speed, service frequency (days) and the number of vessels in each fleet serving one itinerary.

Using this information, the aggregate annual transport capacity on a regular basis can be obtained as follows:-

Capacity(TEU)per annum = Ship Size(TEU) X No.of Oneway Voyages ship year

The figures presented by this study are given to the end of 1989, only vessels (FC, RC, RR, BC, SC) calling at the ports of Busan or Inchon in Korea in deep sea and short sea routes serving Korean trades are covered.

Following this, the regional distribution of inland container traffics through Busan and Inchon ports by these routes is determined. This analysis is subdivided by principal region.

4.2 CHANGE IN SERVICE FREQUENCY

In calculating TEU transport capacity for 1989 the first step is to consider the question of service frequency. Service frequency is an important factor which influences the choice of ship size, ship speed and fleet size. As can be seen in APPENDICES 4-1, 4-2 and 4-3, services of a weekly interval have been the norm in modern deep-sea container shipping, as this is the basis of " the Fixed Day of the Week Service(FDWS) " which is popular in the major container liner trades (JAMRI 1987). Table 4-1 shows clearly the overwhelming popularity of FDWS for the operators of the large ships which now dominate the mainstream trades.

Table 4-1. FDWS operators serving Korea's deep-sea trades

Operators	No of ships	Service frequency	Capacity per annum	Route deployment
Gearbulk	13	weekly	145440	Jap/Kor/PNW
Sea-Land	7	weekly	261793	FE/Jap/PSW
Westwood	4	weekly	211828	Jap/Kor/PNW
K-Line	5	weekly	235626	FE/Jap/PNW
MOL	6	weekly	276696	FE/Jap/PSW
NYK/MOL	6	weekly	240330	FE/Jap/PNW
Nippon/NOL/OOCL	9	weekly	219495	Jap/Kor/PSW
NYK	5	weekly	223317	Jap/Kor/PSW
Hanjin	11	weekly	305541	FE/PNW(PSW)
Hyundai	6	weekly	311234	FE/Jap/USWC
K-Line/NOL/OOCL	5	weekly	304366	ECNA/FE/Jap
OOCL	5	weekly	331516	FE/Jap/PSW/USEC
Hanjin	8	weekly	277316	USEC/PSW/Jap/FE
Evergreen	25	weekly/6 days	350202	RTW(east/west)
Yangming	18	weekly	269132	Eur/FE/USWC/EC
P&OCL/MOL/H-L/NYK	9	weekly	292831	Eur/Jap/Kor
H-L/NYK/MOL/P&OCL	9	weekly	351585	Eur/NE Asia
Nedl/EAC/MISC/CGM	8	weekly	295698	Eur/FE/Jap
Maersk	10	weekly	252138	Eur/FE/Jap
Choyang/Hanjin	9	weekly	242650	Eur/FE/Jap
Sea-Land/Norasia	13	weekly	199792	Eur/Mid-East/FE

Sources: derived from APPENDICES 4-1, 4-2, 4-3 and CIY(1990).

The JAMRI Reports (1987) set out the detailed advantages and some disadvantages of FDWS operations:

1. Periodicity
   (a) Attraction of greater lots of cargo
   (b) Intermodal transport
   (c) Guaranteed delivery on specified dates
   (d) Basis of regular berthing priorities
   (e) Minimising the sales force

2. Homogeneity
   (a) Fixation of departing and arriving days
   (b) Preference for large-sized vessels
   (c) Encouragement to joint service

3. Inflexibility
   FDWS has become a very inflexible mass transport system. It is virtually impossible to constantly increase the sailing frequency (e.g. from once to twice a week) unless both inbound and outbound shipments overflow the cargo space.

To sum up, the merits of FDWS are that it enables shippers to match their logistics needs to the scheduled calls of the vessels and it also gives the carriers in return a guarantee of cargo. It is generally considered that the appearance of large volume lots and large-sized vessels[9] gave birth to the FDWS operation. Based on this trend on mainstream routes, we shall proceed with the analysis of TEU transport capacity of Korea's major container trades.

[9] The analysis of large-sized ships in the world's major container trades is discussed in chapter 2.

4.3 LINER TRADE ROUTES SERVING KOREAN TRADES

The individual routes serving Korean trade are classified into three categories: *deep sea (over 1500 nautical miles), medium sea (over 500 nautical miles) and short sea (under 500 nautical miles)*. North America-Far East, Europe-Far East and Australia/New Zealand-Far East routes are included in the deep sea category, the Intra-Asian route is medium sea, and the Japan-Korean route short sea.

4.3.1 NORTH AMERICA-FAR EAST ROUTE

The container trade between North America and the Far East serving Korean trade has more operators, services, vessels and significantly greater total capacity than any other major trade route. It has also grown continuously, the volume of cargo doubling between 1983 and 1988 with an annual average rate of growth of about 15% over the period. To keep pace, container traffic on this trade achieved some 800 thousand TEUs in 1988 holding about 41% of the Korean total (Table 3-13).

Operator's shares are presented in APPENDIX 4-1 which covers only vessels with a call at a port in Korea on the trade during 1989. Since the first service by KSC on the route in 1976, transport capacity has grown to the point where 20 carriers provided over 4.6 million TEU slots during 1989. For a further detailed analysis, North America[10] can be divided into the following:

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[10] North America covers the United States and Canada.

1. *Far East- West Coast of North America(WCNA) consisting of FE/Pacific North West(PNW) and FE/Pacific South West(PSW).*

2. *Far East- ECNA consisting of FE/East Coast of North America Coast(ECNA) only and FE/Combined WC & ECNA.*

FE-WCNA

WCNA consists of Pacific North West ports (Seattle, Vancouver, Tacoma and Portland) and Pacific South West ports (San Francisco, Los Angeles, Oakland and Long Beach). The sub-route is the most important route on the trade between North America and the Far East. As can be seen in APPENDIX 4-1, this route had a 57.1 % share of the total transport capacity in 1989.

On the FE-WCNA market, MOL (Mitsui-OSK Line) generated the greatest capacity amounting to 377,268 TEU in 1989. This capacity was provided by 9 ships of just under 3000 TEU providing weekly services on both the PNW and PSW sub-routes. NYK, just behind MOL held 13.9% of capacity with 8 vessels serving both the PNW and PSW markets. Hanjin was the third. It deployed 11 fully cellular container carriers in the service, each of a capacity of about 1500 TEUs and with a speed of 18 knots. The top five carriers including Sea-Land and HMM had nearly a 60.4% share of the total.

In terms of nationality of the carriers, Japanese carriers provided 36.4% of capacity in the market, American lines 23.8% and Korean lines 22%. In total, Far East carriers including Japan, Korea, HK and Singapore together provided 67.9% of total capacity.

Turning to ship size, an average of about 2000 TEU was generated on the route. The top five carriers in terms of size of vessel were in sequence HMM, OOCL, Sea-Land, MOL and NYK with 2984 TEU, 2532 TEU, 2510 TEU, 2410 TEU and 2340 TEU, respectively, in 1989. The average ship size of Japanese carriers was 2294 TEU, Korean lines 1971 TEU and US carriers 1828 TEU. In 1989, eight carriers out of a total of 14 operators deployed ships of 2000 TEU or over, holding 71% of transport capacity on this route, another 29% was provided by the 6 carriers operating ships of 2000 TEU and below.

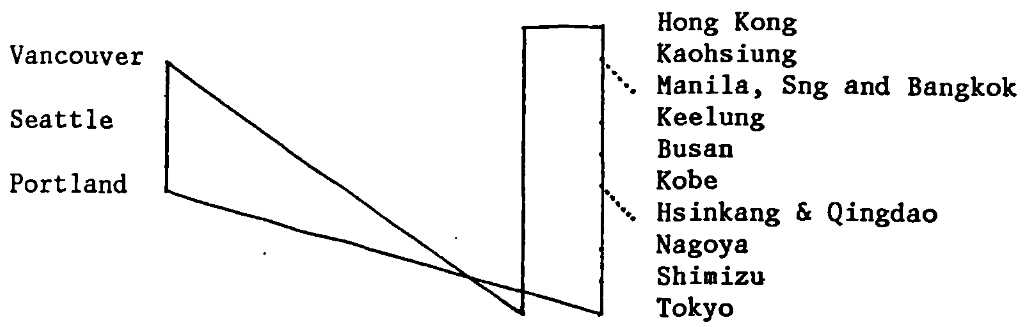
Referring to service frequency, services of a weekly interval have been the standard on this route except for two carriers, NSCP and TMM with fortnightly and 10 daily services, respectively.

Turning to the ports, although most container shipping lines provide a multi-port calling strategy, calling patterns vary a little from line to line. Figures 4-1, 4-2 and 4-3 illustrate itineraries of some leading container lines on the Far East-WCNA route. MOL provides two separate services on the FE/WCNA with one serving FE/PNW and another FE/PSW. Both itineraries are relatively rather extensive in the Far East. The FE/PNW service is a joint service with NYK and calls at eight Far East ports (Hong Kong, Kaohsiung, Keelung, Busan, Kobe, Nagoya, Shimizu and Tokyo), then goes straight through to call at Seattle, Vancouver, and Portland in the PNW. A wider capture of cargo is achieved by a series of feeder networks. The Southeastern Asian ports of Manila, Singapore and Bangkok are fed via Kaohsiung, while Kobe feeds Hsinkang and Qingdao ports. USEC and Mid-West are served via Seattle using mini/microbridge.

The FE/PSW service calls at Singapore, Kaohsiung, Hong Kong, Busan, Kobe, Nagoya, Tokyo, Los Angeles, Oakland. The port of Singapore is a feeder centre for Bombay, Madras, Karachi, Port Kelang and Jakarta ports of the Southeast Asian regions. Kobe acts as a transshipment centre for cargoes to and from Hsinkang and Qingdao. LA serves the USEC/GC and Mid-West via mini/microbridge.

FIGURE 4-1. MOL: FE/WCNA SERVICES

FE/PNW SERVICE



FE/PSW SERVICE

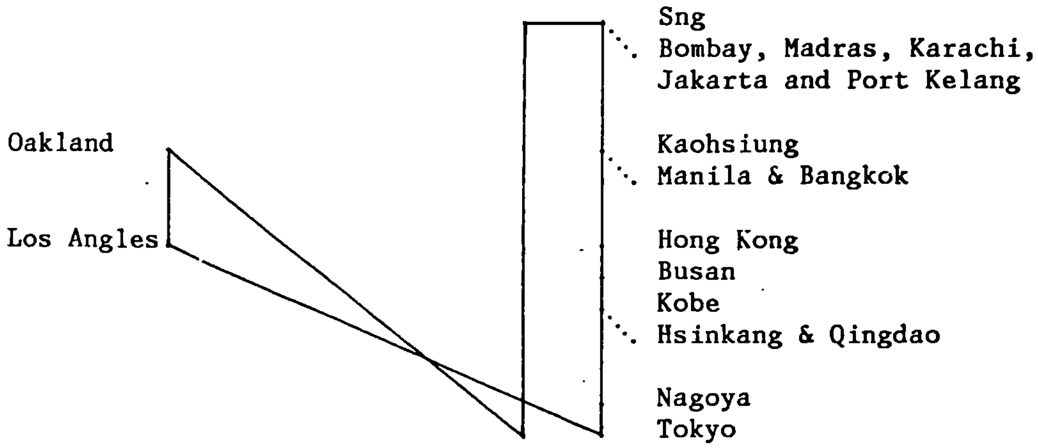
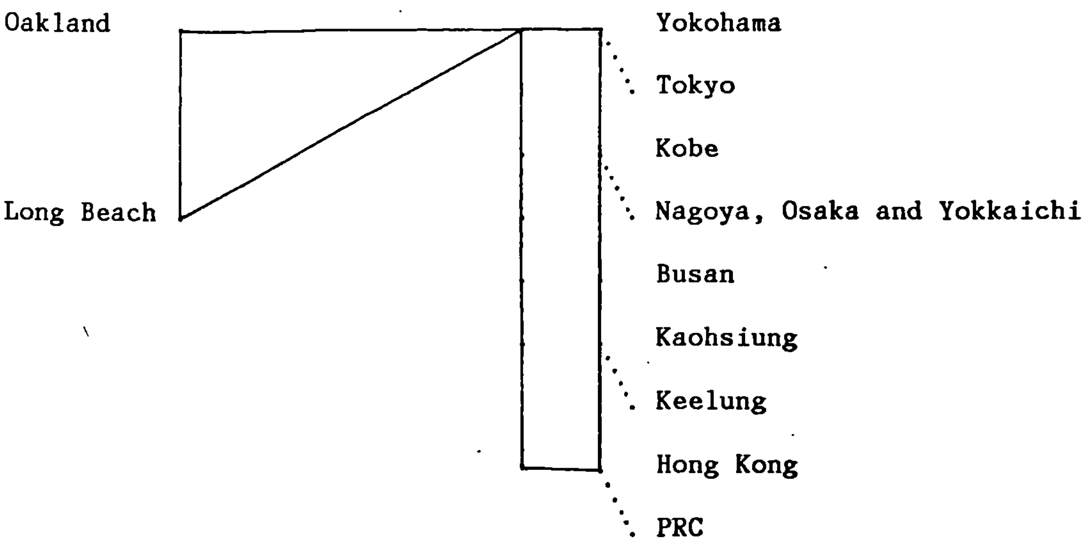


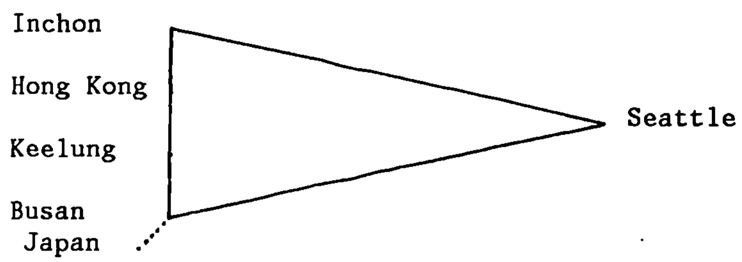
FIGURE 4-2. SEA-LAND: FE/PSW SERVICE



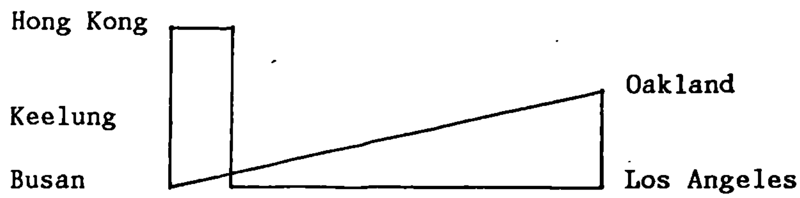
Sea-Land provides a FE/PSW service. The port calls are Long Beach, Oakland,Yokohama, Kobe, Busan, Kaohsiung, and Hong Kong. Cargoes to and from USEC/GC and the Mid-West are served via the port of Long Beach using mini/microbridge. Kobe serves Nagoya, Osaka and Yokkaichi while Kaohsiung provides overland services to and from Keelung and Taichung, and feeds the Philippines. China is provided for by feeder service from Hong Kong. Sea-Land offers similar services to those of MOL on the FE/PSW route.

FIGURE 4-3. HANJIN: FE/WCNA SERVICES

FE/PNW SERVICE



FE/PSW SERVICE



The Korean container line Hanjin provides two services, one for the FE/PNW sector and another for the FE/PSW. It differs from most carriers on the route in that it chooses to serve Inchon port as well as Busan port in Korea. On the FE/PNW, it calls at Inchon,Hong Kong, Keelung, Busan, Seattle. It serves intermodal services via Seattle to and from the USEC/GC and Mid-West. Major Japanese ports are served via feeder connections to and from Busan; whereas on the FE/PSW service, the port calls are Hong Kong, Keelung, Busan, Los Angeles and Oakland. USEC/GC and Mid-West are served via Los Angeles using mini/microbridge.

FE-ECNA

This sub-market which is served by the longest route in the Pacific covers ECNA ports (New York, Savannah, Charleston and Baltimore) and GC (Houston and New Orleans) as well as WCNA ports (Seattle, Vancouver, Tacoma, LA, SF, Oakland and Portland). Carriers on the route provide a wide range of end-to-end services as well as the round-the -world (RTW) service.

As can be seen in APPENDIX 4-1, OOCL generated the greatest capacity amounting to 390,642 TEU in 1989, holding 20% share of the total capacity on the sub-market. Evergreen line, just behind OOCL, contributed 17.9% of capacity in this market. The capacity was provided with a total of 25 fully cellular containerships providing a weekly service on its east bound and six daily on the westbound RTW service. Yangming achieved about 14% as the third largest carrier on the route. These carriers collectively dominated the market with 52% of total capacity, Taiwanese carriers held most of the rest with 32% of capacity.

In terms of average ship size, about 2500 TEU was provided on the route, compared with about 2000 TEU on the FE/WCNA. The top four carriers, were in order, OOCL, Evergreen, NOL and K-Kine in 1989, respectively. Evergreen line deployed ships of 3000 TEUs and over with a speed of 20.7 knots on the westbound RTW service, while ships of 2728 TEUs with a speed of 20.5 knots were deployed on the eastbound RTW service. OOCL generated an average ship size of 3115 TEU with a speed of 20.5 knots. NOL was the third with 2966 TEU. Most carriers in the market deployed ships of 2000 TEUs and over.

Service frequency varies rather more from line to line than on the West coast route. Hanjin, Yangming and Evergreen (EB RTW service) offer a weekly service, while Senator line provides a fortnightly service on both its east and westbound RTW services, BBS line offering every 15 days and Zim line of Israel an 8/9 days service.

Referring to the calling patterns, Evergreen is well known for its RTW services. Figure 4-4 illustrates the itineraries of Evergreen's east and westbound RTW services. On the eastbound service, it calls at *Colombo, Port Kelang, Singapore, Hong Kong, Kaohsiung, Keelung, Busan, Hakata, Osaka, Nagoya, Shimizu and Tokyo* in the Far East and goes straight through to the North American ports (*Los Angeles, Charleston, Baltimore and New York*), and then calls at five European ports (*Le Havre, Antwerp, Rotterdam, Felixstowe and Hamburg*). On the westbound service, there are 20 port calls, viz, *Tokyo, Nagoya, Osaka, Busan, Keelung, Kaohsiung, Hong Kong, Singapore and Colombo* in the Far East; *Hamburg, Felixstowe, Le Havre, Rotterdam and Antwerp* in the Europe; *New York, Norfolk, Charleston,* *Kingston, Panama and Los Angeles* in the North and Central America. The basic multi-port strategy is supported by feeder services. Keelung feeds the Southeastern Asia regions, USGC is served via Los Angeles using minibridge service,Charleston for Kingston and Colombo provides feeder service to/from India and Pakistan.

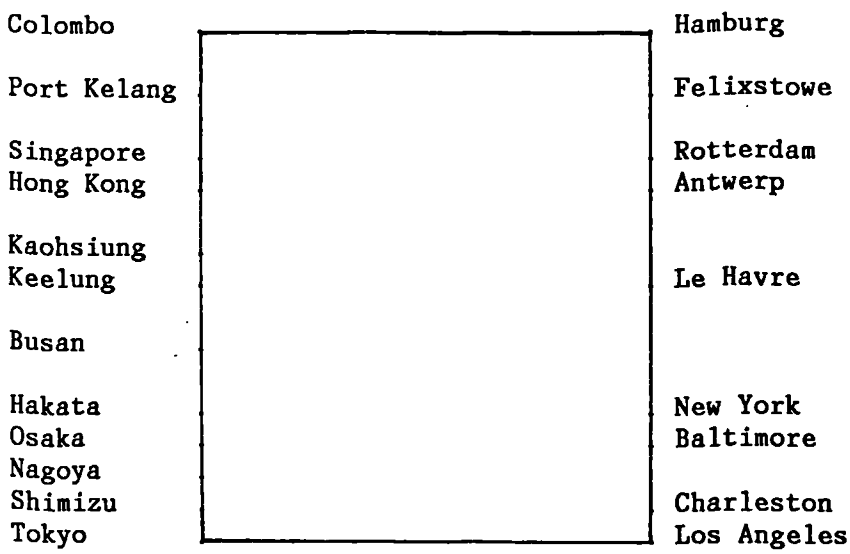
Yangming provides a single service on this route in transpacific services. It calls at the FE ports of Singapore, Hong Kong, Kaohsiung, Keelung, Busan, Kobe, Yokohama. It then goes on to make calls at Los Angeles, Savannah, New York. On the way back to the FE, it calls at Wilmington, Oakland, Los Angeles. Kaohsiung provides feeder service for Manila, and Savannah acts as a transshipment centre for Charleston, Jacksonville, Tampa, Miami and New Orleans. The west coast ports (San Francisco, Oakland and San Diego) are served by feeder links via Los Angeles and Norfolk serves for Baltimore.

Zim line of Israel provides an extensive service network on this service. It calls at the Mediterranean ports of Haifa, Piraeus and Barcelona. Before going through to the FE, it stops at the seven North America ports (Halifax, New York, Norfolk, Savannah, Kingston, Long Beach and San Francisco), and then goes on to make calls at Yokohama, Osaka, Kaohsiung, Hong Kong, Keelung and Busan. On its way back to the Med, it calls at once again, Yokohama, Osaka, Long Beach and the ECNA ports (Savannah, New York and Halifax). An extensive feeder network links Montreal, Toronto, Boston, Philadelphia, Baltimore, Miami, Houston, Bangkok, Manila and Singapore.

NSCSA of Saudi Arabia operates an integrated through ro-ro/container service linking USEC(GC)/Med./Mid-East and Far East. Six RC ships are deployed in the service, each with an average capacity of about 2100 TEUs and with a speed of 18 knots. On the service NSCSA calls at the seven ECNA ports,viz. Houston, New Orleans, Savannah, Wilmington, Baltimore, New York, Halifax. Before going through to the Far East, it choose to call at Valencia, Yanbu, Jeddah, Dammam, Jubail in the Med/Mid-East. It then calls at Singapore(which provides feeder service to and from Bangkok), Port Kelang, Keelung, Busan, Kobe, Hakata, Nagoya, Yokohama in the Far East. It is multi-port services with feeder network. Cargoes to and from WCNA are served via Houston using minibridge.

FIGURE 4-4. EVERGREEN: RTW SERVICES

EASTBOUND RTW SERVICE



WESTBOUND RTW SERVICE

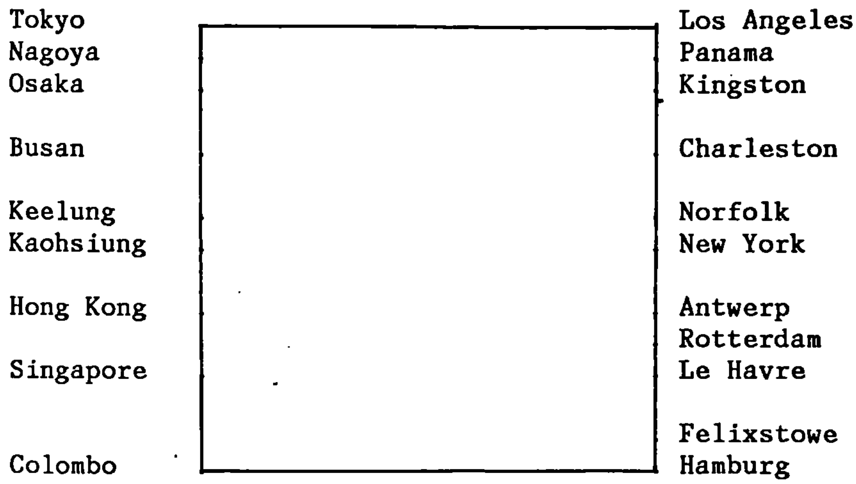


FIGURE 4-5. YANGMING: FE/WC & ECNA SERVICE

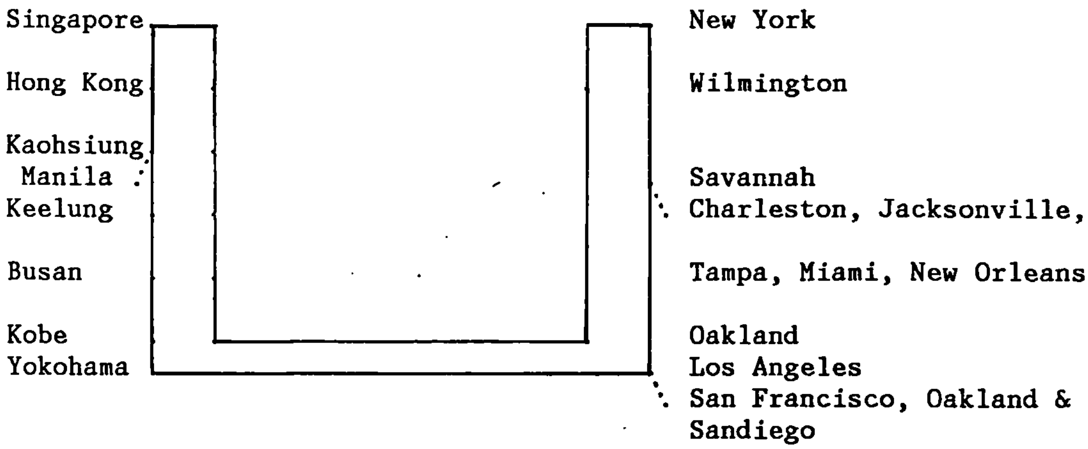


FIGURE 4-6. ZIM: FE/WC & ECNA SERVICE

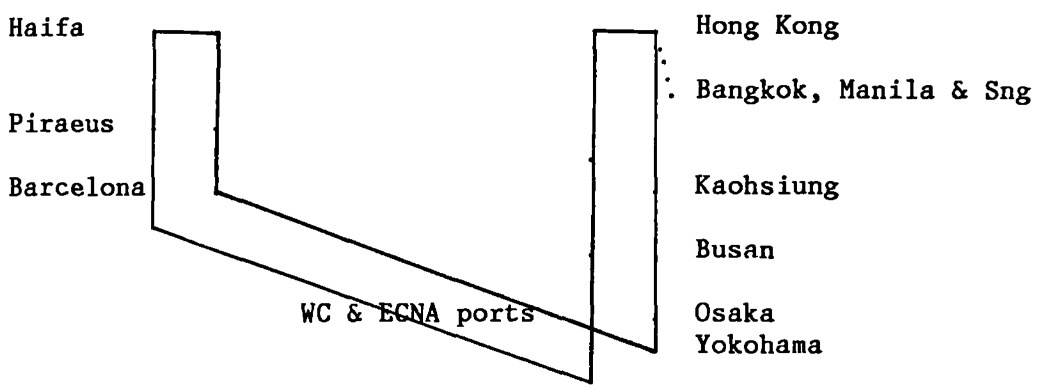
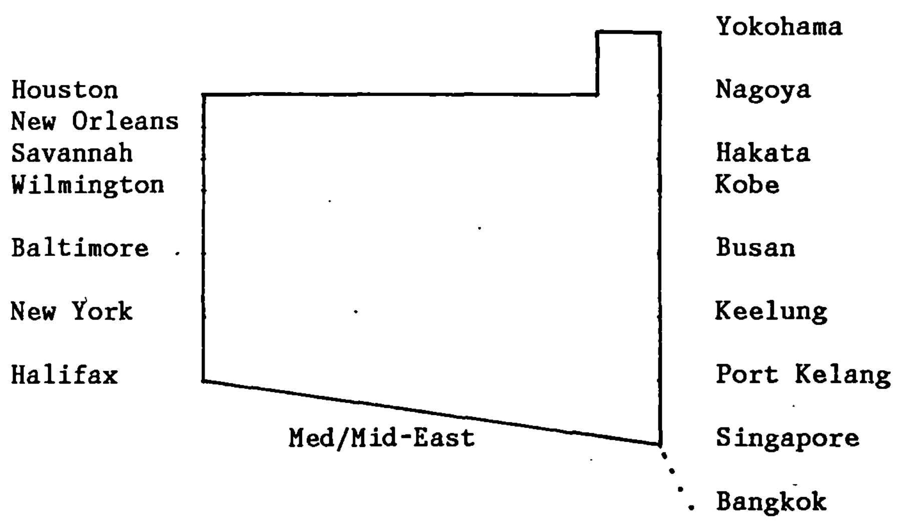


FIGURE 4-7. NSCSA:FE/ECNA SERVICE



4.3.2 EUROPE-FAR EAST ROUTE

Container services from Korea to Europe were introduced in 1975 by the ACE consortium, a member of the FEFC. In 1989, transport capacity on the route amounted to about 2.5 million TEU provided by 19 carriers. Carriers' shares are shown in Appendix 4-2 which covers only vessels with a call at Busan port on this service during 1989. Of this conference lines held 60% and non-conference carriers 40%.

In 1989 the Trio group (Ben Line, Hapag-Lloyd, MOL,NYK and P&OCL) provided the greatest capacity of 644,416 TEU. This was supplied by a total of 18 vessels with a weekly service. The characteristic of the group is that although a fully integrated service is maintained by a three-nation five-line space charter partnership, each line has the responsibility of its own marketing and cargo catchment (CIY 1990). Evergreen line, just behind Trio, generated 14% of capacity as the second largest carrier in this market. The capacity was provided by a total of 25 fully cellular containerships with its east and westbound RTW services. The third was the Scan-Dutch group. The group which had included Nedlloyd, EAC, MISC and CGM accounted for 11.8% share of the total capacity on the route in 1989. Maersk line operating as an independent carrier within the conference deployed 10% share of capacity amounting to 252,138 TEU.

Among non-conference carriers, Norasia generated 6% of capacity with 148,112 TEU followed by Hanjin, CMA and Choyang supplying 130,199 TEU, 124,960 TEU and 112,451 TEU in 1989, respectively. These carriers including Evergeeen line held 68% share of total non-conference capacity.

In terms of ship size, most operators deployed ships of 2000 TEU or over, even 3000 TEU or over, providing an average ship size of 2450 TEU on this route. Sixteen carriers deploying ships of 2000 TEU or over among total 19 operators held 83.8% of total transport capacity, another 16.2% was provided by the four carriers (DSR, CMA, Norasia and Senator line) operating medium sized ships. The top five carriers, were in order, Evergreen, Trio group, Scan Dutch group, Yangming and Maersk line with 3064 TEU, 2927 TEU, 2843 TEU, 2451 TEU and 2424 TEU, respectively. In addition, service interval most carriers provide in this market is a weekly frequency which has become typical in the world's major container trades. Only three carriers (DSR,CMA and Senator line) were the exception. These carriers provide fortnightly, every 10 days and fortnightly service frequency on the route, respectively.

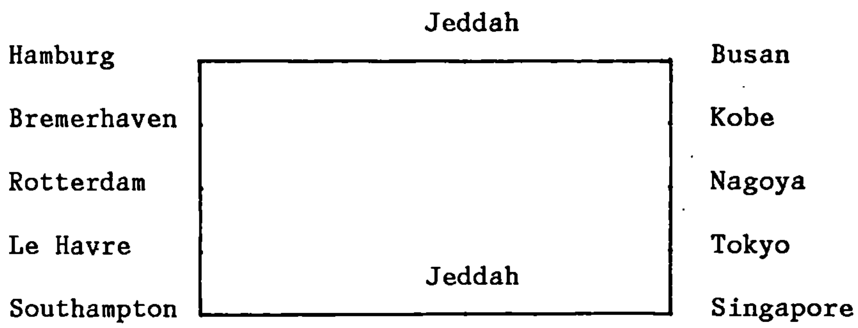
With regard to service structures, most carriers adopt multi-port calling patterns. Figures 4-8, 4-9 and 4-10 show the itineraries of some leading container lines on the service. Jointly operated by BLC, Hapag-Lloyd, MOL, NYK and P&OCL lines, Trio group operates a geographically specialised strategy. Two separate services are provided with one concentrating on Europe-Japan and another on the Europe/NE Asia. The former service starts from Hamburg, Bremerhaven, Rotterdam, Le Havre, Southampton and makes call at the FE ports, viz, Busan, Kobe, Nagoya, Tokyo and Singapore, calling at the Middle East port, Jeddah, on its way. The latter provides the same itinerary at the European end, viz, Southampton, Le Havre, Rotterdam, Hamburg and Bremerhaven, and then goes through to the FE ports (Singapore, Hong Kong, Shimizu, Tokyo, Kobe, Busan, Kaohsiung). Eighteen fully cellular containerships are altogether engaged in the service.

Hanjin providing a joint service with Choyang calls at five European ports, viz, Le Havre, Rotterdam, Hamburg, Bremerhaven and Felixstowe and then goes straight through to the six FE ports, Singapore, Hong Kong, Kaohsiung, Busan, Kobe and Yokohama with no stop at the Middle East or the Mediterranean. Nine fully cellular containerships are provided in the market and wider spread of cargo is provided by a series of feeder networks. Singapore acts as a transshipment centre for cargoes to and from Port Kelang.

The Scan Dutch consortium which are composed of Nedlloyd, EAC, CGM and MISC visits four European continental ports (Gothenburg, Hamburg, Bremerhaven and Rotterdam). UK, Portugal and Morocco ports are served via Rotterdam. At the FE end, it calls at the eight FE ports, viz, Port Kelang, Singapore, Hong Kong, Busan, Kobe, Nagoya, Shimizu and Tokyo. On its way back to Europe, it calls at Hong Kong and Singapore once again, plus the four European continental ports. The service is relatively rather extensive in the Far East. Eight fully cellular containerships are provided in this market.

FIGURE 4-8. TRIO'S FE/EUROPE SERVICES

EUROPE/JAPAN AND FE SERVICE



EUROPE/NE ASIA SERVICE

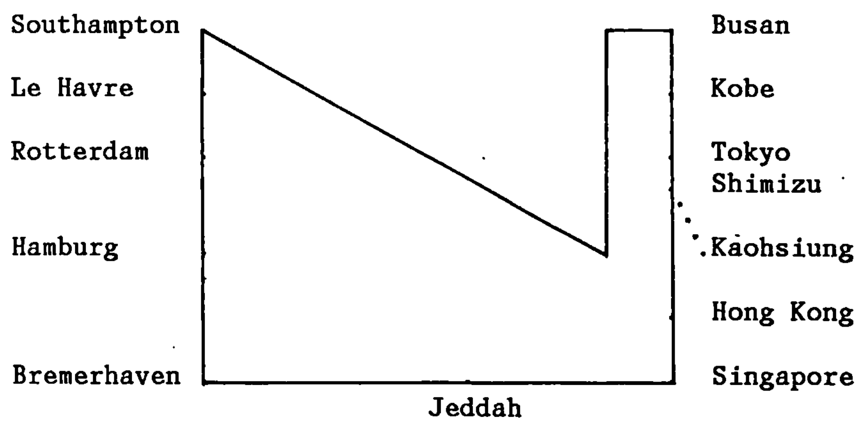


FIGURE 4-9. HANJIN & CHOYANG'S FE/EUROPE SERVICE

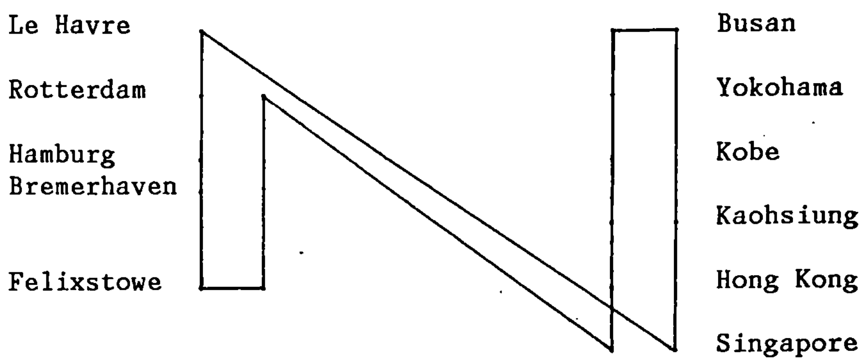
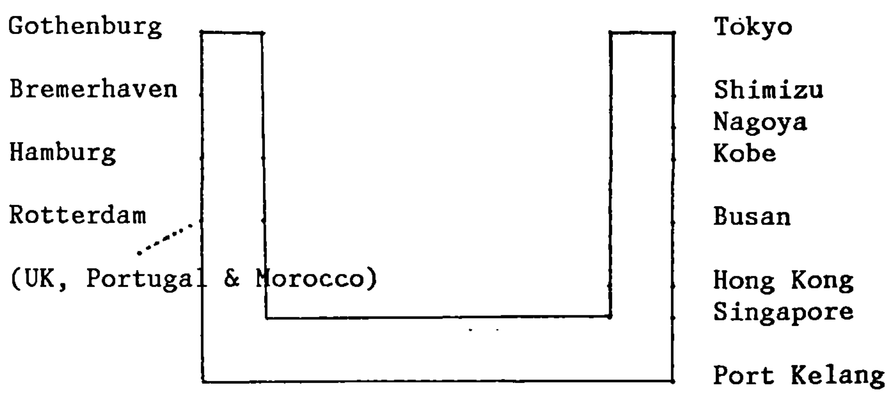


FIGURE 4-10. SCAN DUTCH'S FE/EUROPE SERVICE



4.3.3 FAR EAST-AUSTRALIA/NEW ZEALAND ROUTE

Korean containerised exports to Australia and New Zealand increased at annual rate of 20% and imports increased at 10.7% during the period 1979-1988. As Table 3-13 shows, container traffic was slow until 1983, but was significantly accelerated by the increasing personal and household income in Korea and changing tastes in food to create additional market opportunities for Korean imports of containerised Australian and New Zealand meat products, and fresh fruit. This trend led to an increase in the number of container vessels on this trade. Carriers' shares are shown in APPENDIX 4-3 which covers only vessels with a call at Busan port in this market during 1989.

Transport capacity on the route amounted to 695,600 TEU deployed by 14 carriers in 1989. Of this, conference lines held 55.8% and non-conference carriers 44.2%. Among conference carriers, MOL deployed the greatest capacity amounting to 114,300 TEU. It provides a joint service with NLS, NYK and P & OCL. AJCL, just behind MOL, generated 14.8% share of the total as the second largest carrier. K-Line provided the capacity of 66,795 TEU as the third largest carrier within conference lines. These collectively accounted for 73.2% share of total conference lines. The rest of carriers with under 5% share each, were in order of importance, Choyang, NLS and NYK. The share of non-conference to conference carriers was over 40%. The capacity of non-conference amounted to 307,144 TEU provided by eight carriers with 19 vessels. JNJC, EAC-HIL, P&O, BLP and Tasman were the top five carriers within non-conference carriers. These collectively accounted for 82% share of total non-conference carriers. JNJC took the first position and EAC-HIL, which acquired HKIL of Hong Kong in 1989, was the second largest carrier.

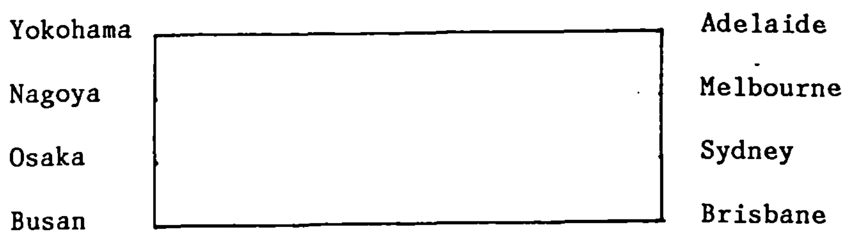
Most carriers on the route deployed ships of between 1000 TEU and 2000 TEU, providing an average ship size of 1130 TEU. 10 carriers deploying ships of 1000 TEU or over among 14 carriers held 81.5% of the total capacity, another 18% was held by the four carriers operating small ships. It indicates that the medium sized carriers have occupied most of their size. The top four lines were MOL, AJCL, JNJC and P&O containers .

In terms of calling patterns, most of the major container lines are involved in end-to-end service, and calling ports are about the same between the lines. Figures 4-11 and 4-12 illustrate itineraries of leading container lines (MOL and JNJC) on this service. MOL provides two separate services in this market with one serving at FE/Australian and another at FE/NZ. The former provides a joint service with NLS, NYK and P&O Containers. It calls at the four FE ports, i.e. Yokohama, Nagoya, Osaka, Busan, and then goes straight through to the Australian ports (Brisbane, Sydney, Melbourne and Adelaide) with no stop on its way. Two fully cellular containerships are deployed with an average ship size of 1800 TEU providing a weekly service. The latter calls at Tokyo, Nagoya, Kobe, Busan, Auckland, Wellington, Lyttelton and Port Chalmers. Five fully cellular containerships are provided with fortnightly service frequency.

JNJC, a consortium of CSCS, MOL, Nippon Liner and NZ Line offers a similar service to that of MOL's FE/NZ service. It starts from Tokyo, Nagoya, Kobe, Moji, Busan and makes call at the NZ ports, i.e. Auckland, Wellington, Lyttelton, Port Chalmers. Three fully cellular containerships are engaged in the service providing fortnightly service frequency with an average ship size of 1400 TEU.

FIGURE 4-11. MOL'S FE/AUST & NZ SERVICES

FE/AUSTRALIA SERVICE



FE/NZ SERVICE

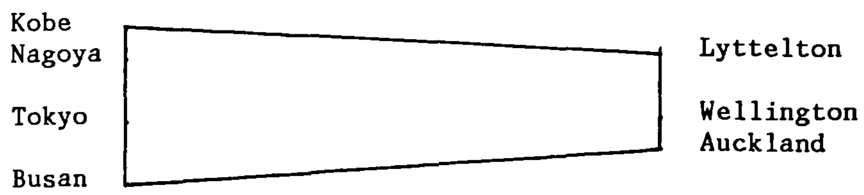
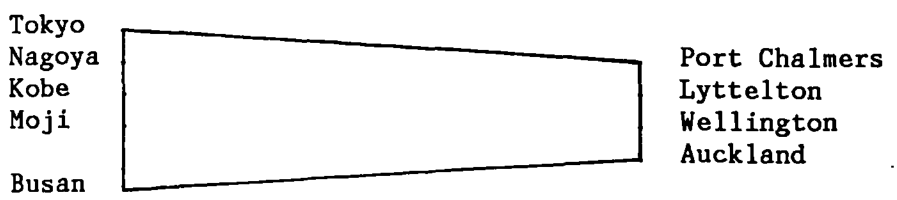


FIGURE 4-12. JNJC'S FE/NZ SERVICE



4.3.4 JAPAN-KOREA ROUTE

The container trade between Japan and Korea is highly regulated. Most of the trade is effectively reserved for Korean carriers as a balancing factor in trade with Japan. Korean carriers are full members of the controlling Korea/Japan/Korea Container Freight Conference(KJKCFC) and take part in a pooling agreement. This grouping covers 80% or over of cargo moving on the route. Some Japanese carriers provide feeder cargo and some ro-ro ferry services carry a few containers (CIY 1990).

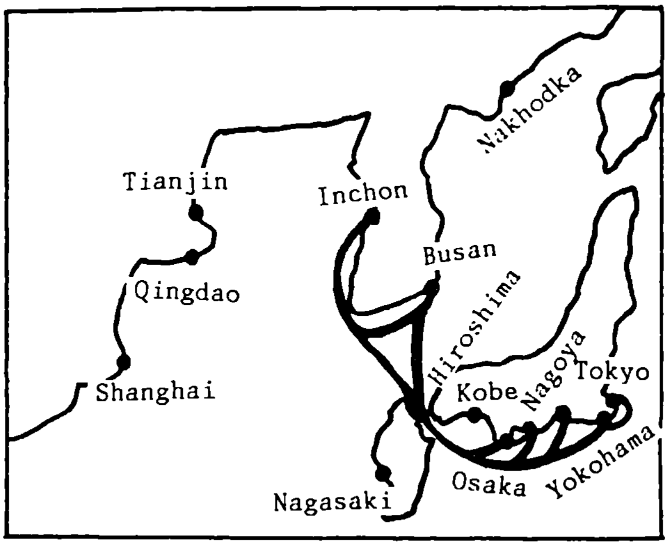
A detailed analysis of the carriers on the service is pictured in APPENDIX 4-4. Eleven carriers generated transport capacity amounting to about 670,000 TEU in 1989. Korean carriers provided 71.4% of the total capacity compared with 28.6% for foreign operators. Only two third country operators (APL and Maersk) are allowed to participate in the trade, although these are both powerful lines. APL provided the greatest capacity amounting to 146,020 TEU and Hanjin was the second. KMTC, just behind Hanjin, contributed 11% of total transport capacity in this market. This line was formerly a player in the transpacific trade but under government direction, it pulled out. The top five carriers including Namsung and Pan Ocean occupied nearly 63% share of the total. Pan Ocean became involved in the trade in 1984 when it merged with Global Shipping which had previously operated on the trade. The carrier held an 8.6% share.

On this short sea route, the ship size is substantially smaller compared with those on the deep-sea route. Many carriers deployed ships of just under 400 TEU. However, APL, Maersk and Hanjin deployed bigger ships with

APL vessels reaching 1400 TEUs. Hanjin and Maersk had, in order of size, 760 TEU and 436 TEU, respectively. The three carriers using ships of 400 TEU or over held 39% of total capacity, another 61% was held by the 8 carriers operating small sized ships. Although small ships are deployed, the fact that there are some large vessels suggests, a fluid competitive situation, in which medium sized vessels could become more important. The service frequency on the route varies significantly from line to line (see appendix 4-4).

On the short sea sector, the number of port calls is normally much less compared with those on the deep-sea route. The route can be divided into various sub-routes between Korean ports (Inchon and Busan) and the Japanese ports (Yokohama, Tokyo, Kobe, Osaka and Nagoya). The calling ports of the major carriers are: *Busan-Yokohama* and *Tokyo* (Choyang and Chunkyung lines); *Inchon-Kobe* (Choyang); *Busan-Osaka* and *Kobe* (Choyang, KMTC, Kuk Jae, Namsung, Pan Ocean and Pan Continental); *Busan-Kobe* (Maersk); *Busan-Yokohama* (APL and Namsung); *Busan-Nagoya* (Chunkyung and Heung-A); *Inchon* and *Busan-Osaka* and *Kobe* (Chunkyung); *Busan-Kobe* and *Yokohama* (Hanjin).

FIGURE 4-13. KOREA-JAPAN ROUTE



4.3.5 THE INTRA-ASIAN ROUTE

On the medium sea sector Taiwan, Hong Kong, Singapore, Malaysia, Indonesia, Philippines and Thailand are the major trading partners. Container traffic to and from the region experienced rapid growth of 32.8% during the 1979-1988 period (Table 3-13). Containerised exports to the region increased at an average annual rate of 32.3% to 200.6 thousand TEU in 1988 due to the high growth rates of the major South East Asian economies. Korean containerised imports from the region grew at a healthy rate of 33.9% to 111.8 thousand TEU in 1988 during the same period. This is caused by Korea's needs for products from the market: the shift from raw materials to finished goods in such commodities as logs, lumber and plywood.

In 1989, there were about 13 carriers providing 818,834 TEU capacity on this route as can be seen in APPENDIX 4-5. The top carrier was NYK deploying 99,981 TEU. The capacity was provided by a total of two FC ships and one SC ship with a weekly service, holding 12.2% share of the total capacity. Evergreen contributed 12.1% of capacity as the second largest carrier. Uniglory, Heung-A and Dongnama followed Evergreen, respectively. The top five carriers collectively accounted for 57.2% of the total capacity. Apart from these carriers, the remaining other lines held 7% below share of the market. These, were in importance, Cheng Lie, Pacific International, Concord, Wan Hai, Kien Hung, Seapak, Fairweather and Atlas. Taiwan carriers occupied 43.7% of capacity in this market, Japanese lines 20.8% and Korean carriers 20.7%. The three countries' carriers together dominated market share with 85.2% of total capacity on the medium sea route.

In terms of average ship size, almost all carriers deployed ships of 1,000 TEU or below excluding Pacific International of Singapore. Pacific International was the top, deploying ships of 1152 TEU of an average ship size. Uniglory, NYK and Evergreen had, in order of size, 959 TEU, 958 TEU and 946 TEU in 1989, respectively. These four carriers using ships of 900 TEU or over held 45% of the capacity in this market, another 55% was held by nine carriers operating the small ships.It means that most carriers on the medium sea service deploy small sized vessels.

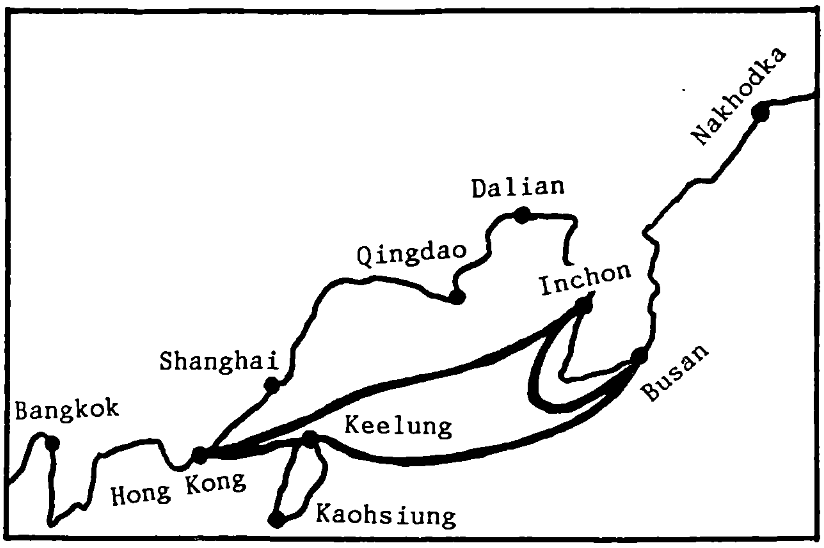
Most carriers on this service provide similar calling patterns from line to line. Figures 4-14 and 4-15 exemplify itineraries of two leading container lines on the route. Korean carrier Dongnama provides two separate services with one serving at Korea/Hong Kong & Taiwan, and another at

Korea/Malaysia & Indonesia. The former starts from Inchon, calling Busan, Keelung, Hong Kong, then back to Inchon. Three fully cellular containerships serve this line with a total capacity of 774 TEUs (250 X 2 + 274). The latter starts from Inchon and Busan alternatively, calling at Keelung, Hong Kong, Jakarta, Penang, Port Kelang and Singapore, then back to Inchon or Busan. The port of Singapore acts as a transshipment centre for cargoes to and from Bangkok. The service is provided by four fully cellular containerships with a total capacity of 2218 TEUs (480 X 2 + 586 + 672). The line is different from most carriers on the route in that it chooses to call at Inchon port as well as Busan In Korea.

Evergreen provides an extensive service network in this market. It starts from Osaka, calling at Kobe, Moji, Busan before going to Keelung, and then goes straight to Hong Kong and Bangkok. On its way back to Osaka, it calls at once again, Kaohsiung and Keelung. Three FC ships and two CC ships with a total capacity of 4728 TEUs (956 X 2 + 926 X 2 + 964) which were chartered from Uniglory are involved in the service.

FIGURE 4-14. DONGNAMA'S INTRA ASIAN SERVICES

KOREA/HONG KONG & TAIWAN SERVICE



KOREA/MALAYSIA & INDONESIA SERVICE

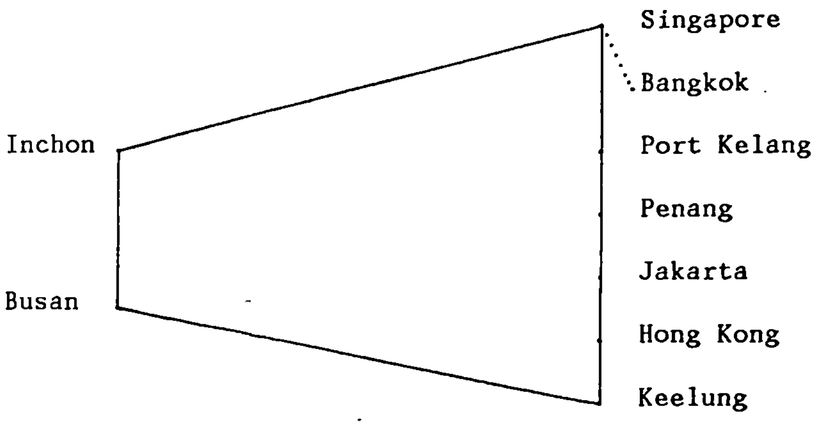
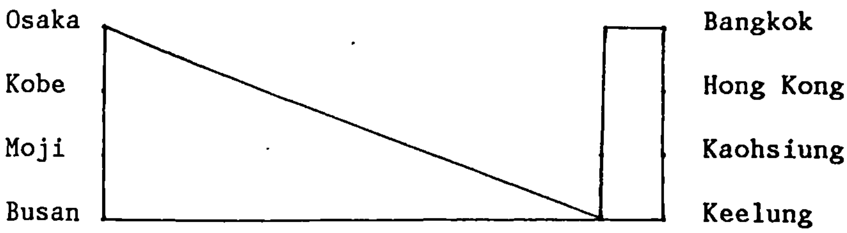


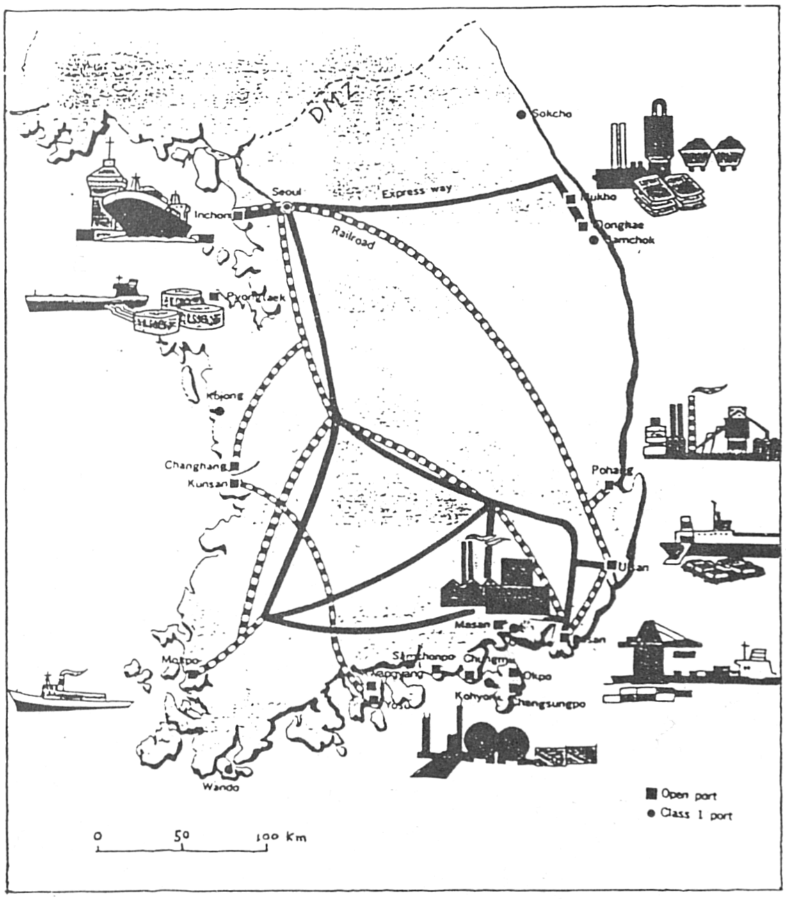
FIGURE 4-15. EVERGREEN'S INTRA ASIAN SERVICE



4.4 THE SIGNIFICANCE OF SEOUL TO CONTAINER SERVICES

So far we have been analysed liner shipping structures serving Korea's foreign trade. Almost all carriers on the routes tend to call at Busan port rather than Inchon in Korea. At present, in Korea, there are 23 major commercial ports such as Busan, Inchon, Kunsan, Pohang and Ulsan, etc., but only the first two have the port facilities to accommodate modern container ships(Figure 4-16).

FIGURE 4-16. KOREA'S MAJOR SEAPORTS



Source:KMPA(1987).

Busan port is the largest in Korea and it serves as the main load centre with containerised cargoes originating from and destined for locations in all parts of the nation. Container handling operations in the port are carried out at Busan's pier 5 and 6 by the Busan Container Terminal Operation Company (BCTOC), a company established by the Korea Maritime and Port Administration (KMPA). The terminal can accommodate four 50,000 DWT container vessels simultaneously and has a theoretical optimum capacity of 1.26 million TEUs (table 4-2). In 1987, it actually handled over 1.8 million TEUs, holding about 95% of Korea's total container trade as can be seen in table 4-2. During the period of 1977 to 1987, container traffic in Busan port grew by four times. The total number of containers handled has rapidly increased in recent years from 454 thousand TEUs in 1977 to 1,825,000 TEUs in 1987. Busan port is presently somewhat congested, having been unable to keep up with cargo growth.

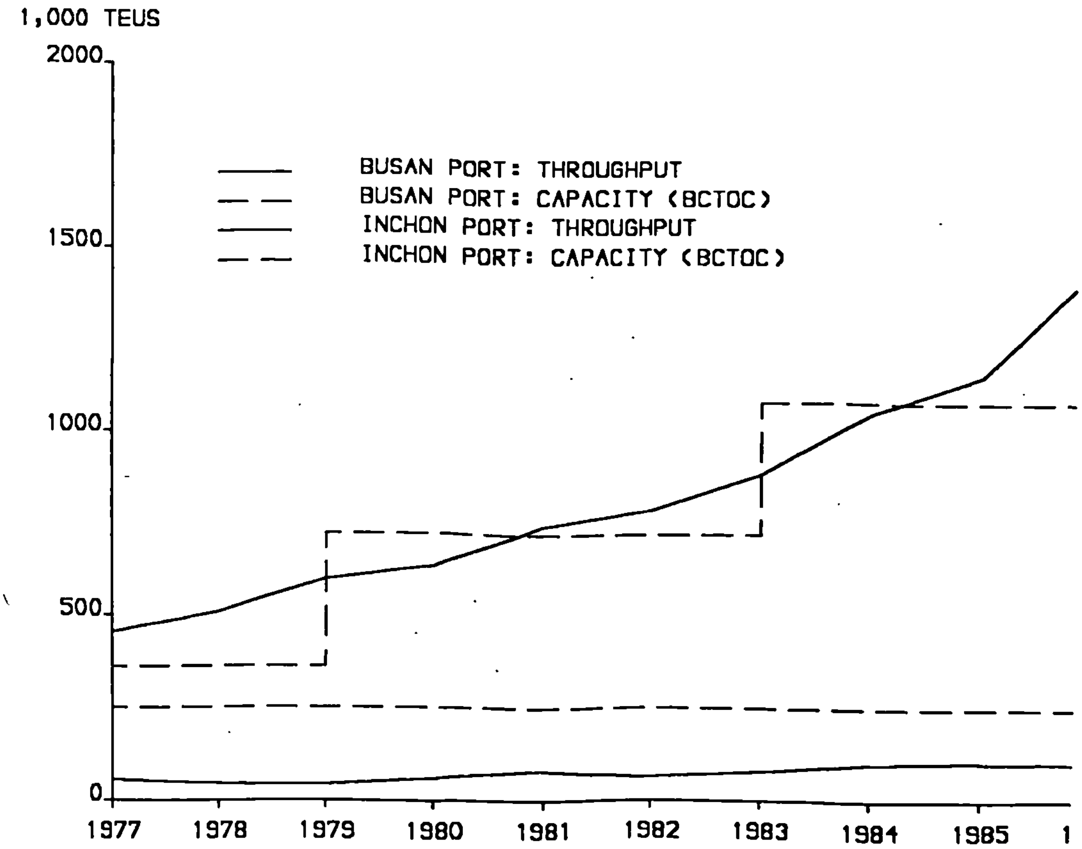
Table 4-2. The Throughput and Capacity of Busan and Inchon ports 1977-1987(1,000 TEUs)

Year	Busan		Inchon	
	Throughput	Capacity	Throughput	Capacity
1977	454.3(88.7)	360	57.6(11.3)	250
1978	506.5(91.4)	360	47.6(8.6)	250
1979	596.6(93.3)	720	42.7(6.7)	250
1980	632.8(91.4)	720	59.5(8.6)	250
1981	744.0(90.2)	720	80.7(9.8)	250
1982	786.7(92.4)	720	64.3(7.6)	250
1983	883.6(91.8)	1080	78.6(8.2)	250
1984	1054.3(91.3)	1080	100.4(8.7)	250
1985	1155.3(91.8)	1080	103.8(8.2)	250
1986	1448.2(93.5)	1080	101.2(6.5)	250
1987	1825.1(94.4)	1260	108.3(5.6)	250

Source: KMI(1988).

Inchon port is the second largest. Container handling in the port is operated by two terminal companies, Hanjin Transportation and the Korean Express Company. The terminal can accommodate ocean-going vessels up to 50,000 DWT and has an annual capacity of 250,000 TEUs. Container traffics handled in the port in 1987 recorded 108,000 TEUs, accounting for some 6% of the national total each year (Table 4-2 and Figure 4-17).

Figure 4-17. The Comparison of the Throughput and Capacity between Busan and Inchon ports



SOURCE: DERIVED FROM TABLE 4-2

4.4.1 REGIONAL SHARES

For analysis of the regional shares of container traffics which are distributed through these two ports, i.e. Busan and Inchon, it is useful to divide the country into regions based on the level of industrial activities (Figure 4-18). For convenience, seven regions may be determined (Table 4-3).

Table 4-3. Inland Container Distribution by Regions in 1987

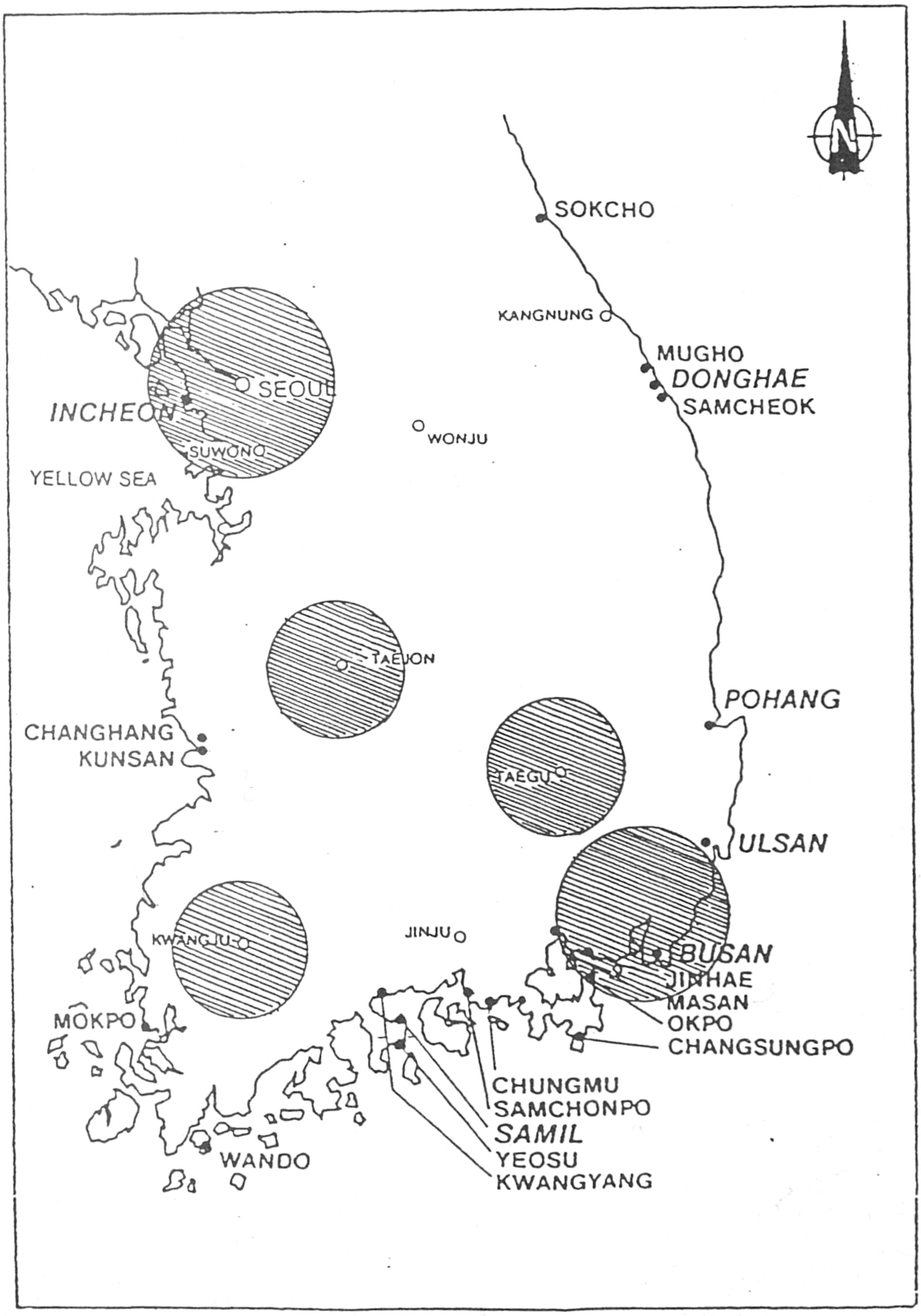
Unit:%

O/D	Busan port	Inchon port	Total container ratio
Container Exports			
Seoul	40.9(413.5)	83.5(39.6)	42.4(453.1)
Taejon	11.2	13.1	11.4
Jeonjoo	4.1	2.0	4.3
Kwangjoo	4.5	0.2	4.3
Donghae	0.1	0	0.1
Taegoo	9.1	1.0	8.7
Busan	30.1	0.2	28.8
Total	100	100	100
Container Imports			
Seoul	31.5(256.4)	81.9(49.9)	35.1(306.3)
Taejon	8.3	14.8	8.8
Jeonjoo	14.3	2.7	13.5
Kwangjoo	4.1	0	3.8
Donghae	0.1	0	0.1
Taegoo	16.6	0.3	15.4
Busan	25.1	0.3	23.3
Total	100	100	100

Note: ( ) means 1000 TEUs.
Source: KMI(1988).

In 1987, about 39% of all container traffics at Busan port went to or came from the Kyungin region whose centre, Seoul is 430 km away from Busan. In the case of Inchon port, 83% of the total went to or came from the region whose boundary is within 50 km. Seoul predominantly took the dominant

FIGURE 4-18. INDUSTRIAL LOCATION OF KOREA

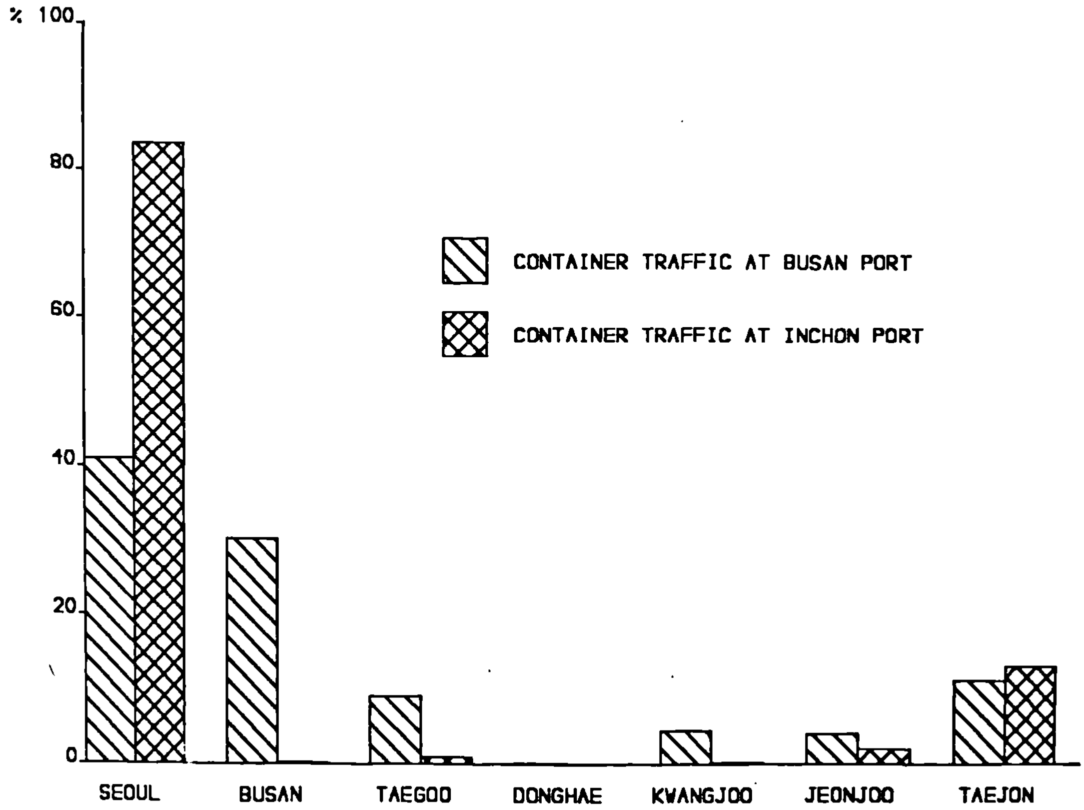


position, recording about 40% (754900 TEUs) of the total container traffics in 1987. By the year 2000, on the basis of the ratio of the year 1987, around 1.9 million TEUs of total container traffic forecast in the intermediate scenario (Table 3-18) will originate in or be destined for Seoul, which is expected to increase about three times compared with the year 1987. In total Seoul must now have well over one-third of the traffic in the Korea's seaborne container trades, possibly almost half.

The population of Seoul excluding the surrounding cities had reached 11.2 million (25% of the total) out of 43.2 million of the total population in Korea at the end of 1989 (see table 3-1) and is expected to increase to about 20.5 million by 2000, holding over 30% of the total (Daily newspapaer 1990). The city of Seoul will eventually become a megalopolis with extensive centres of conurbation, encompassing adjacent cities such as Inchon, Suwon, Sungnam and Buchon. The city is also remarkably prosperous with many import and export firms located in and around. The city is, therefore, inevitably forced to become the only major centre of the country despite many problems, i.e. its narrow site, congestion and air pollution, etc.

The next largest proportion of container traffics, approximately 25% moved to and from the Busan region encompassing the main industrial cities, i.e. Ulsan, Pohang, and Changwon which contain the nation's heavy industries such as steel, industrial machinery and equipment, shipbuilding and car manufacturing. Another 10.2% was for Taejon in the middle part of the country. Among the smaller centres 12% was for the Taegoo (region known well by the traditional textile industry), 8% for Jeonjoo, 4.6% for Kwangjoo including the Yochen petrochemical complex and the Kwangyang steel producing complex, and the rest is for Donghae, the nation's cement manufacturing region. Figure 4-19 illustrates more clearly the container traffic flow at Busan and Inchon ports to and from each region in 1987.

Figure 4-19. Container Traffic Movements at Busan and Inchon ports to and from each region in 1987



SOURCE: DERIVED FROM TABLE 4-3

4.5 CONCLUSION

In this chapter, five major container shipping routes serving Korean trades and regional shares of container traffics are comprehensively analysed. The first section gives a detailed pattern of market share by carriers. Korea is included on the mainstream routes. Therefore, it gets calls from the world's largest carriers using the biggest container ships. In 1989, Evergreen provided 8.6% of capacity as the top carrier of total carriers serving Korean trades. Hanjin held 8.5% as the second largest carrier. NYK, MOL and Yangming followed Hanjin with 6.8%, 6.1% and 5.8% shares, respectively. These dominant positions in Korea's trades were achieved by the deployment of large ships operating at high service frequencies. All carriers deployed vessels of over 2000 TEU average ship size, while most carriers with below 3% shares employed medium and small sized vessels of below 2000 TEU.

All carriers provide FDWS (Fixed Day of Week Service) which has become typical in the world's major container trades. It indicates that the deployment of larger ships and greater service frequency play a significant role in determining market shares. In terms of the nation's shares, the Japanese carriers held 21.3%, Korean 19.2%, Taiwan 17.3% and US 8.8%, and Far East carriers excluding Japanese had 45.1% in 1989.

Referring to the itinerary patterns, four Japanese ports (*Yokohama, Kobe, Nagoya and Tokyo*), Hong Kong, Kaohsiung, Singapore, five European ports (*Rotterdam, Antwerp, Le Havre, Felixstowe and Hamburg*) and five North American ports (*Seattle, Los Angeles, Savannah, Houston and New York*) fit in the standard itinerary on the mainstream trades. Busan port fits in the standard patterns while Inchon port lies some way off the mainline route so that a call at Inchon requires a substantial additional distance (767 nautical miles) on the major routes serving Korea's trades. Given the present sailing time of containerships on the Pacific and Europe/FE routes, two or three days have to be added for this diversion. Rather than making direct calls to Inchon, most carriers serving Korea's trades tend to call at Busan which is geographically close to the mainstream, leaving the distribution to extensive inland transport networks.

With respect to the regional shares of container traffics passing through Busan and Inchon ports, Seoul was the dominant cargo generating region for containerised cargo. In 1987, about 40% of the total handled through these two ports went to or came from the city. Seoul plays an important role as a major centre of container traffics at this time and will do for the foreseeable future. Busan, just behind Seoul, had 25%, Taejon 10%, Taegoo and Jeonjoo held 12% and 8% each.

To sum up, despite the fact Inchon port has the most industrialised hinterland area, and despite the importance of the Seoul metropolitan region to Korea's international seaborne trade, it does not play a significant role as a gateway for Seoul, most cargoes from the city using Busan port via a 430 km-long inland transportation route. This raises the question as to why most carriers do not call at Inchon port which is just 50 km away from Seoul. Behind this strong trend is the underlying question of the balance of costs in intermodal container networks. This is the subject for the next chapters in which the marine, port and inland sector costs are calculated and the trade off between them is evaluated.

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CHAPTER 5. A COMPARISON OF CONTAINER SHIP COSTS AND ITINERARIES

5.1 INTRODUCTION

The background to the transport geography of Korean container trades was traced in the previous chapter, which covered the five major container shipping routes serving Korean trades and cargo distribution in the Korean hinterland. The analysis of routes showed that although Inchon port is located just 50 miles away from Seoul, most containership carriers do not call at the port, so that most cargoes from the city use Busan port 300 miles away. There are a number of reasons for carrier preferences for Busan.

1. Inchon has very limited sea access facilities. It has 10-14m of water but the significant tidal range limits access for large ships.
2. Whereas Busan is well located in relation to existing sea lanes, Inchon requires a substantial diversion.
3. Although Seoul is the major cargo centre in Korea, the number of boxes on each mainline ship for this region is rather limited.

Bang, H.S.(1984) explored the situation using a questionnaire to shippers and shipowners. He found that shippers and shipowners have contrasting views with regard to the use of Inchon. He suggested that shippers avoid using Inchon because there is an absence of regular shipping services on the required routes (49%), an incidence of high sea freight rates (12%), a lack of port services (12%). Shipowners avoid the port because of the shortage of container traffic (53%), additional voyage time (26%) and the restraints of port facilities (21%). However, This analysis was qualitative in nature. The purpose of this analysis is to carry out an objective cost based economic analysis using through transport costs.

This chapter examines the economics of port choice so far as the marine sector is concerned. The first part of the analysis concerns the identification of routes and sailing distances. Following this there is a selection of vessels. Next daily ship costs at sea and in port are estimated. These are then applied to alternative itineraries to give a ship cost comparison.

5.2 THE MAJOR DEEP SEA ROUTES

The ship costing analysis will be related to the two major container routes serving Korean trades i.e. WCNA-Far East and Europe-Far East. As shown in chapter 3, these deep-sea routes account for the major share (about 60%) of Korea's containerised cargoes and will do so for the foreseeable future. Based on the analysis of chapter 4, the standard itinerary on the WCNA route is taken to be: *Hong Kong, Kaohsiung, Busan, Kobe, Yokohama, Los Angeles, San Francisco, Oakland, Seattle and HK.* The distance is 13138 nautical miles (see table 5-1). A table of port to port distances is shown as follows:-

Table 5-1. Port to port distances for the WCNA route

STANDARD			DIVERSION		
Ports	Ports	Dist.(n.m)	Ports	Ports	Dist.(n.m)
Hong Kong	--Kaohsiung	339	Hong Kong	--Kaohsiung	339
KAOHSIUNG	--BUSAN	589	KAOHSIUNG	--INCHON	966
BUSAN	--KOBE	358	INCHON	--KOBE	748
Kobe	--Yokohama	280	Kobe	--Yokohama	280
Yokohama	--Los Angeles	4839	Yokohama	--LA	4839
Los Angeles	--SF	354	Los Angeles	--SF	354
San Francisco	--Oakland	535	San Francisco	--Oakland	535
Oakland	--Hong Kong	5844	Oakland	--Hong Kong	5844
TOTAL		13138			13905

Source: Hydrographic Department(1984).

All container lines on the Europe-FE route offer multiport services with extensions by feeder network. As shown in Appendix 4-2, most shipping lines on the route call at the European ports (Rotterdam, Le Havre, Felixstowe, Hamburg and Bremerhaven) and go straight to the Far East through the Suez canal without a call at the Mediterranean or the Middle East ports. Wider spread of cargo is achieved by a series of feeder networks, Singapore and Hong Kong acting as transhipment centres for the Southeast Asian ports (Port Kelang, Penang, Jakarta, Bombay, Cochin, Madras, Jakarta, Manila and Calcutta). Hong Kong also takes Chinese cargo overland.

For the Europe route the itinerary is: *Hamburg, Bremerhaven, Rotterdam, Felixstowe, Le Havre, Singapore(via Suez), HK, Kaohsiung, Busan, Kobe, Tokyo, Sng and Hamburg.* The distance is 23154 nautical miles (see table 5-2).

Table 5-2. Port to port distances for the Europe case

STANDARD			DIVERSION		
Ports	Ports	Dist.(n.m.)	Ports	Ports	Dist.(n.m.)
Hamburg	-- Bremerhaven	67	Hamburg	-- Bremerhaven	67
Bremerhaven	-- Rotterdam	212	Bremerhaven	-- Rotterdam	212
Rotterdam	-- Felixstowe	113	Rotterdam	-- Felixstowe	113
Felixstowe	-- Le Havre	111	Felixstowe	-- Le Havre	111
Le Havre	-- Singapore	8108	Le Havre	-- Singapore	8108
Singapore	-- Hong Kong	1425	Singapore	-- Hong Kong	1425
Hong Kong	-- Kaohsiung	339	Hong Kong	-- Kaohsiung	339
KAOHSIUNG	-- BUSAN	589	KAOHSIUNG	-- INCHON	1007
BUSAN	-- KOBE	358	INCHON	-- KOBE	707
Kobe	-- Tokyo	298	Kobe	-- Tokyo	298
Tokyo	-- Singapore	2923	Tokyo	-- Singapore	2923
Singapore	-- Hamburg	8611	Singapore	-- Hamburg	8611
TOTAL		23154			23921

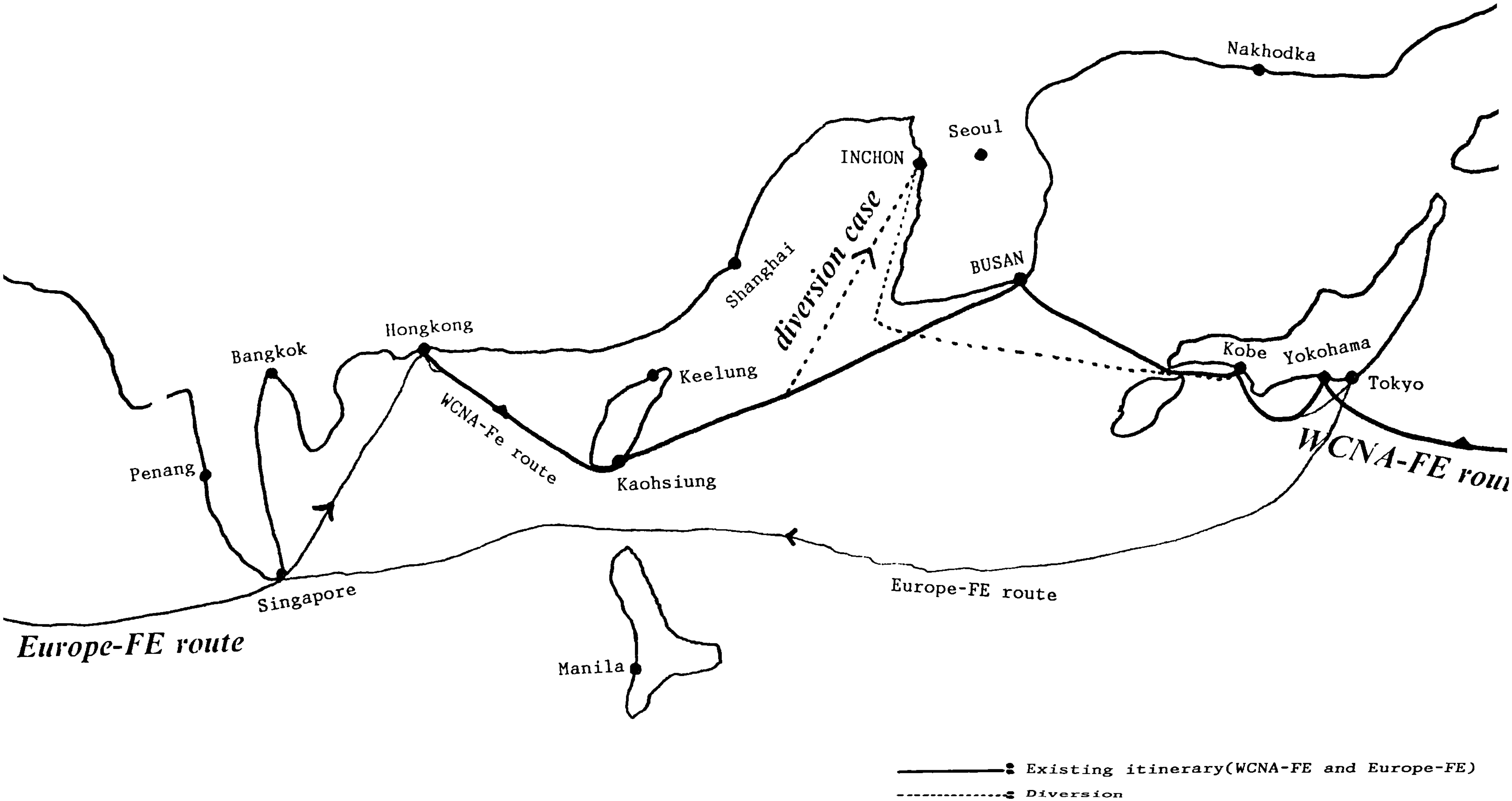
Sources: Hydrographic Department (1976, 1978 and 1984).

To compare these routes for the purpose of the thesis, the Inchon diversion is added to the standard itinerary as shown in figure 5-1. The calculation shows that substitution of a call at Inchon for one at Busan would result in an additional 767 nautical miles to each round trip voyage (see tables 5-1 and 5-2). Based on the tables, adding a call at Busan to one at Inchon adds a 783 nautical miles to the standard itinerary (see appendices 5-3 and 5-6).

5.3 THE SELECTION OF SHIPS

In choosing ships to be used in this analysis the first step is to review developments in the world fleet. We have already discussed recent trends since 1984 and ships on order in chapter 2 (see table 2-3). The table on the

FIGURE 5-1. EXISTING AND DIVERSION ITINERARY TO BE COMPARED AND ANALYSED



recent order pattern shows the importance of very large ships of 3,500 to 4,400 TEUs. Table 5-3 also shows clearly the overwhelming trend to the use of large ships of over 2500 TEUs which now dominate the mainstream trades.

Recently Hapag-Lloyd has contracted for five 4400 TEU ships for delivery in 1993. Maersk line is in the process of deploying twelve 4000 TEU ships into major deep-sea routes by 1993 (CI 1990). As 1980s was the decade when the Panamax barrier was broken by APL, there is no reason in principle operators should not go for vessels of 5000 TEU and over in the late 1990s.

With respect to the deployment of huge containerships, JAMRI(1987) indicated as follows:

> A larger vessel would mean savings not only in the building cost but also in the crew cost, administrative expenses and the operating costs such as the fuel cost, tolls of the two canals and port charges.

It means that the economic rationale for increasing ship carrying capacity is based on the " economics of ship size" i.e. ship costs per unit of carrying capacity decrease with increasing ship size for a given ship type.

Table 5-3. Newbuildings Among Top Twenty Container Carrier March 1990

Carrier	No of Ships	Ship Size (TEUs)	Total slots	Proposed Trade Route
Maersk	7	4000	28000	Europe/USEC/WC/FE
	10	1000	10000	Feeders
Hapag Lloyd	5	4400	22000	Europe/FE
	1	2537	2537	Europe/ANZ
Nedlloyd	5	3100	15500	Europe/FE
	2	3950	7900	Europe/FE
Zim	7	2402	16814	Med/US/FE
Hanjin	6	2678	16068	Europe/FE
	1	400	400	Korea/Jap/Asia
BSC	5	2668	13340	Europe/FE
	5	302	1510	
	1	274	274	
NYK	1	3618	3618	Europe/FE
	3	2800	8400	USWC/FE
	2	1200	2400	Jap/SE Asia
Scan Dutch	1	4425	4425	Europe/FE
	2	3600	7200	Europe/FE
Yangming	3	3500	10500	Eur/FE/USWC/EC
MISC	1	4400	4400	Europe/FE
	3	1234	3702	ANZ/FE/Jap/SE Asia
MOL	2	3613	7226	Europe/FE
SNCDA	3	2200	6600	ANZ/WCNA/Europe/WA
COSCO	1	2700	2700	FE/PRC/USWC
	1	2760	2760	
TOTAL	78		198334	54.0%
Other Orders				
Senator Line	4	2000	8000	RW
	3	1800	5400	RW
Fesco	5	2668	13340	FE/ANZ/WCNA
Lloyd Triestino	3	3000	9000	Med/FE
Contship	4	1600	6400	Europe/Aust/FE
Dole Fresh Fruit	3	1278	3834	ECNA/WCSA
	2	1080	2160	ECNA/C Am
Hamburg Sud	2	1960	3920	Europe/ECSA
	2	1020	2040	Europe/Med/NE
TOTAL	28		54094	14.7 %
WORLD TOTAL			367033	

Source: Containerisation International(1990).

For the purposes of this analysis we will take a new Maersk vessel of 4,000 TEUs and 24 knots, and also the post Panamax C3 of APL at 4340 TEUs and 24.3 knots. A jumboised C3 of 5,300 TEUs is added to look at long term prospects. We will also take the rather slow Evergreen G class vessel of 3,428 TEUs and a new Hanjin ship of 2,670 TEUs and 21.7 knots (see tables 5-4 and 5-5).

Table 5-4. List of the Selected Sample Ships

Operator		Ship's Name	Size(TEU)	Speed(Knots)	Type	Year
APL	(A1)	.	5300	22.0	FC	1992(est)
APL	(B1)	President Truman	4340	24.3	FC	1988
Maersk	(C1)	Majestic Maersk	4000	24.0	FC	1990
Evergreen	(D1)	Ever General	3428	20.8	FC	1988
Hanjin	(E1)	Hanjin Le Havre	2670	21.7	FC	1989

Sources: CIY(1991) and Register of Ships(1991-92).

Table 5-5. Breakdown for the Ships Sampled

Classifacation\ Ships	A1 (5300 TEU)	B1 (4340 TEU)	C1 (4000 TEU)	D1 (3428TEU)	E1 (2670 TEU)
Length overall(m)	305.14	275.14	294.14	269.68	241.32
Length B.P.(m)	290.81	260.81	284.74	253.02	225.23
Breadth moulded(m)	39.41	39.41	32.22	32.21	32.21
Draft maximum(m)	12.50	12.50	13.52	11.63	10.80
DWT		54700	60639	53240	43140
Yard	Bremer vulkan	Bremer vulkan	Odense	Onomichi	Samsung
Installed power (bhp)	56960	56960	57643	23180	28350
Fuel t.p.d.(tonnes)	152.5	152.5	145.8(e)	75.5	84.5

Source: Register of Ships(1991-92).
Note : (e) estimated from installed power on the basis of 15% power margin and 124 gms per bhp hour.

5.4 CALCULATION OF SHIPS' COSTS

5.4.1 SHIPS' CAPITAL COST AND DAILY CAPITAL COST

There are certain difficulties in developing a coherent set of ship capital costs.

> " If ship's prices could be taken to represent costs of construction including some reasonable rate of return on capital, it would be possible to use delivered prices in parametric comparisons. "(Gilman, S. 1980)

This approach would require a stable market in which prices are a reasonably reliable guide. Until recently ships were being offered at anything up to 40% below cost price and in some cases on very favourable credit terms, and for many years the world's ships have been supplied at substantially less than the production cost. Gilman suggested that it was difficult to use market prices alone in any parametric comparison. In recent times the world market has returned to more normal conditions and there has been a very rapid increase in ship prices which have nearly doubled.

Methods for estimating ship costs based on design studies were carried out by Chapman(1969), Carreyette(1971), and Jansson and Shneerson(1987). Jansson and Shneerson analysed the elasticity of capital costs in the liner sector and estimated size elasticity of capital costs of 0.655 in deadweight(DWT) terms. However, the fifty sample ships they selected were composed of bulk carriers rather than fully cellular containerships. The structure of a fully cellular containership is different from that of a bulk carrier. The former requires more steelwork and more advanced technical skill/equipment, being more expensive to build.

More recently Liu(1989) has discussed a general technique of ship cost estimation, taking samples of fifty seven observations of the building prices of fully cellular containerships. All these ships selected were over 1000 TEU and made in Japanese shipyards. He suggested the following results below:

```
(1) Ln(capital cost)(US$m)= -2.44+0.761Ln(TEU)
             (R = 0.69, S.D.=0.187)

(2) Ln(capital cost)(US$m)= -3.86+0.687Ln(DWT)
             (R = 0.52, S.D.=0.233)
```

Turning to speed Gilman has estimated an elasticity of capital costs of 1.0 (Marine Transport Centre paper). Applying these two elasticities a coherent set of capital costs can be based on the price of a single ship. This methodology is different from those used before and helps solve the problem of dealing with the variation in ship prices by yard and by country. Based on this technique, in the analysis we will take a standard current market price of US$ 100 million for the President Truman of APL and relate other capital costs to this using the elasticities derived by Gilman and Liu. All capital and capital related costs will, therefore, be on a current basis not a historic basis (see table 5-6), but this will give a better review of the economic case over the next ten years than using old data with low historic capital costs.

Table 5-6. Capital Costs for Selected Ships

Ship's name	Size(TEU)	Speed(knots)	Tonnage *(gross)	Place of building	Prices (US$m)
Ship A1	5300	22.0	75000		105.0
Ship B1	4340	24.25	61785	Bremer vulkan	100.0
Ship C1	4000	24.0	52181	Odense	93.0
Ship D1	3428	20.75	46445	Onomichi	75.0
Ship E1	2670	21.7	36420	Samsung	64.0

Source: derived from Tables 5-4 and 5-5.
Note : * derived from Register of Ships(1991-92).

CONVERSION TO DAILY COSTS

To arrive at daily capital costs, the initial total capital cost is converted into an annual capital cost via an annuity formula using a given discount rate and the life of the ship, and then divided by the number of working days per annum. For this study it is assumed that

1. the average service life of a vessel is 20 years
2. there are 350 working days per annum
3. a discount rate of 10% is used to calculate the annuity factor.

From a discount rate of 10% at 20 years annuity factor of 8.5134 is derived. By using this factor ship's capital cost can be annualised. Ships' daily capital costs derived on this basis are shown in table 5-7.

Table 5-7. Daily Capital Costs of the Sampled Vessels

Ship's name	Size (TEU)	Total capital cost(US$m)(a)	Discount rate	Annuity factor(b)	Annual capital cost(US$m)(c)	Daily capital cost(US$)(c)
Ship A1	5300	105.0	10%	8.5134	12.3	35143
Ship B1	4340	100.0	10%	8.5134	11.8	33714
Ship C1	4000	93.0	10%	8.5134	10.9	31143
Ship D1	3428	75.0	10%	8.5134	8.8	25143
Ship E1	2670	64.0	10%	8.5134	7.5	21429

Source: (a) derived from Table 5-6.
(b) Corporate Financial Management(1974).
(c) Calculated by this study.

5.4.2 CALCULATION OF SHIP'S OPERATING COSTS

The ship's main operating cost items are maintenance and repair costs, insurance, crew and fuel, etc. Maintenance and repair costs vary according to the ship's size, age and the complexity of its equipment. During a ship's operation, however, the costs are dependent only upon the first two variables (Canadian Transport Commission 1986). With shipping being a highly dangerous business, shipowners tend to subscribe to a number of insurance policies in order to protect ship's capital.

These costs may be estimated in general terms based on the percentages of the ship's initial capital costs. The figure taken by Gilman, S (1980) was 2.7% of initial capital costs per annum while a percentage of 5.0 was suggested by Ryder, S.C. and Chappell, D. (Marine Transport Centre 1979). Insurance costs are a function of ship's size and condition. For these larger vessels it is assumed that the figure should be higher, taking a percentage of 6%. For this study a ratio of 6% will be used for all ships selected. Thus ships' maintenance and insurance costs are used to be a total of 6% of initial capital costs per annum and converted to a daily basis on the same assumption of 350 working days. The results are presented in table 5-8.

Manning levels and crew costs are a moderately important component of a ship's cost structure, although they vary substantially with different flags of registry, ship type and crew nationality. Jansson and Shneerson (1987) have determined that there is no significant relationship between crew costs and ship size on the basis of the data of 34 ships in the deep-sea sector. They derived the following result:

$$\text{Log(crew cost)} = \text{Log}12.8 + 0.03\text{Log } S$$
$$(R = 0.003)$$

In recent years, the growth of ship size and transport capacity, technological development and increased automation have cut down these costs. Crew numbers have been reduced rapidly from the 30 plus of the end of 1970s to between about 14 and 21 today. Evergreen operates with 16 crew members on its Panamax vessel with a capacity of more than 3000 TEU and APL use 20 on their post Panamax ships although in principle they could sail with 12. The determining factor is the operating policy of the carrier and the design and degree of automation of the vessel.

For this study crew numbers are taken to be 16 for all vessels. For these calculations the cost of a European crew was taken with an annual average crew cost per man of US$ 50000 for all of the sampled ships. European crew costs are said to be four to five times those of manning with a Philippine or Chinese crew and 1.5 times those of a Korean crew. This is converted to daily crew costs on the same basis of 350 working days per annum and shown in table 5-8.

Table 5-8. Daily Operating Costs for the Sampled Ships

Ship's name	Initial capital (US$m)*	Annual M&I(US$m)	Daily M&I(US$)	Crew No.	Daily crew cost(US$)	Daily operating cost(US$)
Ship A1	105.0	6.3	18000	16	2286	20286
Ship B1	100.0	6.0	17143	16	2286	19429
Ship C1	93.0	5.6	16000	16	2286	18286
Ship D1	75.0	4.5	12857	16	2286	15143
Ship E1	64.0	3.8	10857	16	2286	13143

Source: * is derived from Table 5-7.

5.4.3 ESTIMATE OF SHIP'S DAILY FUEL COSTS

In the last decade, the rise in the price of fuel resulted in a drive towards improvements in the technical efficiency of ships and engines. Shipbuilders have reduced fuel consumption by improving ship hull form and propulsion technology to reduce the horsepower required to move a ship of a given tonnage at a given speed (Canadian Transport Commission 1986).

Fuel costs are determined by a number of factors such as ship size, the type of the hull and engine, speed, horsepower, type of fuel used and its price. To calculate these costs, fuel consumption at normal service speed has to be estimated. This may be determined from the installed power of the vessel, which is available to us. Installed power may be computed by formula in parametric analyses. The Liverpool University Marine Transport Centre suggested the following two formulas for calculating installed power. With the figures derived from the formulas a comparison of actuals for the samples used in this study is shown in table 5-9.

$$BHPforlargecontainership = 0.09 \times \sqrt{(TEUCapacity)} \times (ServiceSpeed)^3 (5-1)$$

$$BHPforsmallcontainership = 0.08 \times \sqrt{(TEUCapacity)} \times (ServiceSpeed)^3 (5-2)$$

Using the above formulas large ships of 3000 TEUs over are estimated by the formula(5-1) and smaller ship of 3000 TEUs below by the formula(5-2). The result of the calculation for the ships selected is shown in table 5-9.

Table 5-9. Comparison of the estimated and actual installed bhp

Ships	Size (TEUs)	Speed (kn.)	Actual installed bhp(a)	Estimated bhp	Deviation	difference (%)
A1	5300	22.0	56960	69700	12740	22.4
B1	4340	24.3	56960	85075	28115	49.4
C1	4000	24.0	57643	77917	20274	35.2
D1	3428	20.8	23180	47419	24239	104.6
E1	2670	21.7	28350	42240	13890	50.0
				Average deviation:	19852	52.3

Source: (a) derived from Register of Ships(1991-92).

As shown in the table the average deviation of actual installed bhp from the estimated bhp amounts to 19852 equivalent to 52%. This over estimate is not acceptable and for ships with modern engines new formulae are required.

As mentioned, ship's daily fuel cost will be calculated by its daily fuel consumption which will be determined by the scale of horsepower used to generate the ship's service speed. It is widely accepted that 85% of installed power is an average service BHP, which will sustain normal service speed. The remaining 15% is the power service margin used only to deal with special circumstances such as heavy seas and adverse winds.

Before estimating ship's daily fuel costs, it is necessary to know the kinds of fuel consumption for ships equipped with diesel engines. There are three kinds of fuel, i.e. Marine Fuel Oil (MFO) used by the main engine, Marine Diesel Oil (MDO) used by the auxiliary engines and Lubricating Oil required to run the engines. The price of these fuels seems relatively unstable when considering observations over the last few years. In fact, the price of fuel is dependent upon how far away the oil-producing point is, as well as on fluctuations in the exchange rate, on the purchase contract and on taxation on oil products. However, the use of oil prices should not bias the estimates of the study significantly. It is assumed that current oil production levels combined with ongoing problems within OPEC will not cause a sharp increase in the price of oil.

To calculate the daily fuel costs of the ships sampled, the following assumptions are proposed for the purpose of the study on the basis of Gilman, S(ibid) and Bruno Jacques (Canadian Transport Commission 1986). Prices shown are current and based on actual bunker deals in port of Singapore (Lloyd's list, 1991 and telephone interview with Cockett Marine Oil Ltd).

1. Average service BHP of diesels is estimated at 85% of installed power
2. Consumption of marine fuel oil is assumed to be 124 grams per BHP hour. The fuel price is taken to be US$ 80 per tonne.

3. The consumption of auxiliaries at sea is taken at 3 tonnes of marine diesel oil per day for ship below 3000 TEUs and 3.5 tonnes per day for larger ships. It does not vary significantly in relation to speed. The price of this fuel is taken to be US$ 170 per tonne.

4. Fuel consumption in port for diesel engined ships was taken to be 4.5 tonnes per day for ship below 3000 TEUs and 5 tonnes per day for larger ships. The price adopted is US$ 170 per tonne given above.

5. The main engine needs 1 gram of lubricating oil per BHP hour. The price of lubricating oil is taken as US$ 250 per tonne.

Daily fuel costs at sea for the ships selected are estimated on this basis and shown in table 5-10.

Table 5-10. Estimated Ship's Daily Fuel Costs at Sea

	Size (TEU)	Installed BHP(a)	Service BHP(b)	Fuel bunker *(tonnes)	Daily MFO cost (US$)	Daily Lub. (US$)	Daily MDO cost (US$)	Daily fuel cost(US$) at sea
A1	5300	56960	48416	152.5	12200	291	595	13086
B1	4340	56960	48416	152.5	12200	291	595	13086
C1	4000	57643	48997	145.8(e)	11665	294	595	12554
D1	3428	23180	19703	75.5	6040	118	595	6753
E1	2670	28350	24098	84.5	6760	145	510	7415

Sources: (a) derived from Table 5-9.
(b) derived from (a) X 0.85
(*) derived from Table 5-5.
Note: (e) estimated from installed power on the basis of 15% power margin and 124 gms per bhp hour.

5.4.4 CALCULATION OF SHIP'S TIME/COST AT SEA AND IN PORT

5.4.4.1 Ship's Time and Cost at Sea

As analysed in the preceding chapter, ship's time at sea is determined by ship's speed and route length. Nautical Distances Tables provide the round trip distance of each of the six itineraries for a comparative analysis in this study. Time at sea is, thus computed on each itinerary on the basis of given service speed as shown in table 5-11.

Table 5-11. Ship's Time at Sea

	Size (TEU)	Speed (knots)	Time at Sea(days)					
			WCNA-FE (13138 n.m)	(*)WCNA-FE (13905 n.m)	**	Europe-FE (23154 n.m)	(*)Europe-FE (23921 n.m)	**
A1	5300	22.0	24.9	26.3	26.4	43.9	45.3	45.4
B1	4340	24.3	22.6	23.9	23.9	39.8	41.1	41.1
C1	4000	24.0	22.8	24.1	24.2	40.2	41.5	41.6
D1	3428	20.8	26.4	27.9	27.9	46.5	48.0	48.1
E1	2670	21.7	25.2	26.7	26.7	44.5	45.9	46.0

Notes: (1) n.m. means nautical miles.
(2) * and ** are diversion itineraries and Inchon plus Busan.
(3) Nautical miles for Inchon plus Busan ports in the FE/WCNA and FE/Europe itineraries are 13921 n.m and 23937 n.m.

Ship's daily costs at sea are determined by ship's daily capital cost, daily operating cost and daily fuel cost at sea. The summary of the costs for the selected vessels is shown in table 5-12.

Table 5-12. Comparison of Ships' Daily Costs at Sea

	Size (TEU)	Speed (knots)	Daily capital cost(US$)(a)	Daily operating cost(US$)(b)	Daily fuel cost(US$)(c)	Daily Cost at sea(US$)
A1	5300	22.0	35143	20286	13086	68515
B1	4340	24.25	33714	19429	13086	66229
C1	4000	24.0	31143	18286	12554	61983
D1	3428	20.75	25143	15143	6753	47039
E1	2670	21.7	21429	13143	7415	41987

Source: (a) derived from Table 5-7.
(b) derived from Table 5-8.
(c) derived from Table 5-10.

Using the table 5-12 above, cost per TEU at sea can be calculated. For a general analysis of comparative cost efficiency, cost per TEU is the suitable indicator for the purpose of the thesis. The cost per TEU at sea can be obtained by dividing the total cost per trip at sea by ship size (boxes carried). The summary of the calculations is shown in table 5-13.

Table 5-13. Comparison of Cost per TEU at sea(oneway)

	Daily cost at sea(US$) (a)	Cost per trip at sea(US$)(b)		Cost per TEU at sea (oneway) (US$)	
		WCNA-FE	Europe-FE	WCNA-FE	Europe-FE
A1	68515	1706024(1801945)	3007809(3103730)	178.8(188.9)	315.3(325.3)
B1	66229	1496775(1582873)	2635914(2722012)	191.6(202.6)	337.4(348.4)
C1	61983	1413212(1493790)	2491717(2572295)	196.3(207.5)	346.1(357.3)
D1	47039	1241830(1312388)	2187314(2257872)	201.3(212.7)	354.5(365.9)
E1	41987	1058072(1121053)	1868422(1927203)	220.2(233.3)	388.8(401.1)

Source: (a) derived from Table 5-12.
(b) calculated by (a) X ship's time at sea(days).
(c) ( ) are cases where diversion is assumed for the WCNA-FE and Europe-FE routes.

Note : see appendices 5-3 and 5-6 for Inchon plus Busan in the WCNA-FE and Europe-FE routes.

The analysis shows the extent of the extra costs over existing itineraries in both WCNA-FE and Europe-FE trades. From the viewpoint of costs per TEU at sea (oneway), the difference between diversion and existing itinerary ranges from about US$ 10 to US$ 13 per TEU at sea in WCNA-FE and Europe-FE trade, respectively. Consideration of two ports (Inchon plus Busan) in the standard itinerary gives more cost disadvantage to the above situation, increasing the gap of cost (see appendices 5-3 and 5-6). Furthermore, transit time at sea for diversion and two port cases in the two itineraries would be increased over mainline service (see table 5-11) and this does not provide a good benefit to the shippers for the container cargoes of these itineraries.

With respect to the cost per TEU mile at sea, it is obtained by dividing the total daily costs at sea by ship size, speed and 24 hours. Table 5-14 shows the results. As shown in the table below, the ships of APL steaming at 22 and 24.3 knots had the lowest costs per TEU mile. If the ships steam at full service speed, ship A1 estimated is US$ 1.7 cheaper than the "President Truman(B1)". Thus, at full service speed, ship A1 is more productive at sea generating about 2.8 million TEU miles, some 1.2 times more than the 2.5 million TEU miles produced by the President Truman. For vessels of 3400 to 4000 TEU, they have unit costs 9.4%-12.3% less than the small ships of 3000 TEU below.

Table 5-14. Comparison of the cost per TEU mile at sea

	Size (TEU)	Speed (knots)	Total daily costs at sea(US$) (a)	Cost/1000 TEU mile (US$)
A1	5300	22.0	68515	24.5
B1	4340	24.3	66229	26.2
C1	4000	24.0	61983	26.9
D1	3428	20.8	47039	27.6
E1	2670	21.7	41987	30.2

Source: (a) derived from Table 5-13.

5.4.4.2 SHIP'S TIME AND COST IN PORT

Ship's time in port is determined by the total numbers of containers carried on ship, container handling rate and port access time, etc. It is assumed that all ships sampled have a load factor of 90% and an equal number of TEUs is carried in 20ft and 40ft containers, i.e. 40s have one third of the boxes and 20s the remaining two thirds. Considering that these ships are operating on multi-port itineraries, it is expected that there would be re-stow boxes, which are assumed to be 10% of the number of containers carried on the ship. At the end of 1980s, most major ports in the world could sustain between 20 and 30 moves per crane hour. Sustainable daily rates of 500 moves per crane are now expected as the minimum for modern deep sea container ports. Following modern practice each ship is assumed to be handled by two cranes simultaneously and hence container handling rate per day of 1000 moves equivalent to 1500 TEUs is taken. It is assumed to be fixed, and the same for all ports. Thus total ship's time in port can be calculated, making an allowance of four days for access time, waiting for berth and waiting to commence container handling plus the necessary slack in the itinerary to allow for delays, etc. In case of calling at Inchon port, two further days are assumed due to the large tidal range and tug assistance for passage into the lock system[11]. The results are given in table 5-15 below.

Table 5-15. Ship's Time(days) in Port in the WCNA-FE and Europe-FE routes

	Size (TEU)	Load factor	No.of boxes	Movements	Restow (10%)	Total Time in port		
						stand.	diver.	two port case
A1	5300	0.9	3578	14312	358	13.8	15.8	16.8
B1	4340	0.9	2930	11720	293	12.0	14.0	15.0
C1	4000	0.9	2700	10800	270	11.4	13.4	14.4
D1	3428	0.9	2314	9256	231	10.3	12.3	13.2
E1	2670	0.9	1803	7212	180	8.9	10.9	11.9

Note: For Inchon plus Busan(*), three further days are assumed to the FE/WCNA and FE/Europe trades, respectively.

Based on tables 5-11 and 5-15, total round trip time can be calculated. It may be derived by adding ship's time (days) at sea to ship's time (days) in port. This has to be reasonably compatible with roundtrip (days) analysed in

[11] The lock system was constructed in 1967-1976 to improve access.

appendices 4-1 and 4-2. On the WCNA-FE and Europe-FE routes, with a service speed of 21 knots and handling rates per day of 1200 TEU, total round trip time is within 42 days and 63 days, respectively whilst at service speeds of 24 knots and handling rates per day of 1500 TEU it is within 35 days and 56 days, respectively. Table 5-16 shows the results.

Table 5-16. Total Roundtrip Time(days) for the sampled ships

	Size (TEU)	Speed (knots)	WCNA-FE			Europe-FE		
			stand.	diver.	two port	stand.	diver.	two port
A1	5300	22.0	38.7	42.1	43.2	57.7	61.1	62.2
B1	4340	24.3	34.6	37.9	38.9	51.8	55.1	56.1
C1	4000	24.0	34.2	37.5	38.6	51.6	54.9	56.0
D1	3428	20.8	36.7	40.2	41.1	56.8	60.3	61.3
E1	2670	21.7	34.1	37.6	38.6	53.4	56.8	57.9

Sources: derived from Tables 5-11 and 5-15.
Note: stand, diver and two port mean standard, diversion itinerary and Busan plus Inchon case, respectively.

Ship's daily costs in port are the sum of vessel costs and port charges. Vessel costs consist of the ship's capital, maintenance and insurance, crew costs and fuel costs for auxiliaries mentioned in the previous section. Fuel consumption in port for the selected ships is assumed to be 4.5 tonnes per day for ship below 3000 TEU and 5 tonnes per day for larger ships. The fuel price is the same as the marine diesel oil's price of US$ 170 per tonne given the above assumption (see section 5.4.3). On this basis, the result of the calculation of daily vessel costs in port is shown in table 5-17.

Table 5-17. Ship's Daily Costs in Port for the Sampled Ships

	Size (TEU)	Daily capital cost(US$)(a)	Daily operating cost(US$)(b)	Daily fuel cost in port (US$)	Daily ship cost in port (US$)
A1	5300	35143	20286	850	56279
B1	4340	33714	19429	850	53993
C1	4000	31143	18286	850	50279
D1	3428	25143	15143	850	41136
E1	2670	21429	13143	765	35337

Source: (a) derived from Table 5-7.
(b) derived from Table 5-8.

In addition to vessel costs incurred in port, a containership also incurs port charges for services rendered by port authorities, stevedore companies, tug operators and pilots. These include port dues, anchorage, pilotage, tuggage and dockage, etc (Chadwin, M.L., Pope, J.A. and Talley, W.K. 1990). For the port of Busan and Inchon, port dues are based on per ton (US$ 0.16) of gross registered tonnage (per calling port) including light dues. Free port dues shall be accorded to vessel undergoing repair for docking (without cargo in and out) and vessel in distress. Anchorage and dockage charge on the basis of the every 10 gross registered ton (US$ 0.22 and US$ 0.42 respectively) per every 12 hours. Less than 10 tons or less than 12 hours shall be counted as 10 tons or 12 hours respectively (KOSAA 1990).

Pilotage fees are based on the overall length, breadth and depth of the containership. A basic pilotage rate is quoted for each of the Korean ports. Vessels under 1000 gross tonnes or a draft of 3 meters do not require pilotage. For every 1000 tonnes of gross tonnage over the first 3 meters of draft, pilotage is added at the rate of 10% of the basic rate. In case of the Inchon port pilot, the basic charges are US$ 41 from Palmi-Do pilot station to harbour anchorage, shifting to the tidal basin dock from harbour anchorage/

waiting berth (US$ 69), and shifting in harbour between anchorage and berth (US$ 41). These are compulsory for all vessels entering or leaving Inchon waters. Entry or departure (US$ 41) and shifting berth at the inner harbour (US$ 39) only are required at the port of Busan (see table 5-18).

Tug costs are also raised on entry/exit to a port. In this study a 5000 horsepowered tug (US$ 703 per hour/per boat) for 3000 TEUs over, and 3000 H.P. tug (US$ 459 per hour/per boat) for 3000 TEUs and under are assumed to be used in Inchon and Busan ports for all the ships selected. Container ships use one tug each way for a period of 12 hours, so there are US$ 8436 and US$ 5508 per call, respectively and this is required twice in Inchon port. Other costs for services to ships in port are ignored in this analysis due to the lack of available data, but they are likely to be of smaller magnitude than tugs and pilots.

Table 5-18. Port Dues and Charges for the Sampled Ships in both Busan and Inchon ports(unit: US$)

Size (TEU)		Common charges			Busan		Inchon		Totals	
		Port dues	Ancho.	Dock.	Pilot	Tug.	Pilot.	Tug.	Busan	Inchon
A1	5300	11937	1669	3180	1345	8436	2537	16872	26567	36195
B1	4340	9833	1375	2619	1136	8436	2143	16872	23399	32842
C1	4000	8305	1161	2212	985	8436	1858	16872	21099	30408
D1	3428	7392	1034	1969	895	8436	1688	16872	19726	28955
E1	2670	5796	811	1544	735	5508	1386	11016	14394	20553

Source: recalculated from the data of KOSAA(1990).
Notes :(1) Exchange rate US$1.00=Won710.
(2) Ancho.(Anchorage), Pilot.(Pilotage), Dock.(Dockage) and Tug.(Tuggage) charges

On the basis of table 5-18 above, daily vessel costs, port dues and port charges including pilotage, tuggage, dockage and anchorage give the total ship costs per roundtrip in port in both existing and diversion itineraries (table 5-19).

Table 5-19. Total ship costs(US$) per roundtrip in Port between existing and diversion routes

Size (TEU)	Daily ship cost in port (a)	Total costs per round trip in port(exist.) (b)	Total costs per round trip in port(div.) (b)	Total costs per round trip in port(two port) (b)
A1 5300	56279	776650	889208	945487
B1 4340	53993	647916	755902	809895
C1 4000	50279	573181	673739	724018
D1 3428	41136	423701	501859	542995
E1 2670	35337	314499	385173	420510

Note: exist. and div. mean existing and diversion itineraries.
Source: (a) derived from Table 5-17.
(b) derived from appendices 5-1, 5-2 and 5-3.

The table 5-19 above shows that in terms of marine and port sector costs carriers on existing itineraries have a considerable advantage over those on the diversion itineraries. In concrete terms, unit costs are about 14% less than those of diversion case.

Based on table 5-19, for the purposes of parametric analysis, vessel costs per TEU in port may be derived by dividing the total daily costs in port by the handling rate per day. The ship's daily costs in port are given in table 5-19 at the handling rate of 1500 TEU per day. For comparison a handling rate of 1200 TEU per day is also considered. On the basis of these data, the costs per TEU in port for the selected vessels are given in table 5-20 below. The analysis shows the diseconomies of larger size of ships in port. The degree of the cost penalty is dependent upon the handling rate of containers in port, with absolute costs and differentials being reduced as the rate increases.

Table 5-20. Comparison of the costs (US$) per TEU in port

	Size (TEUs)	Total daily costs in port(US$)(a)	Cost/TEU in port(US$)(b)	Cost/TEU in port(US$)(c)
A1	5300	56279	37.5	46.9
B1	4340	53993	36.0	45.0
C1	4000	50279	33.5	41.9
D1	3428	41136	27.4	34.3
E1	2670	35337	23.6	29.5

Source: (a) derived from Table 5-19.
Notes : (b) taken as 1500 TEU per day.
(c) considered as 1200 TEU per day.

5.5 COSTS OF CONTAINERS AND INVENTORIES

The previous sections did not take into account the costs of the container itself and inventory costs on cargo in transit. In this section we examine these costs which will by affected by changes in transit times and will be borne by the carriers and the shippers, respectively (Jansson and Shneerson 1987).

Owners of container ships have to purchase or lease containers. For the analysis in this study, the following assumptions based on current experience have been made:

1. The capital cost of a standard 20ft container is US$ 3000.
2. The life-span of the container is 10 years.
3. A 10% interest rate is assumed. An annuity factor of 6.1446 is obtained for 10% at 10 years.
4. There will be 350 working days per annum.

Dividing container's price by the annuity factor gives an annual capital cost per container, then dividing the annual cost by 350 working days gives a daily capital cost for one container. Using these assumptions, a daily capital cost for a 20ft container is estimated to be US$ 1.395 on a 350 working days basis.

In fact, to calculate exactly the cost of containers associated with a particular diversion is very difficult. This is because it depends upon the exact number of containers on board at the time the diversion is made. On the Europe-Far East itinerary, with a call at Inchon on the eastbound voyage, the containers on board when the diversion is made are those for Korea and Japan and of these the only containers to be significantly delayed are those for Japan. Based on trade patterns analysed by the Marine Transport Centre Japanese cargoes in the itinerary are between about 40% and 45% of the total on the ship. On the other hand, on the Pacific itineraries with more limited Far East calling patterns cargoes for Japan are estimated to be about 60-65%. Based on these proportions the total cost of containers may be derived by multiplying the estimated number destined for Japan by the daily capital cost of a container and by the delay (measured in days). The results are given in tables 5-21 and 5-22 below.

Table 5-21. Container costs(US$) per trip in selected routes

	WCNA-FE			Europe-FE		
	standard	diversion	two port case	standard	diversion	two port case
A1	4806	9612	14418	2957	5915	8871
B1	3935	7870	11805	2422	4844	7266
C1	3627	7254	10881	2232	4464	6696
D1	3108	6216	9324	1913	3826	5739
E1	2421	4842	7263	1490	2980	4470

Note : In case of any measurable delay, two and three days are taken to the Inchon and Inchon plus Busan diversion cases, respectively.

Table 5-22. Total ship costs(US$) per trip with containers in selected routes

	WCNA-FE			Europe-FE		
Ships	standard	diversion	two port case	standard	diversion	two port
A1	2514047	2736960	2831463	3813983	4035048	4127701
B1	2172025	2379487	2460814	3309651	3515600	3595414
C1	2011119	2205191	2286395	3088229	3280906	3360714
D1	1688365	1849418	1913388	2632654	2792512	2859991
E1	1389386	1531621	1583773	2198805	2335909	2391329

Sources: appendices 5-1 § 5-6 and table 5-21.

As can be seen in table 5-22, taking into account container the diversion costs are increased by moderate amounts. From the cost point of view, ships using diversion itineraries in both WCNA-FE and Europe-FE trades generate extra costs over using existing itineraries.

Inventory cost can be defined to be the interest costs on cargo in transit. This cost is determined by the type of cargo and length of transit time (Jansson and Shneerson 1987). The higher the value of cargo and the longer the transit time, the higher the inventory cost. Inventory values of container's contents vary from country to country. The average values of container cargo in the UK's lo/lo container trades vary from about US$ 4000 per 20ft container of pulp/wastepaper or crude fertilisers to around US$ 300,000 per 20 ft container for office machinery, scientific instruments or clothing (Pearson,R 1988).

In Korea's containerised cargo trades, the value of container cargo also varies significantly. Its mean value, however, was lower than that of the developed countries of the UK and Japan because of the lesser sophistication and lower average value of container cargo in Korean trades. For instance, in the container trades between Busan port and US west coast in 1990 it ranges from about US$ 10000 per 20ft container for bags and stuffed toys, to US$ 50000 per 20ft container for Television, Monitors and Machinery[12] (Ghang, J.H. 1990).

The calculation of inventory costs depends upon two factors, i.e. the exact number of containers which are full of cargo at the time of the diversion and the costs of these particular cargoes. In the case of the diversion to Inchon it will be Japanese import cargoes from Europe which are delayed. These consist of cargoes from a whole range of European countries, and it is known that many of them are low value products. We do not have accurate figures but can estimate very roughly that 40% of the containers on the ship are full boxes destined for Japan and the average value per TEU will be no more than US$ 20,000. Based on these broad assumptions the estimated inventory costs are shown in table 5-23 below.

[12] The value of the export containers from Hong Kong, Taiwan and Singapore will have almost same as that of Korea.

Table 5-23. Inventory costs(US$) per trip in selected ships

Ship size (TEU)	Containers for Japan	Value of cargo at US$ 20000	Interest Day @ 10%	Inventory cost One port case	Inventory cost Two port case
5300	2120	42400000	11616	16263	24394
4340	1736	34720000	9512	13316	19974
4000	1600	32000000	8767	12272	18408
3428	1371.2	27424000	7513	10516	15774
2670	1068	21360000	5852	8192	12288

Note: Medium case for interest rate of 10% is adopted by this study.

The costs are quite modest compared to those of the ship diversion itself. They work against the diversion case and slightly more strongly against the two port case. These figures will not be included in the detailed comparison and do not have any significant effect on its outcome.

5.6 CONCLUSION

This chapter compared the two route case studies: *WCNA-FE and Europe-FE itineraries* which account for the major shares of Korea's overseas trades. It considered Busan alone, Inchon alone in place of Busan and Inchon plus Busan in mainline service itinerary and compared the sampled ships in the three itineraries on the basis of the total costs at sea and in port. That is to say, the costing comparison between the existing itinerary, assumed diversion and Inchon plus Busan itineraries is worked out. Table 5-23 compares these three options. The two types (5300 TEUs and 4000 TEUs) of containerships in the FE/WCNA route[13] serving Korea's trades are compared.

Table 5-24 shows the results of this analysis. For a comparative cost efficiency at sea, the diversion itinerary and Inchon plus Busan itinerary generate extra costs of 5.6% (5300 TEUs) and 6.0% (5300 TEUs) in total ship costs per trip over the existing itineraries. The difference between them is about US$95,921 and US$102,772 per voyage at sea, respectively.

[13] The result in the FE/Europe route is consistent with that of the FE/WCNA route.

Table 5-24. A summary table of the standard, diversion and Inchon plus Busan itineraries, the Far East/WCNA trade

	STANDARD (Busan alone)		DIVERSION (Inchon alone)		INCHON PLUS BUSAN	
Marine Sector Costs (US$)	5300 (TEU)	4000 (TEU)	5300 (TEU)	4000 (TEU)	5300 (TEU)	4000 (TEU)
a. Time at sea(days)	24.9	22.8	26.3	24.1	26.4	24.2
b. Costs a day at sea	68515	61983	68515	61983	68515	61983
c. Costs per trip at sea	1706024	1413212	1801945	1493790	1808796	1499989
d. Costs per TEU at sea(oneway)	178.8	196.3	188.9	207.5	189.6	208.3
e. Daily ship costs in port	56279	50279	56279	50279	56279	50279
f. Port dues and charges	26567	21099	36195	30408	62762	51507
g. Costs per trip in port	776650	573181	889208	673739	945487	724018
h. Costs/TEU in port	81.4	79.6	93.2	93.5	99.1	100.5
i. Total roundtrip time(days)	38.7	34.2	42.1	37.5	43.2	38.6
j. Container costs	4806	3627	9612	7254	14418	10881
TOTAL SHIP COSTS (per trip)	2514047	2011119	2736960	2205191	2831463	2286395

Sources: derived from appendices 5-1§5-6.

With regard to costs in port, carriers calling at the standard itineraries have a cost advantage over using the diversion and particularly the two ports case (Inchon plus Busan). In case of calling at Inchon, the increase is due to the larger tidal range (which holds ships in port waiting for high tide), tug assistance for passage into the lock system and extra port charges including pilotage and tuggage compared with a call of Busan port.

Consideration of container costs increases the disadvantage to the above situation, increasing the gap between the standard itinerary and the Inchon only and Inchon plus Busan itineraries. The difference between them ranges from US$ 222,913 (5300 TEUs) and US$ 194,072 (4000 TEUs) in diversion itinerary to US$ 317,416 (5300 TEUs) and 275,276 (4000 TEUs) in the two ports case in total ship costs per trip, respectively. For the carrier, this shows a much greater loss compared with calling at the standard itineraries on the water route. If we take account of inventories the advantage of the standard itinerary becomes much greater.

Clearly, ships using diversion itineraries are significantly more expensive. However, for the main purpose of this thesis, it is necessary to compare these increases with potential savings in inland costs. This is the subject for the next chapter.

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CHAPTER 6. INLAND TRANSPORT IN THE THROUGH MOVEMENT

6.1 INTRODUCTION

The economies of containership calling pattern at Busan and Inchon ports were compared in the previous chapter using cost estimates relating to a representative sample ships. Following this, the present analysis looks at inland transport in Korea, dealing with the extent of carrier involvement, modal costs and the structure of inland networks, etc. The chapter is divided into two parts. In the first an analysis is made of inland haulage arrangements under Merchant and Carrier Haulage. In the second the costs of inland transport for the networks selected in the study are compared.

The analytical approach to the dynamics of inland transport for containerised cargo flows has been developed on the basis of the existing data and personal interviews undertaken in a field trip. Using this information, attempts were made to identify the country's inland container transport systems. The study starts with the extension of container transport networks by ocean carriers and the changes in pricing structures for inland transport as compared to the conventional system. It continues with an analysis for the formalities of the inland container transport systems in intermodal movement and then explores the logistics of the inland move by carriers. Finally calculation of the inland container transport costs by individual modes is presented, and the choice of Inchon and Busan compared and contrasted.

6.2 THE EXTENSION OF CONTAINER TRANSPORT NETWORKS AND THEIR PRICING STRUCTURES

6.2.1 THE STRUCTURE OF TARIFFS IN THE INTERMODAL SYSTEM

> Intermodal transport brought with it a major challenge to shipping companies involved in the container trade. As intermodal movements grow in volume, shipping lines have been faced with the need to expand their operations beyond their traditional responsibilities at sea. With the advance of intermodal transport, shipping lines extended their interests from ship's rail to point of destination. As shipping lines participating in intermodal trade were the major initiators and promoters of intermodal movements[14], they had an initial advantage over other transport modes as far as cargo control was concerned (Hayuth, Y 1987).

With these benefits, shipping lines began to penetrate more aggressively the inland transport market beyond their traditional operating arena. This situation caused changes in conventional rates and led to the introduction of through rates.

The structures of pricing in the conventional system tended to support local port calls. Sea freight which were not differentiated by port[15] covered only the voyage, stevedoring labour in ship and port charges on the ship. The other costs of port labour, port charges on the cargo and inland transport, etc. were separately paid by the shippers and consignees (Gilman, S. 1983). Thus, for any given category of cargo, the differences in freight rates between the ports were either negligible or nil. Shippers would, therefore minimise through system costs by using a nearby port. Shipping companies competed

[14] Containerisation was introduced by the maritime transport industry and has served primarily this industry.

[15] Sea freight rates in the conventional system have been differentiated by commodity.

on service and would have to call regularly at any port whose hinterland they wanted to serve.

Under the intermodal transport system, carriers offer either a three part[16] or five part tariff[17] (see section 2.3.3). In both the three part and the five part system the shipper must take the sea freight plus port charges. The shipper is, however, given the option of breaking the system at the port gate and arranging for his own inland transport if he wants to. If the shipper breaks the system, he can either arrange his own transport using his own trucks, dealing directly with the inland modes, or he can use a freight forwarder. This is the merchant haulage option. Under this option the maximum number of inland moves may be one and a bit to four for one import or export box depending on whether the legitimate logistical system is oriented to the port or the shippers premises, and on whether a back haul can be found for empty boxes.

On the other hand, under the carrier haulage option the shipping line arranges all the inland transport and in some circumstances will absorb some inland costs. In the United States and Europe there is a lot of through movement under carriers control, in which the full three or five part tariff applies. In certain cases there is also absorption pricing applied to carrier haulage (see section 2.3.3 for a detailed explanation of absorption pricing). Under this system a carrier charges the inland transport on the basis of the closest port to the shipper, even if he calls at a port which is further away.

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[16] The three part tariff consists of sea freight, (which in this case includes the two terminal handling charges and takes the container from port gate to port gate), plus inland transport charges at each end of the route.

[17] The five part system consists of the sea freight, plus two terminal handling charges (THCs), plus two inland transport charges.

The carrier would then absorb the difference in inland costs. As mentioned previously the system was developed early on by the UK/Australia trade, following that the other major routes are adopting it. In the USA intermodal pricing by conferences was prohibited by law in the early years, but was legalised under the US Shipping Act of 1984.

6.2.2 KOREA'S INLAND CONTAINER HAULAGE ARRANGEMENTS AND RATE STRUCTURES

The previous section was concerned with a general review of commercial developments in intermodal transport. In this section, based on the developments we shall discuss inland haulage arrangements in Korea in the intermodal era. In Korea inland haulage arrangements can be classified into three options: *merchant haulage operated through freight forwarders, merchant haulage operated by exporters and importers themselves and carrier haulage by shipping lines.*

(1). MERCHANT HAULAGE OPERATED THROUGH FREIGHT FORWARDERS

In Korea most containers are carried inland under merchant haulage arrangements under the control of freight forwarders. The nature of the commercial arrangement is as follows:-

1. Shippers make a transport request to the freight forwarder who has a direct relationship with the ocean carrier.

2. The freight forwarder offers the inland movement under sub contractual relationships to the inland hauliers.

3. The inland hauliers will decide whether they carry containers by road, using their own equipment, or by rail service.

This is shown diagramatically below:-

Figure 6-1. Inland Container Transport Procedure in Korea

```
                                                   (3)  _______
                                                  --->|by Road|------------
                                                  |    -------            |
                                                  |                       |
                                                  |                       |
                                                  |                       |
 ________  (1)  ________________  (2) ______________          --------------
|Shippers|---->|Shipping company|--->|Inland haulier|        |Busan Terminal|
 --------        ---------------      --------------          --------------
   |                  |              | |                            |
   |                  |              | |                            |
   |(1)               |*             | | (3)  _______               |
   |                  |              | |_____|by Rail|______________|
 ----------------- ___|      (2)     |        -------
|Freight forwarder|-------------------
 -----------------
```

Source: Author's Investigation, May 1991.
Note;* is a case that freight forwarder acts for the shipping company's request.

Freight forwarders came into existence as commercial developers of Korea's land and water intermodal traffic in the early 1970s. During the first decade or so of their existence, they were constrained by the strictly regulated environment that characterised Korea's transport system as a whole. With the revision from strict licensing to a registration system in 1983 (table 6-1), the freight forwarders, relieved of their previous constraints, actively started to participate in intermodal traffics, especially in Korea's exports (see table 6-2). They deal with a great deal of the documentation and management and make the booking with the ocean carrier as well as the inland hauliers. They won the trust of shippers in Korea (Author's personal interview with the shippers 1991). Currently they are becoming a new competitive factor in the intermodal transport scene serving Korea's trades. In some senses, the freight forwarders, once the clients of ocean carriers, have become their competitors.

Table 6-1. The Number of International Freight Forwarders serving Korea's trades

Years\	New issue	Cancellation	Return	Total	Remarks
1976	26			26	First enforcement
1977	8			34	
1978	16			50	
1979	3	2	1	50	
1980	2		2	50	
1981		2	1	47	Issuing suspension
1982		2		45	
1983	6		1	50	Licence abolition
1984	12	1		61	Registration
1985	13			74	
1986		3		71	
1987	78			149	
1988	13			162	

Source: Korea's Freight Forwarders' Association (1987) and KMI (1988).

Table 6-2. Container Traffic moved Inland by Freight Forwarders serving Korea's trades,1977-1989(Unit: TEUs)

Years	Exports			Imports			Aggregate		
	Traffic	MTOs	MTO(%)	Traffic	MTOs	MTO(%)	Total	MTOs	MTO(%)
1977	237310	33052	14	170288	1250	1	407598	34302	8
1978	284240	51868	18	224907	4824	2	509147	56692	11
1979	314107	65176	21	278210	6872	2	592317	72408	12
1980	364260	87046	24	245821	11497	5	610081	98543	16
1981	413325	100518	24	273559	10572	4	686884	111090	16
1982	404241	98442	24	297305	9232	3	701546	107674	15
1983	449548	104921	23	340299	10697	3	789847	115618	15
1984	530742	139042	26	390151	13307	3	920893	152349	17
1985	565060	162871	29	421006	17420	4	986066	180291	18
1986	795120	253282	32	476051	26604	6	1271171	279886	22
1987	979379	389807	40	631868	33858	5	1611247	423665	26
1988	1133412	454166	40	757503	55651	7	1890915	507817	28
1989	1066643	507297	48	792387	87459	11	1859030	594756	37

Source: Korea Transport Institute(1991).

As shown in table 6-2, the involvement of freight forwarders as Multimodal Transport Operators(MTOs) serving Korea's trades in inland transport was greatly accelerated in the late 1980s. During the years 1977-1989, containerised export cargoes grew by 26% per annum while imports increased at the remarkably rate of 43%. In absolute numbers, total exports moved by MTOs increased from 33,052 TEUs in 1977 to 507,297 TEUs in 1989 and imports grew to 87,459 TEUs from 1,250 TEUs during the same period. The ratio of the volume carried by MTOs to total containerised cargoes grew significantly from 8.0% in 1977 to 37.0% in 1989. The strength of freight forwarders in export trades is clearly demonstrated in these figures.

Due to the merchant haulage arrangement in Korea's inland transport system, the carriers involvement and charging system go as far as the port (Busan and Inchon) gate. Presently the formal inland freight rates which have to be applied in Korea's inland container transport are presented in table 6-3, by individual mode.

Table 6-3. Inland Container Rates by Modes in Korea

(Unit: US$)

Route\Containers	20 FT		40 FT	
	Loaded	Empty	Loaded	Empty
Road				
Busan CY<-->Seoul	535.2	535.2	712.7	712.7
Inchon<-->Seoul	109.9	109.9	146.5	146.5
Railway				
Busan-->Seoul	137.4	68.7	233.5(*)	116.8
Seoul-->Busan	116.8(*)	68.7	233.5(*)	93.4(**)

Source: Korean Transport Institute(1991).

Notes : (1) Rates on road transport are constructed on round-trip basis.
(2) (*) and (**) on rail transport mean 15% and 20% discount.
(3) This tariff took effect from October, 1990.

As can be seen in table 6-3, container transport in Korea can be broken down into three networks; *Seoul<-->Busan CY by road, Seoul<-->Busan by railway and Seoul<-->Inchon Container Terminal by road.* The detailed procedures relating to these cases will be discussed later (section 6.3). This section now examines inland container rates in Korea in some detail.

Road transport tariffs are decided by mutual negotiation between the Korea Shippers' Council, representing the shippers, and the Korea Customs Association representing the road hauliers. From Busan CY to Seoul or vice versa, rates for 20ft and 40ft are US$ 535.2/20ft and US$ 712.7/40ft containers respectively, being constructed for the loaded plus empty container on round-trip basis[18]. The same principle is applied to Seoul<-->Inchon by road, the rates here also being constructed on a round-trip basis. For local service in Seoul, Busan and Inchon the contractor will be paid separate extra charge US$ 78.9/104.2 for 20ft and 40ft containers respectively (see table 6-4). For the shuttle service from Busan ODCY to BCTOC[19] or vice versa, the contractor will add US$ 31.0/20ft and US$ 40.9/40ft.

Table 6-4. Incidental Charges for 20/40ft containers in Seoul, Busan and Inchon(US$)

Items	Contents	20ft	40ft
Shuttle	Busan ODCY<->BCTOC	31.0	40.9
Local service	in Seoul, Busan and Inchon	78.9	104.2

Source: KTI(1991).

[18] This is based on the number of inland moves which is two for one import or export box in Korea. Container logistics system in Korea is originated to the port rather than the shippers premises and then the shipper use a forwarder with trucks stationed at the port.

[19] Off-Dock Container Yard(ODCY) and Busan Container Terminal Operating Company(BCTOC) will be in detail explained in sections 6.3 and 6.4.

In the case of railroads, rates are based on the 20ft container, and are proclaimed by the Office of Korean National Railroads(KNR). Discounts of about 15% are applied to loaded containers, except for 20ft loaded containers from Busan to Seoul. The main reason is to attract containerised cargoes from road to rail transport. There is an extra charge added for moving containers by rail; *Seoul<-- >Bugok railway station.* Total inland container rates in Korea including these shuttle charges for 20ft and 40ft containers on both road and rail transport between Seoul and Busan in 1990 are shown in table 6-5.

Table 6-5. Total Inland Container Rates by Modes between Busan and Seoul (Unit: US$)

Conts.\Class	Railway (1)	Incidental charge (2)	Total rates by railway	Total rates by road (3)
40ft(loaded)	233.5	136.8	370.3	712.7
(empty)	116.8(a)	105.7	222.5(a)	712.7
	93.4(b)	105.7	199.1(b)	
20ft(loaded)	137.4(a)	105.3	242.7(a)	535.2
	116.8(b)	105.3	222.1(b)	
(empty)	68.7	70.2	138.9	535.2

Source: (1) derived from Table 6-3.
(2) derived from KTI(1991).
(3) derived from Table 6-3.
Notes : (a) means from Busan to Seoul.
(b) means from Seoul to Busan.
(2) includes total incremental charges including shuttle, local service and handling costs for loading/unloading, etc.

From the above table, we can see that the rail is considerably cheaper than road transport. Despite this most containerised cargoes are being carried by truck operators. This is the result of a number of factors. First of all truckers offer direct service to locations not accessible to the main rail corridors, which otherwise would need a truck connection from a railroad station. Secondly, there is actually a large discount given by truck transport operators to their customers. In fact, they charge less than the two full moves. Where they obtain a back haul, they pass on the benefit to the shipper who does not have to pay for all of the empty return.

(2). MERCHANT HAULAGE OPERATED BY EXPORTERS AND IMPORTERS

The second system in Korea's inland container transport is that of merchant haulage operated by exporters and importers themselves. They arrange their own transport using their own trucks, dealing directly with the inland modes. They pick up cargoes at their premises and take it to Busan or Inchon port. Inland container transport procedures under this system are discussed later on section 6.3.

(3). CARRIER HAULAGE BY OCEAN CARRIERS

In recent times, carrier haulage has begun to develop in Korea. Since the late 1980s, Korean shipping companies, in particular Hanjin and Hyundai, have provided a regular and frequent inland transport service by road between Seoul and Busan. The road vehicles which start from Seoul and Busan, respectively generally meet at the intermediate point of Kimchon and exchange containers before returning in the original direction. This system was until recently permitted only for Korean lines. However, this position is now starting to change and some conferences now have a limited inland tariff. This is available for all cargo from Busan to consignees premises in the

Seoul area. This facility is not only for cargo currently on Busan Billing of Lading(B/L), but also cargo on Inchon B/L. Import rates are based on the loaded leg from Busan to consignee's premises in the Seoul area with return of empty containers to Bugok ICD near Seoul (covering Sungnam, Anyang, Banworl, Suwon, Osan and Pyungtack). The rates charged are US$ 328.5/US$ 438.5 for 20ft (heavy cargo) and 40ft containers, respectively (FEFC and Allied Freight Conference, Section 2-Terminal and Inland). Cargoes on a B/L with the place of delivery shown as Seoul only qualify for a limited carriers haulage scheme. If consignees request carrier haulage for cargo on Busan B/L, this is allowed. With respect to carrier haulage, carriers make concessions on the back haul to Busan and charge a reduced rate, although there is no absorption pricing as such applied in Korea's inland container transport system.

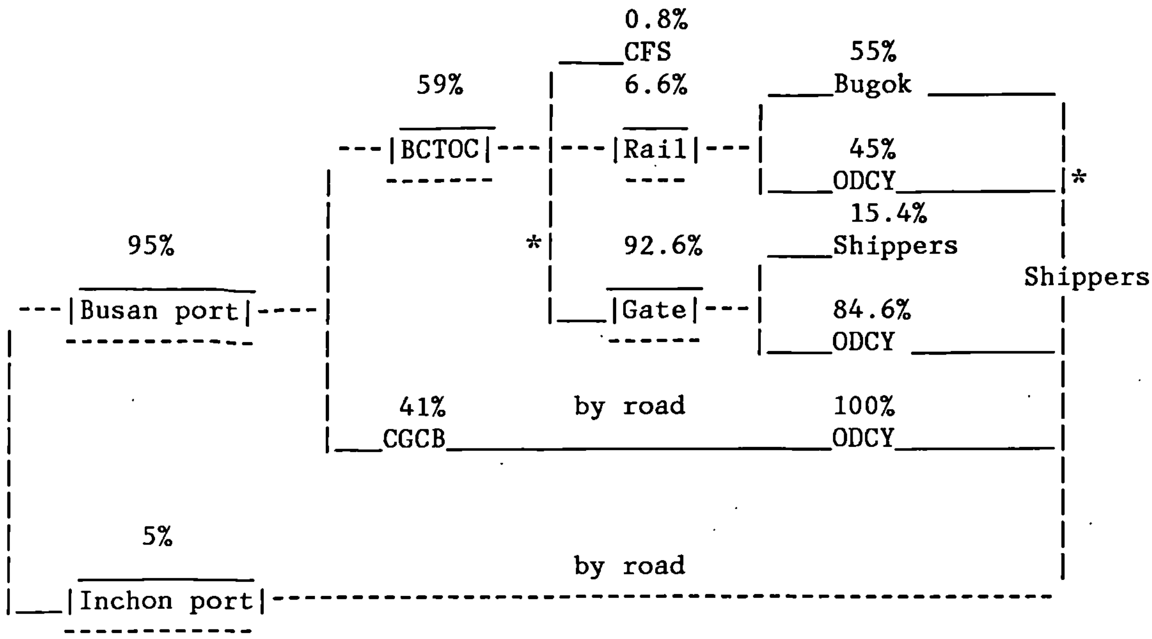
6.3 INLAND CONTAINER TRANSPORT SYSTEMS

In the previous section we have discussed the commercial arrangements in Korea's inland container transport and the rate structures applying. As noted in the section, freight forwarders serving Korea's intermodal market actively began to take part in the country's land transport leg after containers were introduced. Nowadays the number of boxes being carried inland by ocean carriers is increasing. In the end transport operators require the most cost-effective route for the development of Korea's intermodal transport system. The question becomes more important as volumes of container cargoes increase. Before proceeding to define the most efficient network, the present system in Korea will be described in a more detail. The structure of the inland container transport system in Korea is defined in figure 6-2.

As can be seen in the figure all containerised cargoes serving Korea's trades are handled by two ports, Busan and Inchon. Of them the former held 95% of the total in 1989 while the latter had 5%. During the same year Busan Container Terminal Operating Company (BCTOC) handled about 60% of all containerised traffic at Busan port. Because of its limited capacity the rest of the cargo was handled at the conventional berths. At conventional berths all containers are directly transported by road to the Off-Dock Container Yards(ODCY) scattered around Busan city. This is due to the extreme shortage of storage space at the berths.

At BCTOC 0.8% of containers went to the CFS inside the terminal for stripping, 6.6% moved directly to the railway between Busan and Seoul, and the remaining 93% passed through the gate by road. Of the traffics passing through the gate, only 15% was directly transferred to the shippers by road transport and the remaining 85% went to the ODCYs operated by 16 road hauliers. Thus Korea's inland container transport systems are largely dependent upon trunk haul by road from Busan with a little moving by combined modes, rail and road. They can be broken down into three networks: *BCTOC<-->Seoul by road, BCTOC<-->Seoul by rail* and *Inchon port<-->Seoul by road* (see figure 6-2). To grasp more clearly the situation of container distribution, it is useful to analyse the networks separately.

Figure 6-2. The Total System of Korea's Inland Container Carriage



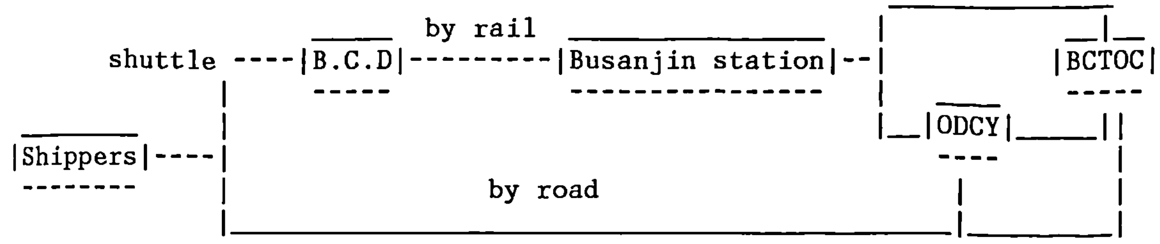
Source: KTI(1991).
Notes :(1) BCTOC(Busan Container Terminal Operating Company)
(2) CGCB(Conventional General Cargo Berth)
(3) CFS(Container Freight Station)
(4) ODCY(Off-Dock Container Yard)
(5) % is the proportion of container traffic in 1989.
(6) * mean the carriage by road.

6.3.1 BCTOC<--> SEOUL

In this section consideration is given only to BCTOC as the pivot port and CGCB is excluded due to the smaller proportion of container traffic handled at the berths every year. Based on figures 6-1 and 6-2, the inland container transport systems for import and export cargoes between Seoul and BCTOC are presented separately. These have different procedures in accordance with FCL (Full Container Load) and LCL (Less than Container Load).

(1). INLAND CONTAINER MOVEMENT FOR FCL EXPORT CARGO

Figure 6-3. Inland Container Carriage for Exports(FCL)



Source: The author's investigation, May 1991.

As shown in figure 6-3, inland container movements for exports(FCL) have a somewhat different form depending on the choice of road and rail. The order for the main body concerned is as follows:-

Main body concerned	by road	by rail
Shippers, freight forwarders and shipping company	(1) The shipper makes a transport contract with the shipping company or freight forwarder and stuffs cargoes into the empty container received from them. (2)Provided that he completes the custom formalities, the shipping company requests again the transport contract to domestic inland hauliers(DIH).	
Inland haulier	(3) The operator will have to decide whether he moves the container requested by road or rail.	
Bugok Container Depot(BCD)		(4) In case of rail, DIH requests freight van to the railway station in BCD and moves the container to BCD. (5) Hongikhae, a cargo handling company,handles container on the rail.
Busanjin Railway Station		(6) Some of containers moved by rail go to ODCY and the rest to BCTOC directly.
ODCY	(4) Containers moved by road were unloaded at ODCY, arranged and transported to BCTOC.	
BCTOC	(5) Container moved by road are stacked on the marshalling yard and then shipped on the vessel.	(7) Containers transported from Busanjin are unloaded, stacked on marshalling yard and then shipped on ship.

(2). INLAND CONTAINER MOVEMENT FOR FCL IMPORT CARGO

Figure 6-4. Inland Container Carriage for Imports(FCL)

```
               (1)  _________      by rail     ___          by road
            ______|Busanjin |______________|BCD|______________________
           |        ---------                ---                      |
           |                 |                                        |
           |                 |                                        |
 _____     |  (2)  _____     |             by road                 ___|___
|BCTOC|---|------|ODCY|------------------------------------------|Shipper|
 -----   shuttle  -----                                            -------
           |                                                          |
           |  (3)                      by road                        |
           |__________________________________________________________|
```

Source: The author's investigation, May 1991.
Notes : (1) carriage by rail.
(2) a case by road to the shipper after clearing customs at ODCY.
(3) a case carried by road directly to the shippers and cleared at the shipper's bonded area.

Inland container movements for imports(FCL) are provided by three types as shown in figure 6-4. The procedures are as following:-

Main body concerned	by road	by rail
BCTOC	(1) After the containers are discharged from the ship, they will be stacked on marshalling yard.(2) Cargo handling for road and rail transport, respectively.	
Inland haulier	(3) Container will be moved to ODCY or the shipper's bonded area.	(3) Shuttle service by rail or road to Busanjin railway station.
ODCY	(4) Some are stored at ODCY, cleared and transported by road to the shipper, the other carried by rail via ODCY.	
Busanjin		(4) Freight van for Seoul will be allocated by the request of the inland hauliers.
BCD		(5) Containers will be unloaded from the rail by the Hongikhae.
Inland haulier		(6) Containers will be moved by road to the shipper's bonded area.

(3). INLAND CONTAINER MOVEMENTS FOR LCL EXPORT CARGO

In most countries where containerisation is at an early stage and where individual consignments tend to be rather small, LCL containers account for a considerable share in container movements(UNCTAD 1984). In Korea where LCL export cargoes are transported to Busan terminal, they can be classified into two cases as noted in figure 6-5, depending on the place of the customs clearance necessary for the through transport of LCL containers. However, most LCL export cargoes are transported by road directly to BCTOC, or shipped to Busan ODCY, cleared on arrival and then shipped to BCTOC. There is an ample CFS area of 25,119 square metres excluding office space for the storage of customs-cleared cargoes in BCTOC. In exporting cargoes APL, Sea-Land, Hanjin, Hyundai, Choyang and Sukwang (freight forwarder) use the CFS, while in import container traffic all shipping lines are in a position to use it.

(4). INLAND CONTAINER MOVEMENTS FOR LCL IMPORT CARGO

Inland container movements for LCL import cargoes are of two types;

1. With customs formalities at consignee's premises(*).
2. With customs clearance at BCTOC or ODCY CFS(**).

This procedure is illustrated in figure 6-6.

Figure 6-5. Inland Container Carriage for Exports(LCL)

```
                                        stuffing
                                       _________
                                    __|BCTOC CFS|____
                                   |   ---------     |
 ________                          |                 |         _____
|Shippers|---Transport operator---->   stuffing      |________|BCTOC|
 --------(Bonded transport by road)|   ________      |         -----
                                   |__|ODCY CFS|_____|
                                       --------
```

Note: This is a type which is cleared at the shippers' premises.

```
                                 customs clearance & stuffing
                                            _________
                                 ---------|BCTOC CFS|--------------|
                                |          ---------               |
 ________                       |                                __|__
|Shippers|---Transport operator--->                             |BCTOC|
 --------    (Carriage by road) | customs clearance & stuffing   -----
                                |           ________               |
                                |__________|ODCY CFS|______________|
                                            --------
```

Note: This is the one which is cleared at BCTOC or ODCY CFS.

Figure 6-6. Inland Container Carriage for Imports(LCL)

```
                 stripping
                 _________
              __|BCTOC CFS|__                 clearing customs
  _____      |   ---------   |road transport  ________________    _______
*|BCTOC|-->      stripping   |------------->|Bonded warehouse|-->|Shipper|
  -----      |   ________    |by the operator----------------     -------
             |__|ODCY CFS|___|
                 --------


               stripping & clearing
                   _________
                __|BCTOC CFS|__________
  _____        |   ---------           | road transport by      _______
**|BCTOC|----> stripping & clearing    |--------------------->|Shipper|
  -----        |   ________            | the operator           -------
               |__|ODCY CFS|___________|
                   --------
```

6.3.2 INCHON CONTAINER TERMINAL<--> SEOUL

The flows of containers on the Inchon <--> Seoul route are much smaller than those from Busan to Seoul. In spite of its proximity to Seoul, around 40km west of the nation's capital, congestion on this route causes a serious problem and this is likely to remain so. As a result it takes about 3 hours by road between Inchon terminal and Seoul.

As mentioned previously the port of Inchon carries only 5% of the nation's container cargo. Of this almost 95% goes to or comes from the Kyungin regions (including Seoul) whose boundary is within 50km. Thus Inchon port has its own clearly defined and fairly localised hinterland. Its nearness to Seoul is also a significant factor in its development as a major industrial port. Although the port has the most heavily developed, industralised and densely populated hinterland area in Korea, it does not act as a gate-way for Seoul, most container traffics from Kyungin industrial zone using Busan terminal via the 430km long inland transport routes (see section 4.3).

The container traffic statistics of the port of Inchon show that the port serves Intra-Asian and Japan-Korea trades and in-bound FCL traffic more than out-bound (see table 6-6 and chapter 4). As the inland container movements for FCL import/export cargo between Inchon port and Seoul have the same procedures as illustrated in figure 6-2, detailed explanation is not required in this section.

The inland rates on this route by road are mutually negotiated between the Korea Shippers' Council and the Korea Customs Association representing the road hauliers. The inland charges for 20ft and 40ft will be US$109.9/20ft and 146.5/40ft containers respectively, being equally applied for the loaded or empty containers and the rates being charged on a round-trip basis. For local service in Seoul and Inchon the contractor will be paid an extra charge US$ 78.9/US$ 104.2 for 20ft and 40ft containers, respectively (see tables 6-3 & 6-4).

Table 6-6. Container Traffic handled at Inchon port, 1978-1989
(Unit: TEUs)

Class\Years	1978	1980	1982	1984	1986	1988	1989
Import	26064	32949	35051	62371	57067	84109	60707
Export	21501	26609	29198	38017	44111	66235	54964
Total	47565	59558	64249	100388	101178	150333	115674

Source: KTI(1991).

6.4 LOGISTICS OF THE INLAND MOVE

Having dealt with through movement with regard to FCL and LCL cargoes, the question of empty movements has to be dealt with. For analytical convenience the analysis is confined to FCL cargoes and the BCTOC <--> Seoul route.

In case of export boxes empty containers are picked up from Bugok Inland Container Depot (ICD) which is 35km away from Seoul (see figure 6-7). These are loaded at shipper premises, moved to Busan port and then stationed at the Off-Dock Container Yards (ODCY) scattered around Busan city. For import cargo loaded boxes are picked up at Busan port, taken to the shippers' premise and then the empties are sent to the Bugok ICD. In both cases freight forwarders with trucks usually take part in and have a direct and close contractual relationship with the shippers and carriers (see figure 6-1).

Figure 6-7. The Location of Bugok Inland Container Depot

```
                          . Seoul                        ---
Kyungin expressway |                                      |
        .          |  1 highway                           |
    Inchon         |                                      |
                   |                                      |
        42 highway . Anyang                               | 35km
                   |                                      |
                   |          . Kwachon                   |
             Kunpo .  47 highway                          |
                   |                                      |
  _________        |                                      |
 |Bugok ICD|*------|                                     ---
  ---------        |
                   . Suwon
                   |
                   | To Busan
```

Of special concern is the existence of the Bugok ICD. This was established near Seoul in 1984 by Korean National Railroads (KNR) and its aim was to attract more traffic from road to rail. The ICD is presently being operated by the individual parties concerned, viz. KNR, 16 domestic inland hauliers and the Hangikhae stevedoring company. The KNR undertakes only the trunk haulage and leaves the local distribution to road hauliers. The Container Yard (CY) is leased to the 16 inland road hauliers, among which only Saebang can use the CFS. The handling facilities are leased and operated by Hongikhae. The facilities and handling equipment at Bugok ICD are shown in table 6-7.

Table 6-7. Facilities and Handling Equipment at Bugok ICD

Classification	Scale
CY	189,451 square metres
CFS	3,600 square metres
Transtainer	2
Top-handler	8
Fork-lift	14
Tractor	8
Chassis	8

Source: KMI(1988).

Inland clearance depots, or inland container depots (ICDs) have been a noticeable feature of the development of containerisation. ICDs throughout the world were established to improve the efficiency of inland transport, and reduce the ever-growing congestion in the land areas around major ports due to the lack of available back-up space for handling the increasing volume of container flows (Hayuth, Y. 1987). Hayuth described the role of the ICDs stating:-

> One manifestation that has developed over the past decade and has become a major element in the overall transport chain, is the concept of an inland container port. Variously called inland container port or terminal, the implementation of the concept has affected trade-flows, specific routings between ports and hinterlands and some traditional port functions (Hayuth, Y 1980).

According to UNCTAD multimodal transport and containerisation (1984), the main functions of ICDs may include as following:-

1. customs clearance of containers
2. transfer of containers between various modes
3. temporary storage of containers and cargoes
4. stuffing and stripping of containers
5. consolidation of LCL cargoes
6. positioning of containers
7. maintenance and repair of containers.

Among those listed, customs clearance of containers, transfer of containers between various modes, temporary storage of containers and cargoes, stuffing and stripping of containers, consolidation of LCL cargoes and positioning of containers are the typical functions in ICDs. Unfortunately most of these functions are not performed at Bugok ICD. It is being used just for empty container stock holding for the shippers in the Kyungin regions. As mentioned previously, the 16 trucking companies use their space in Bugok ICD as storage for containers. Most of these containers are moved by road. The rights and responsibilities of operating the depot are spread among the companies, and thus depot operation is not efficient. This is ultimately the result of lack of attention on the part of Korean policy-makers and public officials. Government controls many aspects of transport but has had no policy for this sector.

Another concern is the scatter of the ODCYs around Busan. The reasons for this are that Busan port does not have the enough capacity to handle the increasing container volume and it does not meet the demand for space for the container yards required for the storage of containers, stuffing and devanning of containers and customs clearance. This has led to the dispersion at a multitude of ODCYs within Busan city. At present there are 34 ODCYs operated by the 16 inland road hauliers within Busan city, with 1,153,287 square metres of space (KMI 1990). Shippers in the southern regions of Seoul (Daegu, Busan and Chunjoo, etc.) also have to pick up their empty containers from the ODCYs. Their main functions are as follows:-

1. Receiving of full export containers from the shippers
2. Delivery of full import containers to consignees
3. CFS service, inbound and outbound
4. Receiving, storage and delivery of empty containers
5. Repair and maintenance of containers
6. Long term storage of containers, mostly empty units.

The lack of the systematic linkages between the scattered ODCYs and Bugok ICD has caused delays. Connection by rail and road has been complicated and the cargoes must wait for the available transport means. Delays in customs clearance also frequently occur.

So far we have dealt with the haulage arrangements in inland transport, the rate structure for the system and the present structure of inland container transport system in Korea. It is shown that in inland haulage agreements three options, i.e. merchant haulage operated through freight forwarders, merchant haulage operated by exporters and importers themselves and carrier haulage by shipping lines are applied. Nowadays a moderate number of containers in Korea's liner trades are being moved inland under carrier haulage rather than merchant haulage and it is expected that this trend will accelerate in future. With regard to the present logistics of the inland move there are a number of problems, especially at Bugok ICD and the ODCYs around Busan. The inefficient operation of Bugok ICD and the scatter of ODCYs within Busan city create serious bottlenecks in Korea's inland container transport system. These are the serious consequences of failure of government to provide adequate container handling facilities. These problems will be considered in more detail later on.

6.5 COSTS OF INLAND TRANSPORT BY MODE

Following the general review of inland transport systems and in order to evaluate the economic options for the future, we shall proceed to compute the cost of the individual modes for the inland carriage of containers. For analytical convenience, a 20ft and a 40ft FCL container are adopted as the basic unit. The analytical task is carried out by selecting several important routes and subjecting them to a comparative costing analysis. The costing method broadly follows Gilman, S. et al (Container Logistics & Terminal Design 1981) although the assumptions differ in detail.

6.5.1 ROAD HAULAGE COSTS

In road transport two routes are chosen for comparative analysis:

1. Seoul <--> BCTOC via ODCY.
2. Seoul <--> Inchon Container Terminal.

As described previously these routes have considerable importance and now constitute the backbone of the inland transport systems for the carriage of containers (see figure 6-2). The former can be classified under two main segments, i.e. *trunk haulage cost, handling costs at ODCY* whereas the latter falls into one, *trunk haulage cost*[20].

[20] Terminal costs at the ports are excluded because these are included in the charges of the ocean carriers, (sea freight under a three part system and THCs under a five part system).

(1). TRUNK HAULAGE COSTS

In road transport[21] the items of which costs are made up are the capital cost of road vehicle, the costs of crew, tyres, fuel, oil, vehicle repairs and maintenance, road maintenance and administration, etc. Following Garrat, M.G. (1980) the following assumptions are made:-

1. Truck/trailers for the carriage of a 20ft and a 40ft container will be used.
2. The truck/trailer will have a service life of 8 years.
3. A truck is operational for 300 days per annum.
4. An average annual distance is 141,900km on Seoul<-->BCTOC(473km) and 48,000km based on roundtrip on Seoul<-->Inchon(40km).
5. Average load will be 90 percent of loading capacity.

Capital Costs

Strictly speaking, the term "capital cost" refers to a vehicle's initial building cost. In this analysis data was available in the field trip. All kinds of truck/trailers are made in Korea and their costs were published in "equipment prices" by KMI (1988). The building prices quoted in Korean currency have been converted into US dollars on the basis of the annual average exchange rate. Since prices were published in 1988 inflation has to be taken into account. The rate of inflation for Korea during the period of 1988/90 is taken to be that of the price index of manufactures. The average annual rate in the period was about 7.9% (see table 6-8).

[21] The initial capital cost of road construction is considered as a sunk cost in this study.

Table 6-8. Change of Producer Price Index in Korea

Year	Producer price index	% change
1985	100	.
1986	120.7	17.2
1987	143.6	15.9
1988	162.7	11.7
1989	171.2	5.0
1990	192.1	10.9
Average annual change(1988/90)		7.9

Source: KMI(1991).

The building prices are converted into present value in 1990. The estimated truck/trailer's capital cost can be annualised by using an annuity factor. A discount rate of 10% in real terms is chosen to calculate the annuity factor. It is assumed that the average truck/trailer life is 8 years with negligible scrappage value. An annuity factor of 5.3349 is obtained for 10% at 8 years. Dividing the truck, trailer's price by this annuity gives an annual capital cost of each item of equipment as can be seen in table 6-9.

Table 6-9. Annual capital cost of the selected truck/trailer

	(1) Building (a)price(Wm)	(2) Annual exch. rate US$1.00	(3) 1988 value(us$)	(4) 1991 price(US$)	(5) Annual cap.(US$)
Truck CW50 GTL 53T	40.2	684.1	68541.5	72650	13618
Trailer 40ft PCT	8.2	684.1	13981.2	15480	2902
Trailer 20ft PCT		684.1	(*)11200.9	12000	2249

Source: (a) derived from KMI(1988).
Note : (1) W means Korean currency.
(2) * means an estimation of trailer and generally trailer for a 40ft box has a slightly more expensive than a 20ft.

The driver and his wages

The driver's wages and benefits are computed by the annual salary and fringe benefit package on a per-hour basis. Drivers' wages differ significantly from country to country but the wage level in Korea is in the middle class and the annual cost for each crew member is taken to be USS19000 (see table 6-10).

Insurance cost

Road transport can be highly dangerous. In order to provide protection against a physical loss or damage to the vehicle and liability to third parties, most truck companies self-insure. This cost varies appreciably by region and vehicle ownership, as well as by type of operation, while it is also a function of vehicle's size and condition. Self insurance usually accounts for 5-10% of the initial capital cost. In this study a percentage of 5 is used and it is based on annual insurance cost (see table 6-10).

Table 6-10. Vehicle's annual insurance cost(unit: US$)

	Annual capital cost	Annual cost per head	Annual insurance
Truck	13618	19000	826
Trailer(for 40ft)	2902	.	.
Trailer(for 20ft)	2249	.	.
Total	16520(40ft) 15867(20ft)	19000	826

Source: derived from table 6-9.

Tyres

Tyre costs vary with a number of factors that are not directly related to speed, i.e. braking, accelerating, cornering and the road surface. Thus it has been treated as a fixed cost per kilometre. Based on Gilman, et al. (1981) and UNCTAD (1984), it is assumed as a price of US$ 4800 per set of 18 tyres and a lifetime performance of 100,000km on asphalt surface, and this is taken as a fixed cost (US$ 0.048) per kilometre.

Fuel

Fuel cost is computed by multiplying the fuel price per litre by average fuel consumption per kilometre. Fuel costs are based on a study of fuel consumption carried out in UNCTAD (1984). This assumed a fuel consumption of 50 litres per 100km and a diesel price of US$ 0.40 litre (excluding tax). However, the end of 1990 was a period of fuel surplus and rapidly decreasing prices in Korea. The fuel costs used in this study are those prevailing at the end of the year in the country. A fuel consumption of 0.50 litre per kilometre is taken and a price of US$ 0.35 per litre. This represents a cost of US$ 0.18 per kilometre.

Maintenance and repairs of vehicles

The maintenance and repair cost of vehicles varies significantly with the driver's dexterity, the vehicle's degree of obsolescence, traveling conditions and climate, etc. but it is generally considered as a fixed proportion of an average annual capital cost. In the study it is assumed to be 13% of the vehicle's annual capital cost on the basis of UNCTAD (1984). The vehicle's annual maintenance and repairs cost per kilometre is computed as follows:

```
Annual capital cost x 13.0% / total traveling distance per year
=US$ 0.033(Seoul<-->Busan) and US$ 0.098(Seoul<-->Inchon) per km(a 40ft).
=US$ 0.031(Seoul<-->Busan) and US$ 0.096(Seoul<-->Inchon) per km(a 20ft).
```

Maintenance costs of developing & maintaining the road network

These costs are occurred to maintain and repair the parts of road. The maintenance activities include cutting grass and brush, repairing and grading the surface, replenishing materials, repairing and reshaping the shoulder, repairing pavement and sealing, and applying single surface treatment and overlay of concrete asphalt. These can be changed by different conditions, so it is very difficult to determine the exact cost of maintenance. Fortunately, the Korean Highway Corporation provides useful data from which figures for maintenance costs of the road network per route[22] may be derived (C.H.Cho 1992). The costs based on weight(tons) are calculated by vehicle per kilometre as follows:-

[22] All vehicles in Korea have to pay the road vehicle licence fees whenever using the highway.

1. Small truck (under 2.5 tons): US$ 0.029 per km
2. Ordinary truck (2.5 to 10 tons): US$ 0.033 per km
3. Large truck (over 10 tons) : US$ 0.066 per km

So far we have computed the items which constitute the trunk haulage costs. The inland haulage costs of individual options can be computed by determining a haulage rate between Seoul and Busan (Inchon), and multiplying this rate by the volume of units expected to move between those routes. Based on this criteria, the directly attributable cost of carrying a 20ft container by trunk haulage using road between Seoul and Busan (Inchon) terminal, respectively is shown as follows:

1. Fixed costs per year(capital+wage+insurance): US$ 35693(one driver)
2. Variable costs per km(tyres+fuel+vehicle's maintenance and repairs): US$ 0.259/km(S<->B), US$ 0.324/km(S<->I)[23]
3. General administration[24](quasi-variable cost): US$ 4346.7(S<->B), US$ 3074.7(S<->I)
4. Cost function(CF) per vehicle(US$)

   Seoul<-->Busan=> 37834.6 + 0.274CD(CD; carrying distance)
   Seoul<-->Inchon=> 37834.6 + 0.343CD

5. Cost function per TEU

   Seoul<-->Busan => 70.1 + 0.30CD
   Seoul<-->Inchon=> 17.5 + 0.38CD

6. Trunk haulage cost by road vehicle per TEU between Seoul and Busan (Inchon)terminals:

   Seoul<-->Busan=>70.1 + 0.30 X distance(km)= US$ 211.3
   Seoul<-->Inchon=>17.5 + 0.38 X distance(km)=US$ 47.9

[23] S<->B and S<->I mean the routes between Seoul and Busan(Inchon), respectively.

[24] This is estimated to be 6% of fixed and variable costs.

As can be seen the above formula does not take into account the cost of infrastructure. The trunk costs by road for a 20ft container between Seoul and Busan/Inchon are computed as US$ 211.3 and US$ 47.9, respectively. Based on the same assumptions and methods, the trunk costs by road for a 40ft box between Seoul and Busan/Inchon are US$ 284.6 and US$ 66.9, respectively.

(2). COSTS AT THE ODCY

As mentioned above most containerised cargoes in the Seoul region are moved to BCTOC via ODCYs scattered around Busan city. It is, therefore, necessary to take into account the costs incurred at these ODCY. These constitute the capital cost of the equipment, labour, fuel, tyre, repairs and maintenance, and general administration, etc. This is computed on the basis of the same principles and assumptions as the trunk haulage cost by road. Annual throughput at ODCYs is taken to be 50,000 TEUs in 1990. Firstly, annual capital costs of each item of equipment are shown in table 6-11.

Table 6-11. Equipments at ODCY and the annual capital cost(US$)

	(1) No	(2) Price (Wm)	(3) Making year	(4) Life-time (years)	(5) Annual exch. (US$)	(6) Making price (US$)	(7) Present value (US$)	(8) Annuity factor at 10%	Total annual cap.
Transtainer	2	454.0	1988	20	684.1	663646	774077	8.5136	189110
Top-handler	1	318.0	1988	15	684.1	464844	542194	7.6061	76518
Forklift	7	109.0	1988	5	684.1	159333	185846	3.7908	433944
Tractor	3	40.2	1988	3	684.1	58763	68541	3.4869	86253
Chassi	9	8.2	1988	9	684.1	11987	13982	5.7590	25785
Total	22								811610

Sources: (1)(2)(3) adopted from KMI(1988).
(4) estimated from Adler, H.A.(1987).
(7) derived from the present value formula.

The labour cost for driver and repairman

Labour costs can be classified into two elements; drivers and the repairmen. It is usual for there to be two drivers per vehicle and a repairman every four vehicles. As mentioned previously, the driver's wage level in Korea is in the middle range whilst a repairman's wages are a little lower. It is assumed that the annual cost for each driver is US$ 19000 and for each repairman US$ 15000. Table 6-12 shows the annual labour cost of each of those equipments.

Table 6-12. Labour costs for the selected equipments(Unit: US$)

	No.of driver (per vehicle)	Total driver	Repairman	Annual cost for driver	Annual cost for repairman	Total annual cost
Transtainer	2	4	1	76000	15000	91000
Top-handler	2	2	1	38000	15000	53000
Forklift	2	14	2	266000	15000	296000
Tractor	2	6	1	114000	30000	129000

Source: derived from table 6-11.

Fuel, Lubricants and Tyre cost

Fuel costs are based on fuel consumption of 240,000 litre at ODCY per year. The fuel price per litre is taken to be US$ 0.35 in 1990. The consumption of lubricants may be treated in a similar way to fuel consumption although it is highly dependent upon vehicle make and working conditions. Lubricating oil may be seen as a fixed proportion (28%) of the fuel cost (UNCTAD 1984). A figure of 28 percent of fuel costs is taken by this study. Tyre wear and replacement is the subject of much technical investigation and in the study about 100 tyres per year are assumed to be used on the basis of a price of US$ 240 per tyre. The result of the calculation of annual equipment costs at ODCY is as follows:-

1. Fuel cost: 240000 litres X US$ 0.35 per litre = US$ 84000
2. Lubricants: (1) X 28% = US$ 23520
3. Tyres: 100 tyres X US$ 240 = US$ 24000

We have discussed the items which constitute the costs at the ODCY. The cost for both 20ft and 40ft boxes at the ODCY can be obtained by summing up the items and dividing the total costs by annual throughput (see table 6-13). With annual throughput based on the 40/20ft split, the result is a cost of US$ 22.8 for a 20ft box and US$ 34.3 for a 40ft box at ODCY.

Table 6-13. The cost for a 20ft box at ODCY

1. Fixed cost(US$) per annum	
capital	811610
wage and labour cost	569000
Total(a)	1380610
2. Variable cost(US$) per annum	
fuel	84000
lubricants	23520
tyre	24000
equipment's repairs & maintenance*	105509
Total(b)	237029
3. Quasi-variable cost(US$)(a)+(b)**	97058
4. Total Cost at ODCY(US$)(1)+(2)+(3)	1714697
5. The Cost(US$) per TEU at ODCY	22.8

Notes: * is assumed to be 13% of average annual capital cost.
** is estimated to be 6% of fixed and variable costs.

6.5.2 RAIL TRANSPORT COSTS

For the rail transport cost the following segments need to be analysed:- the linehaul costs between Bugok and BCTOC, transhipment costs at Bugok ICD and collection/delivery costs by road between Seoul and Bugok. As mentioned in section 6.3.1 this is a typical route for the rail carriage of containers in the inland transport systems between Seoul and BCTOC.

(1). LINE-HAUL COSTS

For the rail line-haul operations between Bugok and BCTOC, the following assumptions have been taken.

1. Trunk operation is direct between specially constructed liner train terminal(BCTOC) and Bugok ICD.
2. The 20ft/40ft container forms part of a train of 25 wagons each wagon carrying 2 TEUs/FEUs.
3. The trunk haulage is by heavy duty diesel locomotive(3000 bhp) working under express freight train and the average speed on the line is 70km an hour for freight trains.
4. The locomotive and container carrying wagons will have lifetime 15 years.
5. The average annual distance is 153300km between Bugok and BCTOC(420km) and a single carrying traffic will be 90% of carrying load.
6. Container movements are carried out only during night time, after loading and unloading containers during day time and then a freight train per day is run between Bugok and BCTOC.
7. Locomotive is available at Susek rail station near Seoul and on arrival at Busan it is separated from the wagons to haul other freight wagons or passenger services.

Capital costs

For the analysis of this study the capital cost of the equipments is taken from "equipment prices" obtained in the field trip. The locomotives and wagons were all built in Korea and thus their capital costs are measured by the same "Korean Criteria". The building prices are converted into present value (US$) in 1990. The estimated diesel locomotive and wagons' capital cost can be annualised by using an annuity factor. In order to compute the factor a discount rate of 10% in real terms is adopted. It is assumed that the average locomotive and wagon's life is 15 years. They are assumed to be in service 365 days per annum with two shifts on a roundway basis. The annuity factor is 7.60608. Thus locomotive and wagon's annual capital costs are shown in table 6-14.

Table 6-14. Locomotive and wagon's annual capital costs

	(1) Building prices (mW)	(2) Year build	(3) Annual exch.rate (us$1.00)	(4) Building price (m$)	(5) Present value (m$)	Annu. capit. (us$)	Total annual capit.
Diesel locomotive (3000 bhp)	1430	1988	684.1	2.1	2.4	341831	341831
Container carrying wagon	45	1988	684.1	0.07	0.08	10518	262950

Source: (1)(2) derived from "equipments prices" published in KMI(1988).
(5) calculated from the present value formula.

Train crew

There is a fixed relationship between type of train and number of crew. Like most of the railways in the world there are two persons on the locomotive, " Driver" and " Assistant Driver" and in addition Korean trains have a " Guard". All are public service personnel with their wages controlled by the government and maintained at a level lower than that of truck drivers. The wages and benefits may be calculated by the annual salary. The annual cost for each person is calculated in table 6-15.

Table 6-15. Total annual labour cost(Unit: US$)

	Monthly	Annual cost per head	Total annual cost with shift
Driver	1410	16920	33840
Assistant driver	990	11880	23760
Guard	1130	13560	27120
Total	3530	42360	84720

Fuel and Engine/Lubricating oils

In the case of rail transport in the study it is assumed that fuel and power consists of diesel. With regard to the estimation of fuel consumption in rail transport, Hide, H. (1983) suggested an approach. That is to use technical relationships of tractive effort and resistance to predict the balancing speed on a section of line. The tractive effort required is, then, converted to power consumption. However, he proved himself that it is in practice very hard to observe the actual fuel consumption due to the technical relationships for reasons of driver quality, carriage and locomotive brake condition and operational practices.

Multimodal Transport and Containerisation (UNCTAD 1984) indicated that 4-7 litres per train kilometre is utilised while Gilman, S. et al (1981) suggested 4 litres per km for main diesel is actually consumed. In this study the latter figure is taken. Based on a price of US$ 0.35 per litre this represents a cost of US$ 1.4 per kilometre. Further to this, the consumption of engine oil may be treated in a similar way to fuel consumption although it is highly dependent upon vehicle make. Engine oil is normally considered as a fixed part (about 15%) of the fuel consumption (Hide, H. 1983) and computed as US$ 0.21 per kilometre.

Repairs and maintenance of rolling stock and vehicles

The repairs and maintenance costs for all fleet assets may be broken down into routine, minor and major overhaul. Each activity requires labour, materials and workshop facilities while the former normally represents a joint cost allocated over the total vehicle stock and treated on a proportional basis. Railway undertakings as well as road transport tend to impose a fixed repairs and maintenance policy based-on distance run, hours run and age in years, etc. It is in general treated as a fixed proportion of annual capital cost which in the study is taken to be 12% based on historical data compiled in Korea. The repairs and maintenance cost of rolling stock and vehicles per km are calculated as follows:-

Annual capital cost X 12% / total distance run(km) per year
= US$ 0.47 per kilometre.

Maintenance and renewal costs of routine track

These costs are occurred to maintain and repair the main line. In Korea, the maintenance costs of rail are calculated to be about US$ 0.014 per ton-km in 1990, which is based on annual rail maintenance costs of Kyungbu railway line and rail container traffic per annum.

Other costs (signalling operation and station operation costs) for rail transport are excluded in this analysis due to the lack of the exact data, but they are likely to be of small magnitude.

So far we have dealt with the elements which constitute the line-haul costs. If we calculate the costs by rail between Bugok and BCTOC, it can be obtained by summing up the total items and dividing them by the distance and carrying volumes. Based on the case of road transport the result is presented in the following formulas. As can be shown below, it does not take into consideration the costs of infrastructure which include rail maintenance, signalling operation and station operation. No allowance has been made for them because they are not likely to be greatly affected in the study. Based on the assumptions the line-haul cost by rail for a 20ft box between Bugok and BCTOC is computed as US$ 65.6. Under the same assumptions and methods the result for a 40ft box is calculated as US$ 117.1.

1. Fixed costs per annum(capital and labour costs): US$ 689501
2. Variable costs per km(fuel, oil and repairs/maintenance): US$ 2.08
3. Quasi-variable cost[25]: US$ 60502
4. Cost Function per rolling stock/vehicle = > 730871 + 2.21 D(D;distance)
5. Cost function per TEU = > 44.5 + 0.05 D
6. Line-haul cost per TEU by rail between Bugok and BCTOC = > US$ 65.6

[25] It is assumed to be 6% of fixed and variable costs as has been estimated in the example of road transport.

(2). THE TRANSHIPMENT COST AT BUGOK ICD

As mentioned previously, in case of using rail transport all containerised cargoes are carried via Bugok ICD to their destinations. Thus it is a matter of course to calculate the costs incurred at Bugok ICD which constitute the equipments' capital, labour, fuel and oil, tyre, repairs and maintenance, and general administration. The computation for the costs can be taken by classifying the cargo handling equipments at the place. As described in section 6.4, for rail transport operation Bugok has equipped with 2 Transtainer (T/T), 8 Top-handler, 14 Fork-lift, 8 Tractor and 8 Chassis. The computing method follows the same principles and assumptions as analysed the costs at ODCY and the result is presented in tables 6-16, 17 and 18. As can be shown in table 6-18, without taking into account the costs of infrastructure, the cost for a 20ft box at Bugok ICD is calculated as US$ 15.7. Under the same conditions the result for a 40ft box is a cost of US$ 20.8 at Bugok ICD.

Table 6-16. Total annual capital costs for equipment at Bugok ICD

	(1) No.	(2) Building price (Wm)	(3) Life-time (years)	(4) Annual exch. (US$1)	(5) Present value (US$)	(6) Discount rate	(7) Annuity factor	Annual capit. (US$)	Total annual cap.(US$)
T/T	2	454	20	684.1	774077	10%	8.5136	94555	189110
T-H	8	318	15	684.1	542194	10%	7.6061	76518	612144
F-L	14	109	5	684.1	185846	10%	3.7908	61992	867888
Tra.	8	40.2	3	684.1	68541	10%	2.4869	28751	230008
Cha.	8	8.2	9	684.1	13982	10%	5.7590	2865	22920

Sources: (1) derived from section 6.4.
(2) derived from "equipment prices".
(3) derived from Table 6-11.

Table 6-17. Labour costs for operation of equipments at Bugok ICD

	*No.of driver (per vehicle)	Total driver	Repairman	Annual cost for driver (US$)	Annual cost for repairman (US$)	Total annual cost (US$)
T/T	2	4	1	76000	15000	91000
T-H	2	16	2	304000	30000	334000
F-L	2	28	4	532000	60000	592000
Tractor	2	16	2	304000	30000	334000

* derived from Tables 6-12 and 16.

Table 6-18. The cost for a 20ft box at Bugok ICD excluding costs of infrastructure(Unit: US$)

1. Fixed cost per annum	
capital	1922070
wages and benefits	1351000
Total	3273070
2. Variable cost per annum	
fuel(a)	126904
lubricants	12690
tyre(b)	33600
repairs and maintenance of the equipments	249869
Total	423063
3. Quasi-variable cost	221768
4. Total costs(1)+(2)+(3)	3917901
5. The cost per TEU[(4)/annual throughput]	15.7

Sources: derived from Tables 6-16 and 17.
(a)(b) derived from "equipment prices".
Notes : (2)(3) are based on the same assumptions as analysed the costs at ODCY(see table 6-13).

(3). COLLECTION/DELIVERY COST BETWEEN SEOUL AND BUGOK

Rail system costs to the trunk route and terminal have been calculated, but in order to compare rail/road with pure road haulage, it is necessary to include the road system costs attributable to delivery between Seoul and Bugok ICD. This is no more than an arbitrary attribution of costs so the delivery elements of the road transits can be treated alike as analysed in trunk haulage costs by road (see section 6.5.1). The collection and delivery by road in the study involves only one operation at each end and the average annual distance per truck is 42,000 km on the basis of roundtrip between Seoul and Bugok.

The costing method and assumptions follow the same criteria as computed the costs at trunk haulage by road and the result is shown in the following formulas based on section 6.5.1. As seen in the formulas below, without taking into consideration the costs of road infrastructure, the collection and delivery cost for a 20ft box by road between Seoul and Bugok ICD is computed as US$ 40.3. Based on the same principle as a 20ft box, the cost for a 40ft box between Seoul and Bugok by road is US$ 62.3.

1. Fixed costs per annum(capital + wages + insurance): US$ 36346
2. Variable costs per kilometre (tyres + fuel + vehicle's repairs and maintenance): US$ 0.273 per km
3. General administration cost per annum: US$ 2868.8
4. Cost function(CF) per vehicle(US$): 38526.8 + 0.289CD
5. Cost function per TEU: 35.7 + 0.38CD
6. Delivery cost per TEU by road between Seoul and Bugok ICD: US$ 40.3

6.5.3 COMPARISON OF TOTAL COSTS IN INLAND TRANSPORT SYSTEMS

A comparison of the total costs for the selected routes with an indication of the relative importance of trunk and depot costs is shown in table 6-19, where the assessed costs for both 20 and 40ft boxes are given for the distances between Seoul and Busan/Inchon, respectively. For a general indication of comparative cost efficiency, the costs of a 20ft box and a 40ft for the various distances are the appropriate indicator in the study and it can be obtained by summing up the costs incurred at each section. The table shows the contents of rail and road transport costs at a selected distances and indicates the marked difference between the composition of those costs.

Table 6-19. Relative total costs and rates for both 20 and 40ft boxes between Seoul and Busan/Inchon(Unit: US$)

Costs\ Routes	Seoul<-->Busan				Seoul<-->Inchon	
	Rail		Road		Road	
	(20ft)	(40ft)	(20ft)	(40ft)	(20ft)	(40ft)
1. Trunk transit	65.6	117.1	211.3	284.6	47.9	66.9
2. ODCY			22.8	34.3		
3. Bugok ICD	15.7	20.8				
4. Collection/delivery	40.3	62.3				
Total costs	121.6	200.2	234.1	318.9	47.9	66.9
Total rates	222.1(S->B)	370.3	535.2	712.7	109.9	146.5
	242.7(B->S)	370.3				

Sources: (1) derived from section 6.5.1-(1) and 6.5.2-(1).
(2) derived from Table 6-13.
(3) derived from Table 6-18.
(3) derived from section 6.5.2-(4).
Note: Total rates mean loaded container for both 20ft and 40ft boxes.

As can be seen in the table above, the route between Seoul and Inchon by road had the lowest costs (US$ 47.9 and 66.9) for a 20ft and a 40ft box. On only trunk transit, it is shown as about US$ 20 for a 20ft box more economic than even the rail system between Bugok and BCTOC. The trunk road system costs between Seoul and Busan are almost twice as great as the trunk rail system costs for both 20 and 40ft boxes. In addition it does not cost much more to move a 40ft box than a 20ft between Seoul and Busan. The cost per TEU mile by road of a 40ft box is only about half that of a 20ft. For the rail transport cost, the result is the same. This is consistent with Korea's inland container rates pattern analysed in table 6-5 in which 40ft box rates are much less than double 20ft rates.

Where the rail operation is involved, it generates additional costs involving the use of Bugok depot although the overall costs of rail transit via the depot would generally be far lower than for road transit via ODCY. These comparisons, for the reasons already given, present the situation in the most favourable light from the viewpoint of costs. As mentioned the analysis does not take into account the costs of infrastructure by road and rail because they are already considered to be sunk cost in this thesis. No account has been taken of social costs which may arise as the result of accidents, delays, air pollution, weather hazards and congestion, etc. It is considered that these factors would strengthen the case for rail which is already supported in this analysis.

6.6 PROBLEMS AND BOTTLENECKS WITHIN THE INLAND TRANSPORT SYSTEMS

As indicated in section 6.3 and 6.4, there are many problems in the inland sector. This is mainly due to the excessive dependence on freight forwarders or inland road hauliers and the ineffective system of rail transport.

At present, in both Europe and the US there is a considerable amount of carrier haulage. In contrast to these countries, Korea has been slow in offering such an integrated intermodal transport service. And such a service is necessary if it is to be successful in catching up with containerisation in the shipping industry of the developed countries. In Korea through transport by ocean carriers is still in its early stage. As discussed in section 6.2, Korea export cargoes are usually carried by freight forwarders by truck to Busan ODCYs where they are sorted prior to moving to the port. Korean import cargoes have the opposite procedure. The ratio of containers being carried door-to-door by ocean carriers is relatively low. Thus shippers have not yet enjoyed the full advantages of containerisation. Freight forwarders and inland hauliers which have their own ODCYs within Busan city make maximum use of them. This adds costs to the system while the transit time of goods is not necessarily shortened. Therefore, through transport services by carriers may be preferred by Korean shippers. In order for this to come about the Korean government will have to adopt a more open approach which allows and encourages more ocean carriers to offer through transport services.

Another problem lies in the ineffective system of rail transport. As shown in tables 6-5 and 6-19, rail transport could be the most cost-effective mode for long hauls. There are, however, many problems in establishing an efficient inland rail system and as a result, rail has a low market share even on long hauls.

Containers have been moved by the Korean National Railroad(KNR) since 1972 and the numbers carried have grown a little every year, although rail movements have actually failed to keep pace with the rapidly growing container throughput. The percentage share is still very low compared to rail transport capacity (see table 6-20). Railroads are transporting only about 65% of their capacity (see table 6-21). As shown in the tables the capacity of rail transport has increased substantially from 310,000 TEUs in 1987 to 380,000 TEUs in 1989 although the actual transport volumes far short of this. Thus the most desirable mode for moving containers directly from Busan port to Bugok ICD is not working well. This adds to congestion in the already heavily crowded highway, increases wear on the roads and increases overall costs of the inland transport system.

Table 6-20. The share of road and rail in inland container movement from Busan port to Seoul (Unit: 000 TEUs, %)

	1981	1983	1984	1985	1986	1987	1988	1989
A. Total containers	825	961	1155	1259	1549	1933	2217	2271
B. Traffic at Busan	744	884	1054	1155	1448	1825	2065	2159
C. Traffic for Kyungin	305	331	352	377	428	710	782	854
(*)	(40.9)	(37.4)	(33.4)	(32.6)	(29.6)	(38.9)	(37.9)	(39.6)
D. Rail share	52	74	78	85	147	200	233	247
(**)	(17.0)	(22.3)	(22.1)	(22.5)	(34.3)	(28.1)	(29.8)	(28.9)
E. Road share	253	257	274	292	281	510	549	607
(***)	(83.0)	(77.7)	(77.9)	(77.5)	(65.7)	(71.9)	(70.2)	(71.1)

Sources: KMI(1988 and 1990).
Note: (*)=c/b, (**)=d/c, (***)=e/c.

Table 6-21. Comparison of rail transport volume and capacity
(unit: 000 TEUs)

Year	Rail capacity(a)	Transport volume(b)	%(b/a)
1987	310	200	64.5
1988	350	233	66.6
1989	380	247	65.0

Source: KTI(1991).

It is widely accepted that rail has advantages on long distances and for large volume transport. As calculated in table 6-19, rail transport shows economic advantages in the distances of over 200 km between Seoul and Busan port. Therefore, it is highly desirable that containers should be moved by rail rather than road between Seoul and Busan port.

Based on personal interviews with the shippers(May 1991), the major reasons for the inefficiency and unattractiveness of rail transport are the following:-

1. Compared to road transport, rail is multi-sector and the connections are not well organised.

2. In contrast to road the inland tariff of the rail is very strict and it does not offer any discounts to large volume cargoes.

3. Korean National Railroad does not have an active marketing strategy in attracting containerised cargoes.

The main focus of inefficiency arises from the fact that Bugok ICD is not being used adequately to attract rail transport of containers. As noted in section 6.4, the inefficient operation of Bugok derives from the fact that 16 trucking companies, which have their own trucks and many ODCYs within Busan city, are operating the depot separately in 16 different ways. Thus, it is desirable that a new operating company for the Bugok ICD should be established to manage the depot and control all movements of containers within it. This will make the handling of cargo in the depot much more effective.

Another problem existing in inland transport is that of the customs procedures for the import and export of containerised cargoes. There is no established customs function in the Bugok ICD. Almost all the LCL cargoes are cleared in the scattered ODCYs within Busan city, adding to traffic congestion and delays in clearance. To speed up the customs clearance process, Bugok ICD should have a clearance function. Instituting efficient customs procedures is very important for the efficiency of the inland transport system.

The last point of importance is the shortage of port space at Busan. Serving Korea's major hinterlands, including the capital Seoul, Busan port is the major centre for foreign trade in Korea. However, due to the rapid growth of seaborne container traffic, Busan container terminal is already in excess of optimum throughput, creating significant congestion. The lack of adequate land in Busan port for container processing and storage made the ODCY operator an essential feature in the container transport system. As shown in figure 6-2, about 90% of all container traffic was moved through the ODCY facilities in 1989. This creates additional costs, such as the shuttle charges for moving containers between the terminal and ODCY, and the rehandling charges involved. This is an additional and unnecessary cost which has been imposed on shippers and consignees. Continued use of the ODCY facilities for import and export containers would impose significant additional costs on Korea's economy in the form of higher inland transport costs to and from Busan port. The transfer of the ODCYs to port located terminals will eliminate these problems and improve the efficiency of container movements.

Under the recently completed plan, which extended until mid-1990, it had been planned to build 2 new container terminals, i.e. the Third and Fourth Phase container terminals. The former was in fact implemented in late June 1991. It contained three 300m berths able to accommodate 50,000 dwt, 4300 TEU containerships, and had an 80-hectare hardstanding area holding 10,000 TEU in ground slots. The total quay length of 900m is to be served by six post-Panamax gantry cranes. Annual throughputs of about 900,000 TEU could be handled based on a two-shift operation. The Phase Four development is being developed at a separate harbour site, 250km along the coast from Busan, near the town of Kwangyang. The terminal is due to come on stream in 1994, creating a further 1.2 million TEU capacity. The project, planned for the year 2000, will yield an additional capacity of 2.4 million TEU (Cargoware International 1991). Thus, Korea's south-east coastline will contain facilities able to handle in excessive of five million TEU by the start of the 21st century. Once these additional sites are constructed, in the year 2000, the container facilities will be adequate in relation to the intermediate scenario forecast in the chapter 3 (see table 3-18).

Running concurrently with the port development is the construction of the rail and road network. In the era of intermodality, a seaport is no longer a terminus, but a major interface between foreland and hinterland. Although the marine box terminals themselves are performing reasonably well in turning ships around, inadequacy of intermodal links is causing congestion in and around the port areas. Therefore, with the development of a new container terminal, all transport links, i.e. rail, road and seaport should be considered together based on a comprehensive and strategic approach. As noted, currently most container trains are stopped at Busanjin rail station because of the lack of a facility at BCTOC. The railroad facility of BCTOC should be expanded. More sets of track need to be added to the existing track in the BCTOC rail terminal so that full container trains can be formed there. This would make a direct rail connection between BCTOC and Bugok possible. Under the new system, it should be possible to have direct connections between Busan port and Bugok terminal.

In the end, to establish an efficient inland transport in Korea, integrated operations between Busan port and Bugok ICD must be implemented. The share of rail transport will be increased through this integrated operation. In order to do so, the Bugok ICD should be reorganised. Korean National Railroad will have to operate the depot to solve the problems associated with dispersed operation among 16 trucking companies. Customs clearance should also be accomplished in the Bugok depot through customs offices located on the spot. A contract should be signed between the shipping lines and KNR so that when the cargo enters Bugok, an international Bill of Lading(B/L) can be issued to the shippers. The measures to be taken will be dealt with in more detail in chapter 8.

6.7 CONCLUSION

In this chapter inland container transport systems in the through movement in Korea are broadly discussed. With regard to inland haulage arrangements, many boxes in the liner trade serving Korea's containerised cargoes are being carried inland by merchant haulage operated by freight forwarders and exporters/importers themselves. In particular shippers favour freight forwarders using road transport who charge less than the two full moves. Formal inland container rates by modes between Seoul and Busan/Inchon are shown in table 6-22. It can be seen from the table that the rail is considerably cheaper than road transport for both 20ft and 40ft boxes between Seoul and Busan. At face value road costs are almost double. However, in actual fact there is a large discount given by trunk transport operators to their customers. With respect to box rates, 40ft box rates are much less than double 20ft rates between Seoul and Busan/Inchon.

In recent times, however, with a more open approach in Korea's inland container transport system, carrier haulage by Korean lines and some foreign lines has developed. In the longer term carrier haulage by ocean carriers should play a major role in Korea's seaborne container trades. Rates are based on the loaded leg from Busan to consignee's premises in the Seoul area and return of empty containers to Bugok ICD.

Table 6-22. Inland container rates and transport costs by modes between Seoul and Busan/Inchon (unit: US$) 1990

Route\ Containers	20ft			40ft		
	Loaded	(**)	empty	Loaded	(**)	empty
Road						
Seoul<-->Busan	535.2	(234.1)	535.2	712.7	(318.9)	712.7
Seoul<-->Inchon	109.9	(47.9)	109.9	146.5	(66.9)	146.5
Rail						
Busan-->Seoul	242.7		138.9	370.3		222.5
Seoul-->Busan	222.1	(121.6)	138.9	370.3	(200.2)	199.1

Note: (**) means inland transport costs by modes for both 20ft and 40ft boxes.

The rates are charged US$ 328.5/US$ 438.5 for 20ft and 40ft boxes, respectively. This system would be applied to cargoes on B/L with place of delivery shown as Seoul only. There is, however, no absorption pricing at the present time.

Following this the chapter proceeded to compute the costs of the three inland transport routes: *Seoul<-->Busan by road via ODCY, Seoul<-->Busan by rail via a Bugok depot and Seoul<-->Inchon by road.* Before analysing the costs, the inland transport systems for FCL and LCL containers are examined in detail. The costing comparisons on those routes are carried out on the basis of the costs for both 20ft and 40ft boxes with regard to FCL container for the selected distances (see table 6-22). For a comparative cost efficiency in inland transport, the route between Seoul and Inchon by road had the lowest costs (US$ 47.9 and US$ 66.9) for a 20ft and a 40ft box, respectively. Inland container transport by road between Seoul and Busan generates extra costs over using by rail for both 20ft and 40ft boxes. The difference between the two is around US$ 110 for a 20ft box and US$ 118 for a 40ft box. This reaches almost two times. In addition, for both rail and road transport, it does not cost much more to move a 40ft box than a 20ft for the selected routes. The cost per TEU mile of a 40ft box is only about half that of a 20ft. Despite the direct advantage of low rail rates in inland transport costs, it is clear that most containers are still being moved by road rather than rail.

In Korea's inland container transport sector, it can be clearly seen from the discussions in section 6.6 that Korea faces enormous difficulties on roads and railways. At the present time, almost all highways are heavily congested causing serious delay and higher transport costs. In 1989 around 93% was carried by road and the rest by rail. This is in spite of near saturation of the current road network. Unlike the road network, rail has still room to expand its business in terms of capacity utilisation. In 1989 the share of rail in container traffic was only 7 per cent. Until recently KNR was not trying to attract a greater proportion of containers and the construction of the railway system was also given very little consideration in Korea. It is not possible that any significant improvement of the road infrastructure will take place just now. There is only one alternative left, i.e. more intensive use of rail. In view of transport cost, the road condition of the country and the long distances over which boxes will need to move, the railways could be the key to carrying container traffic over long trunk hauls in Korea.

The major reasons that rail transport is not effectively used are mainly due to the inefficiency of Bugok depot and the inactive marketing strategy of

KNR. The problems existing in Korea's inland container transport analysed in this chapter are as follows:-

1. Inefficient operation of Bugok depot operated separately by 16 trucking companies.
2. No existence of customs clearance of containers at Bugok depot.
3. A multitude of Off-Dock Container Yards(ODCYs) within Busan city.
4. Excessive dependence of container transport on the road around Busan.
5. Lack of systematic linkages between Busan port and scattered ODCYs.
6. Stringent tariff system of rail compared to road.
7. Multi-sector operations by rail and unintegrated operations.
8. An inactive marketing strategy on the part of KNR.

To establish an efficient inland transport system, these problems should be urgently addressed. As time passes the problems are becoming more serious. First of all, to obtain the full advantages of through transport systems, inland transport of containers will have to encouraged by ocean carriers. This may not only provide shippers with many advantages, i.e. carrier control and container tracking from origin through to destination, rapid delivery, the close integration of maritime transport systems with production and distribution, through bills of lading and integrated insurance cover, etc it may also ease the above-mentioned problems to some extent. In addition, measures to increase the share of rail transport should be taken. These measures to improve the current situation that hinders the container import and export business of Korea are discussed in more detail later on.

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CHAPTER 7. EVALUATION OF THE COST EFFICIENCY OF KOREAN INTERMODAL TRANSPORT SYSTEMS

7.1 INTRODUCTION

Our discussion so far may be summarised as follows. With respect to costs in the marine sector, ships on the Europe/Far East and Pacific routes calling at Inchon port generate extra costs of up to 9% over the existing itineraries using Busan port. However, in the inland sector the route from Seoul to Inchon by road costs less than half that of Seoul to Busan. The purpose of this chapter is to evaluate this trade off in network costs in relation to the development of Korea's intermodal transport systems. Although they have a smaller effect than marine and inland sector costs, port costs will also be taken into account.

The chapter proceeds in two sections. In section one we will discuss the cost profiles in these intermodal networks. In section two, on the basis of the results evaluated, we will examine what alternatives are plausible in the future.

7.2 MARINE SECTOR ALTERNATIVES AND DIVERSION COSTS

This section analyses the cost profiles on intermodal networks. In this connection it should be pointed out that there are three inland transport routes serving Korea's trades: *Inchon port by road, and Busan port by road and rail*, respectively. Before we go on to deal with costs, it is necessary to refer to two most important parameters which control the overall relationship between marine and inland sector costs. The first is the proportion of cargo on the ship associated with the Korean trades, and the second the proportion of Korean cargo for the Seoul area.

The ships used in the analysis of chapter 5 have carrying capacities of from 2670 TEU to a notional 5300 TEU. However, they make only a single call in Korea at which they both discharge Korean imports and load exports, and the total (container exchange) tends to vary only between about 400 TEUs and 700 TEUs (Personal Interview with Shipping Companies 1991). Taking these figures as a guide and assuming container exchanges vary roughly in line with ship size we obtain the figures of table 7-1. For analytical convenience, the WCNA-FE route serving Korea's trades is adopted but as shown in chapter 5 the diversion costs are the same as the Europe/Far East route.

Table 7-1. Container exchanges estimated in proportion to ship size

Traffics\Ship size	5300 TEU	4340 TEU	4000 TEU	3428 TEU	2670 TEU
	700 TEUs	700 TEUs	600 TEUs	500 TEUs	400 TEUs

With regard to the distribution of these traffics inland, the origin and destination patterns were presented in table 4-2 (see chapter 4). Around 40% of these containers will be for the Seoul area. Adding the adjacent cities of Inchon, Suwon, Taejon and Jeonjoo the proportion in the north is increased to 55%. The remainder will be for the southern part of the country including Taegoo and Busan, and thus have lower inland distribution costs from Busan than from Inchon.

7.2.1 THE BASE CASE AND A COMPARISON WITH THE USE OF INCHON

Based on the above facts table 7-2 provides an analysis of the total costs of the base case, which takes the present itinerary and road transport for inland moves. Table 7-3 then makes the comparison with the substitution of Inchon for Busan. The build up of costs in each sector has already been dealt with in chapters 5 and 6, respectively.

As shown in the tables, there are two inland transport cases. The first is distribution via a system of inland depots from Busan port, and the second direct distribution from Inchon port. Transport from the port to the inland depot and destinations would be by road. Inland charges for road are higher than for rail. The case for rail will be discussed later (see table 7-5). If Korea is served by Inchon only, it can be seen that there would be a significant increase in total costs in the case of all ships compared with the Busan only case. Modest savings in inland sector costs for direct distribution to Seoul are shown, but these are offset to a degree by inland sector cost increases to the south of Seoul. This is due to additional costs from Inchon to the southern area. From the viewpoint of costs, all ships calling at Inchon generate extra costs of about 7% over Busan. The difference between them is from US$ 130,507 (for a ship of 2670 TEU) to US$ 202,388 (for a ship of 5300 TEU) in total costs per voyage. This shows a negative benefit for the shipping lines calling at Inchon in terms of total costs compared with a base case using Busan. Consideration of inland rates also shows a significant saving in the standard itinerary compared with the diversion itinerary. The difference between them ranges from US$ 127,423(2670 TEU) to US$ 196,992(5300 TEU) per trip.

Table 7-2. Costs(US$) relating to a standard(Busan) itinerary on the Pacific

	Ship Capacity(Twenty Foot Equivalents)				
	5300	4340	4000	3428	2670
1. Marine Sector Costs					
(a) Costs per day at sea	68515	66229	61983	47039	41987
(b) Costs per trip at sea	1706024	1496775	1413212	1241830	1058072
(c) Daily ship cost in port	56279	53993	50279	41136	35337
(d) Ship costs a trip in port	776650	647916	573181	423701	314499
(e) Port dues and charges	26567	23399	21099	19726	14394
(f) Container costs	4806	3935	3627	3108	2421
Roundtrip Ship Costs plus Korea port(Busan) charges	2514047	2172025	2011119	1688365	1389386
2. Inland Transport Costs	=PRESENT SPLITS=				
	700 TEUs	700 TEUs FOR KOREA	600 TEUs	500 TEUs	400 TEUs
	385 TEUs	385 TEUs	330 TEUs	275 TEUs	220 TEUs
(a) Inland sector for Seoul* (direct distribution)	180258	180258	154506	128756	103004
	315 TEUs	315 TEUs	270 TEUs	225 TEUs	180 TEUs
(b) Inland movement for southern part	31500	31500	27000	22500	18000
Total Inland Transport Costs	211758	211758	181506	151256	121004
Ship Roundtrip Costs plus Korea port and Inland costs	2725805	2383783	2192625	1839621	1510390
(a) Inland rates for Seoul	411950	411950	353100	294250	235400
(b) Inland rates for south	49140	49140	42120	35100	28080
Total Inland Transport Rates	461090	461090	395220	329350	263480
Total Rates	2975137	2633115	2406339	2017715	1652866

Sources: (1) derived from APPENDIX 5-1.
(2) derived from Table 6-19.

Note: * 55% of container traffics for Korea is assumed to be for Seoul.

Table 7-3. Costs(US$) relating to the diversion(Inchon) itinerary on the Pacific

	Ship Capacity(Twenty Foot Equivalents)				
	5300	4340	4000	3428	2670
1. Marine Sector Costs					
a. Cost per day at sea	68515	66229	61983	47039	41987
b. Cost per trip at sea	1801945	1582873	1493790	1312388	1121053
c. Cost per day in port	56279	53993	50279	41136	35337
d. Ship costs a trip in port	889208	755902	673739	501859	385173
e. Port dues and charges	36195	32842	30408	28955	20553
f. Container costs	9612	7870	7254	6216	4842
Roundtrip Ship Costs plus Korea port(Inchon) charges	2736960	2379487	2205191	1849418	1531621
Inchon Differential(increase) (comparison with the base case)	222913	207462	194072	161053	142235
2. Inland Transport Costs	=PRESENT SPLITS=				
	700 TEUs	700 TEUs	600 TEUs	500 TEUs	400 TEUs
		FOR KOREA			
	385 TEUs	385 TEUs	330 TEUs	275 TEUs	220 TEUs
a. Inland sector costs* to Seoul	36883	36883	31614	26345	21076
	315 TEUs	315 TEUs	270 TEUs	225 TEUs	180 TEUs
b. Inland sector costs for south of Seoul	154350	154350	132300	110250	88200
c. Total inland costs	191233	191233	163914	136595	109276
Inland sector savings (based on a base case)	20525	20525	17592	14661	11728
Ship Roundtrip Costs plus Korea port(Inchon)&inland costs	2928193	2570720	2369105	1986013	1640897
Total Costs Increase a trip	202388	186937	176480	146392	130507
a. Rates for Seoul	84700	84700	72600	60500	48400
b. Rates for the south	350469	350469	300402	250335	200268
Total inland rates	435169	435169	373002	310835	248668
Inland rate savings	25921	25921	22218	18515	14812
Total Rates	3172129	2814656	2578193	2160253	1780289

Sources: (1) derived from APPENDIX 5-2.
(2) derived from Table 6-19.

Note: * 55% of container traffics for Korea is assumed to be for Seoul.

7.2.2 THE TWO PORT CASE

In order to evaluate the use of Inchon without the disadvantage of extra inland costs to the Busan hinterland, the use of Busan alone is compared with itineraries including both Busan and Inchon (see tables 7-2 and 7-4). Putting Busan back into the schedule would not add significantly to sailing distance or costs, but it would add to port dues and charges and to ship time in port. It is shown that there would be an increase in total costs in adding Inchon port to the standard itinerary. Inland transport savings are greater but port charges on all ships are quite significant, increasing from about US$ 34,947 (for a ship of 2670 TEU) to around US$ 62,762 (for a ship of 5300 TEU) per call. This addition in the costs of the Busan and Inchon itinerary offsets inland sector savings from the two port strategy. The overall difference between the two port case and the Busan only case varies from an increase of about US$ 112,459 for the ship of 2670 TEU to US$ 174,041 for the ship of 5300 TEU in total costs per voyage. The configuration with both ports in the itinerary still generates additional costs of about 6% over the standard itinerary. This is leaving aside other considerations, such as the limitations on the time available within the overall round trip and the cost of improving the port of Inchon so that it could handle big ships adequately. The analysis shows that the addition of a second Korean port (Inchon) to the standard itinerary would not be justified. As mentioned above Inchon has presently very limited sea access facilities and a significant tidal range limiting access for large ships. Substituting inland rates for costs, it can be seen that there would be a moderate loss for the sampled ships compared with the Busan only case.

Table 7-4. Costs(US$) relating to the Busan plus Inchon case

	Ship Capacity(Twenty Foot Equivalents)				
	5300	4340	4000	3428	2670
1. Marine Sector Costs					
a. Cost per day at sea	68515	66229	61983	47039	41987
b. Cost per trip at sea	1808796	1582873	1499989	1312388	1121053
c. Daily ship cost in port	56279	53993	50279	41136	35337
d. Costs per trip in port	945487	809895	724018	542995	420510
e. Port dues(Busan port)	26567	23399	21099	19726	14394
f. Port dues(Inchon port)	36195	32842	30408	28955	20553
g. Container costs	14418	11805	10881	9324	7263
Roundtrip Ship costs plus Korea ports(Busan&Inchon)charges	2831463	2460814	2286395	1913388	1583773
Inchon + Busan Difference (comparison with a base case)	317416	288789	275276	225023	194387
2. Inland Transport Costs			=PRESENT SPLITS=		
	700 TEUs	700 TEUs	600 TEUs FOR KOREA	500 TEUs	400 TEUs
	385 TEUs	385 TEUs	330 TEUs	275 TEUs	220 TEUs
a. Inland sector cost from Inchon *	36883	36883	31614	26345	21076
	315 TEUs	315 TEUs	270 TEUs	225 TEUs	180 TEUs
b. Inland sector cost from Busan	31500	31500	27000	22500	18000
Total Inland Costs	68383	68383	58614	48845	39076
Total Inland Savings (based on a base case)	143375	143375	122892	102411	81928
Ship Roundtrip Costs plus Korea two ports charges	2899846	2529197	2345009	1962233	1622849
Total Costs Increases (based on a base case)	174041	145414	152384	122612	112459
a. Inland rates for Seoul	84700	84700	72600	60500	48400
b. Inland rates for south	86940	86940	74520	62100	49680
Total Inland Rates	171640	171640	147120	122600	98080
Total Inland Rate Savings	289450	289450	248100	206750	165400
Total Rates	3003103	2652454	2433515	2035988	1681853

Sources: (1) derived from APPENDIX 5-3.
(2) derived from 6-19.

Note: * 55% of container traffics for Korea is assumed to be for Seoul.

7.2.3 THE RAIL TRANSPORT CASE

The above analysis has been based on the case of road transport in the inland sector. Where rail transport is involved, the result would be different. In order to make a fair comparison, the overall costs of rail transit via the Bugok depot are presented in table 7-5, the results being expressed in costs per ship call on the WCNA to FE itinerary serving Korea's trades.

This analysis shows that where rail is used to move containers via the Bugok depot to and from Seoul, the overall costs would be far lower than those by road (see tables 7-2 and 7-5) and the case for the use of Inchon deteriorates (compared to table 7-3). There is a significant potential cost advantage for carriers using the rail operation in inland transport, especially when serving the Seoul area from Busan. If service quality were good, rail would be of course much more competitive for the Seoul cargoes. Rail rates would be far lower (see table 7-5), and at the same time there would be significant savings of inland transport costs from Busan port. In addition, the difference between the Busan case using rail transit and the Inchon only case varies from US$ 180,007 per trip for a ship of 2670 TEU to about US$ 289,014 for a ship of 5300 TEU in total costs per call. This is equivalent to cost savings of about 10% against the Inchon only case. In conclusion, taking into account marine and inland sector costs together, the comparison indicates that the rail option via Busan is the most competitive case in Korea's intermodal transport system. Considering inland rates, the result is also consistent with the costs case just analysed. The difference between the Busan case using rail transit and the Inchon case ranges from US$

256,035(2670 TEU) to US$ 422,063(5300 TEU) per visit. The benefits are much larger than those obtained using cost data.

Table 7-5. Costs(US$) on a standard Busan itinerary using the rail mode for Busan-Bugok

	Ship Capacity(Twenty Foot Equivalents)				
	5300	4340	4000	3428	2670
1. Marine Sector Costs (Roundtrip Ship Costs plus Korea port charges)	2514047	2172025	2011119	1688365	1389386
2. Inland Transport Costs			=PRESENT SPLITS=		
	700 TEUs	700 TEUs	600 TEUs FOR KOREA	500 TEUs	400 TEUs
	385 TEUs	385 TEUs	330 TEUs	275 TEUs	220 TEUs
(a) Trunk transit for Seoul*	50512	50512	43296	36080	28864
(b) The costs at Bugok ICD	12089	12089	10362	8635	6908
(c) Collection and delivery for Seoul*	31031	31031	26598	22165	17732
	315 TEUs	315 TEUs	270 TEUs	225 TEUs	180 TEUs
(d) Inland movement for southern area	31500	31500	27000	22500	18000
Total Inland Transport Costs	125132	125132	107256	89380	71504
Total Inland Costs Savings (comparison with a base case)	86626	86626	74250	61876	49500
Ship Roundtrip Costs plus Korea port and Inland Costs	2639179	2297157	2118375	1777745	1460890
Total Costs Difference(savings) (comparison by road)	86626	86626	74250	61876	49500
a. Inland rates for Seoul	186879	186879	160182	133485	106788
b. Inland rates for south	49140	49140	42120	35100	28080
Total Inland Rates	236019	236019	202302	168585	134868
Total Inland Rates Savings	225071	225071	192918	160765	128612
Total Rates	2750066	2408044	2213421	1856950	1524254

Sources: (1) derived from Table 7-2 and APPENDIX 5-1.
(2) derived from Table 6-19.

Note: * 55% of container traffics for Korea is assumed to be for Seoul.

7.2.4 GROWTH OF CARGO VOLUME & CHANGES IN INLAND DISTRIBUTION

So far the analysis has been based on the present container exchanges and distribution of cargo inland. If Korea's economy grows steadily and the country's seaborne container traffic grows these factors could change. There could be a greater degree of specialisation between itineraries allowing Korean container exchanges to increase. In this case we will have to consider two points; an estimate of the increase in the proportion of Korean cargo, and suitable splits between the Seoul and Busan proportions. The volumes for Korea's seaborne container traffic for the future are estimated in tables 3-17, 3-18 and 3-19. As shown in the tables, the volumes of Korea's export and import container traffics are expected to continue to grow up to the year 2000, recording over twice the present levels in the intermediate scenario.

With regard to the second point, Seoul now takes the dominant position and has well over one-third of Korea's seaborne container traffics. The city is becoming a megalopolis with extensive centres of conurbation encompassing adjacent cities. The population of the Seoul area including the surrounding cities reaches almost 40% of the total in Korea. The city is also remarkably prosperous with manufacturing and processing industries, commerce, insurance and financial markets. Presumably this trend is expected to continue in the future.

Considering these points the following assumptions are proposed for the comparative analysis of the foreseeable future and the results shown in tables

7-6, 7-7 and 7-8. These are chosen to give the maximum feasible advantage to the case for Inchon.

1. Large ships on mainstream routes serving Korea's trades will have container exchanges of between 2000 and 2500 TEUs in Korea.

2. Around 70 percent of Korean traffic will be for the Seoul area and the remainder for the south.

Based on the above assumptions tables 7-6, 7-7 and 7-8 show the projected total costs in several different scenarios. It can be seen from the tables that the Busan plus Inchon case has lower costs than the new Busan only base case, but even so the benefits are only marginal. Using inland rates the savings do at last reach a moderate level. That is to say, the projected cases show that, on significantly favourable assumptions on container exchanges and proportions of containerised traffics for the Seoul area, the addition of Inchon to the standard itinerary would be justified in the future. However, even this case uses road transport for the inland modes, and does not take account of the cost of developing Inchon to an an adequate level.

Table 7-6. Costs(US$) relating to a standard(Busan) itinerary on the Pacific (projected case)

	Ship Capacity(Twenty Foot Equivalents)				
	5300	4340	4000	3428	2670
1. Marine Sector Costs (Roundtrip Ship Costs plus Korea port charges)	2514047	2172025	2011119	1688365	1389386
2. Inland Transport Costs			=PROJECTED SPLITS=		
	1250 TEU	1250 TEU	1200 TEU FOR KOREA	1100 TEU	1000 TEU
	875 TEU	875 TEU	840 TEU	770 TEU	700 TEU
a. Inland sector for Seoul* (direct distribution)	409675	409675	393288	360514	327740
	375 TEU	375 TEU	360 TEU	330 TEU	300 TEU
b. Inland movement for the southern area **	78750	78750	75600	69300	63000
Total Inland Transport Costs	488425	488425	468888	429814	390740
Ship Roundtrip Costs plus Korea port and Inland Costs	3002472	2660450	2480007	2118179	1780126

Sources: (1) derived from Table 7-2.
(2) derived from Table 6-19.

Note: * 70% of containers for Korea is assumed to be for Seoul.
** the remaining 30% will be for the southern part.

Table 7-7. Costs(US$) relating to the diversion(Inchon) itinerary on the Pacific (projected case)

	Ship Capacity(Twenty Foot Equivalents)				
	5300	4340	4000	3428	2670
1. Marine Sector Costs (Roundtrip Ship Costs plus Korea port charges)	2736960	2379487	2205191	1849418	1531621
Inchon Differential Increases	222913	207462	194072	161053	142235

2. Inland Diversion Costs

	=PROJECTED SPLITS=				
	1250 TEU	1250 TEU	1200 TEU FOR KOREA	1100 TEU	1000 TEU
	875 TEU	875 TEU	840 TEU	770 TEU	700 TEU
a. Inland sector costs* to Seoul	83825	83825	80472	73766	67060
	375 TEU	375 TEU	360 TEU	330 TEU	300 TEU
b. Inland sector costs for the south of Seoul **	183750	183750	176400	161700	147000
Total Inland Costs	267575	267575	256872	235466	214060
Total Inland Costs(savings) (comparison with table 7-6)	220850	220850	212016	194348	176680
Ship Roundtrip Costs plus Korea port & Inland Costs	3004535	2647062	2462063	2084884	1745681
Total Costs Differential (comparison with a base case)	2063	13388	17944	33295	34445

Sources: (1) derived from Table 7-3.
(2) derived from Table 6-19.

Note: * 70% of containers will be for Seoul.
** The remaining 30% will be for the southern area.

Table 7-8. Costs(US$) relating to Busan plus Inchon on the Pacific (projected case)

	Ship Capacity(Twenty Foot Equivalents)				
	5300	4340	4000	3428	2670
1. Marine Sector Costs (Roundtrip Ship Costs plus Korea port charges)	2831463	2460814	2286395	1913388	1583773
Busan + Inchon Increases (comparison with a base case)	317416	288789	275276	225023	194387

2. Inland Transport Costs

	=PROJECTED SPLITS= FOR KOREA				
	1250 TEU	1250 TEU	1200 TEU	1100 TEU	1000 TEU
	875 TEU	875 TEU	840 TEU	770 TEU	700 TEU
a. Inland sector cost* from Inchon	83825	83825	80472	73766	67060
	375 TEU	375 TEU	360 TEU	330 TEU	300 TEU
b. Inland sector cost from Busan **	78750	78750	75600	69300	63000
Total Inland Transport Costs	162575	162575	156072	143066	130060
Total Inland Sector(savings)	325850	325850	312816	286748	260680
Ship Roundtrip Costs plus the two ports charges & inland costs	2994038	2623389	2442467	2056454	1713833
Total Costs Difference(savings) (comparison with a base case)	8434	37061	37540	61725	66293

Sources: (1) derived from Table 7-4.
(2) derived from Table 6-19.

Note: * 70% of containers will be for Seoul from Inchon port.
** The remaining 30% will be directly for the southern area from Busan port.

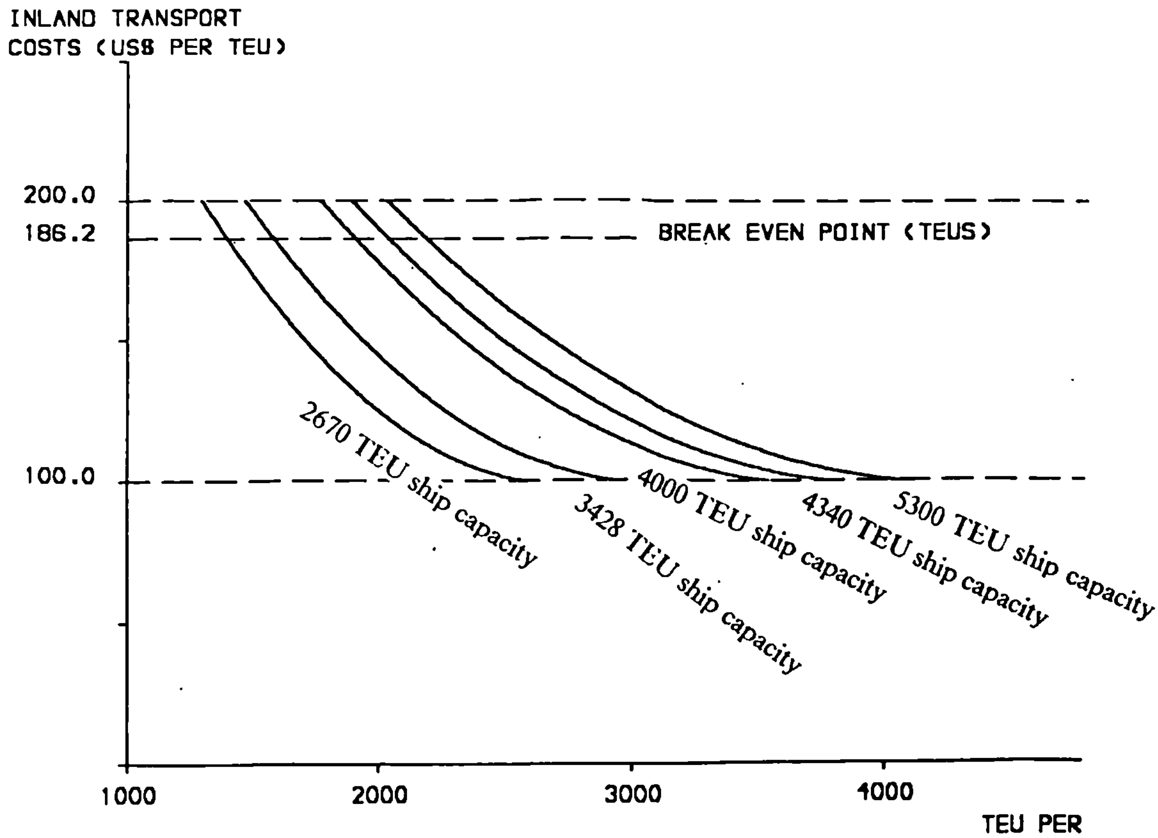
7.3 THE RELATIVE INEFFICIENCY OF INCHON PORT IN DEEP-SEA INTERMODAL NETWORKS

We have compared the costs of moving containers through transport systems using the ports of Busan and Inchon, under a number of assumptions on, itinerary, mode, and proportion of cargo for Korea. The calculations were made in terms of total costs and inland rates. At the present situation it can be seen from the comparisons that the movement of containers through Busan port is the most cost-effective beating both Inchon only and the two port case.

Figure 7-1 provides a graphical illustration of the results. This takes into account the costs of inland road transport, the increased sea freight and port charges to Inchon. The results of this comparison show that the breakeven point for Inchon port is a minimum container exchange of *1394 TEUs carried per ship call (for a 2670 TEU ship), 1579 TEUs (for a 3428 TEU ship), 1903 TEUs (for a 4000 TEU ship), 2034 TEUs (for a 4340 TEU ship) and 2185 TEUs (for a 5300 TEU ship)* (see table 7-9). This is calculated based on the marine sector costs and the costs (US$ 234.1 and US$ 47.9) per TEU in inland road transport costs between Seoul and Busan/Inchon, respectively. More detailed comparisons are presented in table 7-9 on the basis of the difference in inland road transport costs between Seoul and Busan/Inchon. The greater the difference, the less the number of containers for Inchon required.

As can be seen in table 7-9 and figure 7-1, it becomes more economic for the shipping lines to call at Busan for Korea's hinterlands under the present situation of containers carrying both imports and exports. Taking into account the present circumstances in Korea's container markets, it would be fairly hard to meet the breakeven points to use Inchon. This explains why Inchon has not played a more important role in the Korea's deep sea container trades. It also shows that the situation is unlikely to change over the medium term future.

Figure 7-1. The breakeven points of container exchanges for Seoul via Busan and Inchon ports



SOURCE: RECALCULATED FROM APPENDICES 5-1, 5-2 AND TABLE 6-19.

Table 7-9. The comparisons of container exchanges for Seoul via Busan and Inchon

Ship capacity (TEU)	Breakeven points		
	Difference* (186.2)	Difference* (100.0)	Difference* (200.0)
5300	2185 TEUs	4052 TEUs	2026 TEUs
4340	2034 TEUs	3772 TEUs	1886 TEUs
4000	1903 TEUs	3528 TEUs	1764 TEUs
3428	1579 TEUs	2928 TEUs	1464 TEUs
2670	1394 TEUs	2586 TEUs	1293 TEUs

Source: derived from figure 7-1.
Note: * means the difference in inland road transport costs between Seoul and Busan/Inchon, respectively.

7.4 FORMATION OF OPTIMUM INTERMODAL TRANSPORT NETWORK

The ports of call for container liner services are decided by the ocean carriers based on the considerations such as transit times and costs in the network as a whole, port access, port resources, the inland origin/destination of containerised cargoes, links with inland transport and the potential to attract traffic in the future, etc. In the intermodal age, the condition of port itself is a major factor which affects the ship operator's choice. Other things being equal, those ports with efficient container handling systems, adequate land area and excellent geographic location are in a superior competitive position. For this reason too Busan and the south are in a far superior position to Inchon in Korea's deep sea container trades, and it will obtain an even greater advantage in the next decade as present plans are completed.

As discussed in chapter 4, Seoul takes the most significant position in Korea's container markets. For the Seoul area, there are two kinds of inland transport modes from Busan port, by rail and by road. The total costs for the two modes from Busan port to Seoul are presented in tables 7-6 and 7-10 which show the most cost-effective network in moving Korea's containerised cargoes for the foreseeable future.

As shown in the tables, the total costs using rail via the Bugok depot to and from Seoul are much lower than those of the two port case using road (see tables 7-8 and 7-10). The difference between them is from US$ 91,767 per trip (for a ship of 2670 TEU) to US$ 189,141 per trip (for a ship of 5300 TEU) in the through costs per visit and the cost savings are of the order of 6%. From the viewpoint of total costs, this network provides a significant advantage for carriers using the rail operation in Korea's inland transport through Busan port. In terms of 40ft boxes, the cost advantage of the rail is enhanced further over the use of 20ft boxes (see tables 7-10 and 7-11). The difference between them ranges from US$ 47,750 (for a ship of 2670 TEU) to US$ 59,636 (for a ship of 5300 TEU) in the total costs per visit. Therefore, the use of 40ft boxes on the rail mode has to be increased and KNR should gradually play a greater role in intermodal container transport in the longer term. This will be the most cost-effective approach towards the development of Korea's inland container transport system.

Table 7-10. Costs(US$) on a standard Busan itinerary using the rail mode for Busan-Seoul (projected case)

	Ship Capacity(Twenty Foot Equivalents)				
	5300	4340	4000	3428	2670
1. Marine Sector Costs (Roundtrip ship costs plus Busan port charges)	2514047	2172025	2011119	1688365	1389386
Total roundtrip ship costs differential(savings) (comparison with two port case)	317416	288789	275276	225023	194387
2. Inland Transport Costs					
=PROJECT SPLITS= FOR KOREA	1250 TEU	1250 TEU	1200 TEU	1100 TEU	1000 TEU
	875 TEU	875 TEU	840 TEU	770 TEU	700 TEU
a. Trunk transit to Bugok *	114100	114100	109536	100408	91280
b. Collection/delivery **	98000	98000	94080	86240	78400
	375 TEU	375 TEU	360 TEU	330 TEU	300 TEU
c. Inland movement for the southern area *	78750	78750	75600	69300	63000
Total Inland Transport Costs	290850	290850	279216	255948	232680
Total Inland Costs(loss) (comparison with two port case)	128275	128275	123144	112882	102620
Ship Roundtrip Costs plus port charges & inland costs	2804897	2462875	2290335	1944313	1622066
Total Costs Difference(savings) (comparison with two port case)	189141	160514	152132	112141	91767

Sources: derived from Tables 6-19 and 7-6.

Note: * 70% of containers for Korea is assumed to be for Seoul and the remaining 30% will be for the southern part.

** includes the cost at Bugok ICD.

Table 7-11. Costs(US$) on a standard Busan itinerary using the rail mode(40ft boxes) for Busan-Seoul (projected case)

	Ship Capacity				
	5300	4340	4000	3428	2670
1. Marine Sector Costs (Roundtrip Ship Costs plus Busan port charges)	2514047	2172025	2011119	1688365	1389386
2. Inland Transport Costs					
	=PROJECT SPLITS=				
	625 FEUs	625 FEUs	600 FEUs For KOREA	550 FEUs	500 FEUs
	438 FEUs	438 FEUs	420 FEUs	385 FEUs	350 FEUs
a. Trunk transit to Bugok *	102580	102580	98364	90167	81970
b. Collection/delivery *	72796	72796	69804	63987	58170
	187 FEUs	187 FEUs	180 FEUs	165 FEUs	150 FEUs
c. Inland movement for the southern area *	55838	55838	53748	49269	44790
Total Inland Transport Costs	231214	231214	221916	203423	184930
Total Inland Costs(savings) (comparison with table 7-10)	59636	59636	57300	52525	47750
Ship Roundtrip Costs plus Korea port charges & Inland Costs	2745261	2403239	2233035	1891788	1574316
Total Costs Difference(savings) (comparison with use of 20ft boxes)	59636	59636	57300	52525	47750

Sources: derived from Tables 6-19 and 7-10.
Note: * 70% of containers is for Seoul and the remaining for the south.

7.5 CONCLUSION

This chapter has discussed several through transport configurations, i.e. the Busan only case, substitution of Inchon for Busan and addition of Inchon to Busan. The study compared the total cost profiles by route on the basis of WCNA/FE itinerary serving Korea's trade. Under all conditions for the present time, Busan alone is the most economic for Korea's deep sea trade from the viewpoint of total costs of this study, beating both Inchon only and the two port case. For the projected case, based on the variations in the assumptions of container exchanges and cargo split which favour Inchon, it is shown that Inchon has a breakeven point (ignoring port development costs) although this could only be reached in a much longer term.

As mentioned in the chapter, the condition of the port itself is a major factor which influences the ship operator's choice. For this reason Busan has been in a particularly favoured position as a load centre which responded quickly and economically to very large ships. Inchon port is well located for inland distribution of the Kyungin area and suited for small ships serving Intra-Asian and Japan/Korea trades while the port is at disadvantage on deep-sea routes integrated with WCNA and Europe.

Through Busan port, the rail mode is the most economic for serving Seoul via Bugok. The difference between the rail and road from Busan port to Seoul reaches from US$ 49,500 (for a ship of 2670 TEU) to US$ 86,626 (for a ship of 5300 TEU) in total costs per call, generating lower inland costs of about 3.3%. If we consider the infrastructure costs, the case for rail would be strengthened. This is because road infrastructure costs are somewhat higher than rail.

Taking into account inland rates, the results are the same as the total costs. The overall difference between them is from US$ 128,612(2670 TEU) to US$ 225,071(5300 TEU) per trip. Compared to the Inchon only case, the gap becomes greater. It ranges from about US$ 256,035 (for a ship of 2670 TEU) to US$ 422,063 (for a ship of 5300 TEU) in total rates per call. The benefits are much larger than those of total costs. However, for reasons referred to in chapter 6, the rail mode is not well used in Korea. As a result, efforts for development of rail transport need to be increased. These should concentrate on service quality which will be crucial in attracting shippers and providing efficient intermodal transport in the future.

CHAPTER 8. SUMMARY AND CONCLUSIONS

8.1 SUMMARY OF FINDINGS

Four major issues have been examined in the discussions of previous chapters, i.e. the growth of seaborne container traffic, the route structures for the container shipping fleet serving Korea's trades, the development of container ports and inland carriage systems in intermodal transport. Based on the findings, we re-examine an analysis of the developments of intermodal transport in Korea, and make general recommendations for efficient intermodal transport policy for the foreseeable future with particular emphasis on coordination between road, rail and port development.

THE GROWTH OF THE SEABORNE CONTAINER TRAFFIC

Since the 1970s when containerisation was introduced in Korea, containerised traffic volumes have grown significantly from 580,000 TEUs in 1977 to about 2,000,000 TEUs in 1988, with an average rate of increase of 18% per annum. Based on the future economic growth rate, it is anticipated that Korea's seaborne container traffic would grow continuously. In this thesis, a forecast up to the year 2000 is developed based on a correlation between economic growth and the growth of container traffic. Three different scenarios (optimistic, intermediate and pessimistic) are assumed with growth rates of 10%, 7% and 4.6%, respectively. However, the intermediate case is only used for cases of the analysis. The pessimistic scenario of economic growth assumed in the thesis seems unlikely. The low growth rate of 4.6% per annum can be realised only if things go wrong in the country's economy. However, in practice, the first three years 1989-1991 showed a moderate growth of the Korea's seaborne container traffic. It is expected that this phenomenon will last for some time. Based on the intermediate scenario, Korea's seaborne container traffic by 2000 will reach 4.3 million TEUs (see table 3-18).

BUSAN PORT ON THE MAINSTREAM AND DEEP SEA ROUTES SERVING KOREA'S TRADES

Most containership carriers serving Korea's deep sea trades do call at Busan rather than Inchon. Compared to Busan, Inchon has a number of disadvantages, i.e. the significant tidal range limiting access for large ships and a substantial diversion to existing sea lanes, etc. In particular, carriers calling at Busan have a cost advantage (about 7% in total ship costs per trip) over Inchon. In addition, as shown in table 5-14, the large vessels are cheaper by about 9%-12% in unit costs than the smaller vessels of 2670 TEUs. This is reflected in the enormous concentration on very large vessels for the mainstream trades. The economic efficiency of the large vessels favours further Busan port as the hub centre serving Korea's trades, as it responded to those vessels.

PORT AND INLAND TRANSPORT SYSTEMS, COMMERCIAL ARRANGEMENTS AND INTERMODAL NETWORKS

In Korea's liner trades a significant number of boxes are carried inland under merchant haulage arrangements operated by freight forwarders with trucks. Shippers also act on their own account. Carriers involvement and charging systems go as far as the port (Busan and Inchon) gate. From Busan/Inchon to Seoul or vice versa, inland container rates are being constructed for the loaded plus empty containers on a round-trip basis.

However, there is actually a large discount given by truck transport operators to their customers and they charge less than the two moves. In recent times, carrier haulage has begun to develop in Korea but the ratio is very low. Thus shippers have not yet enjoyed the full advantages of containerisation in Korea. As a result of the present situation, most containers are moved by road to Busan port by small scale freight forwarders using their own or rented trucks and their own ODCYs within Busan city. This causes an additional cost to inland container transport systems while the transit time of cargoes is not necessarily shortened. Unlike road transport, it is found that the rail network has still room to expand its business in terms of capacity utilisation. It is suggested that by making the maximum use of rail, the immediate pressure on congested roads can be eased. With respect to intermodal transport networks, from the viewpoint of total costs developed in the study, rail transport passing through Busan port is the most economic for Korea's deep sea trades. Under the present conditions, it beats both Inchon only and the two port case. For the projected case, based on assumptions of container exchanges and cargo splits which significantly favour Inchon, a case where Inchon is almost breaks even (ignoring port development costs) can be developed. But this case really confirms the overall advantage of Busan as the assumptions on which it is based are extreme.

Attention is now turned to the efforts for the development of efficient intermodal transport in Korea. In order to improve the Korea's present transport system, particularly two problems, i.e. the shortage of port facilities and the inefficiency of inland transport by rail will have to be solved.

8.2 THE DEVELOPMENT OF PORT FACILITIES

Currently, a large construction programme for container ports in Korea is under way. Facing the intermodal era there are some comments to be made on the future development strategy for Korea's container port system. In recent times the trend on the world mainstream container routes is to use larger and larger vessels. The growth in ship size places increased pressure on the port development side, requiring 14 metres of water at full load and a quay length of some 300 metres per ship. In order to provide adequate services for these large container ships, it is recommended that the priority should be given to build enough capacity to handle the nation's deep-sea container traffic.

The development of massive new container ports has been carried out at Busan and Kwangyang in order to tackle growing port congestion. As mentioned in chapter 6, the Third Phase Development of Busan port was completed in June, 1991 providing considerable relief for the port. The Fourth Phase construction was begun at the end of 1991. The US$300 million project, which will be entirely government-financed, comprises the construction of four new 350m berths, each equipped with two post-Panamax cranes, with depths alongside of 14 metres. By 1995 when the project is expected to complete, Busan port will have a further one million TEU per year of capacity.

In particular Kwangyang, on the south coast in the country, is planned to take the pressure off Busan which, despite recent expansion, is straining under the burden of handling 95% of Korea's container traffic (see figure 6-2). In October 1991, construction began on the first phase of the new port, a project valued at US$400 million. This phase will complete by 1995 with four berths, equipped with eight post-Panamax cranes. The Second Phase, with an estimated value of US$ 450 million will provide a further six berths by 2000. The Third Phase project in Kwangyang depends on the Korea's container volumes although provisionally, for the period 2006-11, the construction of a further six berths is scheduled to give a total of 16. Each berth will have a length of 350 metres and depths of 14m with a capacity of 240,000 TEU per year. By 2000 both Busan and Kwangyang would have a narrow surplus capacity compared to Korea's seaborne container traffic forecast in chapter 3 (see the intermediate case in table 3-18). As indicated in section 7.3, Inchon is economically and geographically unsuitable to be a major container hub port in Korea. Therefore, the current tremendous investment of port facilities on the south coast is a suitable choice. So could be the immense investment in Kwangyang in the southwest close to Busan. It is expected that the ports on Korea's south coast will play a more and more important role in the containerisation of seaborne trades generally in the Far East, especially after 1997 when Hong Kong returns to Chinese rule.

8.3 ELEMENTS OF AN EFFICIENT INLAND TRANSPORT SYSTEM

One major problem in Korea's inland transport network relates to the inefficient operation of the rail system. More than 90% of containerised cargoes from Busan port are moved by road via the main highways, the rest being carried by rail transport (see figure 6-2). The excessive use of trucks does impose a major burden on the highway, especially serious on the route between Seoul and Busan where many trade related industries are located. The Kyungbu highway is experiencing over-flow problems due to the recently increasing number of passenger cars and trucks. In addition, most container traffics are carried only during the day, further aggravating the traffic condition of the highway. As described previously the traffic demand on the route already exceeds its design capacity by more than two times. Further, compared to rail, the use of the truck causes additional transport costs to corporations which eventually are passed on consumers in Korea. This leads to worsening price competitiveness and lowering the productivity of the national economy, and thus economic growth is impeded. Therefore, in order to improve the current serious situation in Korea's inland container transport, railroad transport should be used effectively between Seoul and Busan Port. Several measures should be taken to increase the use of rail transport.

Modifications of the rail transport rate: In general rail transport does have the merit of low cost and discounts on long distance and large volumes. However, as we have already seen, the current system operated by KNR does not reflect this. This needs to be modified. Since the latter part of 1987, KNR has provided discount pricing for empty containers. This has caused KNR to move a lot of empty containers filling the space. This policy of KNR needs to be applied for transporting loaded containers. KNR also can adopt special contract rates for shippers on the basis of container volumes, offering large discount rates to shippers who commit a significant amount of volume to the rail. In addition, service differential pricing can be offered on special services which can be applied to daylight services. Considering the fact that most containers by rail are moved at night, the strategy may open up a good opportunity for attracting more cargoes to rail transport.

The privitisation of Bugok depot: As described in section 6.4, Bugok has many problems. The inefficient operation of Bugok depot is fundamentally caused by the fact that 16 trucking companies are operating the depot separately in 16 different ways. Thus, it is desirable that a new operating company for effectively controlling Bugok be established. The single operating company should be privitised, under a regulatory regime which would guarantee open and non discriminatory access to all potential users. Its function will include the control of cargo, the management of facilities and equipment, the operation of transport, the loading and discharging of the cargo and the assistance of customs inspection. This will help make possible efficient connections between Bugok and Busan. The efficient operation in the Bugok should be allied to the effective and smooth linked direct operation with BCTOC terminal and the newly developing terminals. The efficient linkage will contribute to the shrinking usage of ODCYs, rapid transport of cargo and improved function at Busan port. It is, then, expected that Bugok will serve as an efficient inland terminal for Busan port.

The existence of customs inspection facility in the Bugok depot: Customs procedure for the import and export of containerised cargoes (particularly LCL) in Korea are such that clearance takes place in the Busan ODCYs. This adds to traffic congestion and delays the clearance itself. To speed up the customs clearance process, the Bugok ICD should have a clearance function. Customs officers should be available in the depot at all times and this requires that bonded cargo be transported for Bugok easily. U.K has over 20 customs approved depots providing for inland clearance functions. One of the world's largest inland container terminals is located in Johannesburg. Containers moving from the port of Durban by unit train in bonded are cleared in Johannesburg rather than in the port. A model Taiwan ICD, Nei Li is located in Pa Teh and handles a substantial amount of containers from Taiwan's northern industrial zone, providing customs clearance services. At the present time, efforts to improve clearance process in Korea are not fully effective. Instituting efficient customs procedures is very important to the efficient system of inland transport in Korea.

The transfer of the ODCYs within the Busan city: As indicated already, continued use of the ODCYs for import and export containers imposes significant additional costs on the Korea's economy in the form of higher inland transport costs to and from the port. The existence of the ODCYs at present prevents the full benefits of intermodalism from being realised. It is also related to environmental pollution and serious traffic congestion in the city caused by a high volume of container movements and the unsightly presence of large container parks in residential areas. The transfer of the ODCYs facilities onto existing and future terminals will eliminate these problems and improve the efficiency of freight movement. The result of such a move would not only transfer the facilities to the port terminal, but would also eliminate unnecessary shuttle and rehandling charges.

The establishment of a separate division of the KNR to specialise rail freight: Presently most trucking companies make their own contracts with shippers and shipping companies to take full responsibility for moving containers between Seoul and Busan. By contrast, KNR is not active enough to design its own marketing strategy. To strengthen the strategy, KNR needs to establish a separate division to handle container traffic. In order to do so, the government will have to pay more attention to these efforts. This was not such a serious problem when container movements were not very large. As time passes, the container traffic grows significantly. In the United Kingdom there is a good example of the UK's Freightliner service in rail distribution. KNR needs to adopt actively the system to transport containers between Busan port and other regions in the country. This may be an important solution required to promote efficient container movements in Korea.

The issue of the through bill of lading: The extension of intermodal services by offering a through bill of lading to inland points has been one of the keys to optimising service. Actually, in the USA and Europe the shipping lines establish relationships with inland transport operators whereby the bill of lading covers transport from origin to destination. However, in Korea most containers move on domestic bills of lading to Busan. The shipper does not receive payment for commodities shipped until the shipping line's bill of lading has been executed. Likewise the case of USA and Europe, KNR should also establish relationships with steamship lines. When this is done, the shipper can receive the payment for commodities on delivery of a container to KNR.

In following up the above suggestions an integrated planning process will be required. To manage the process as a coherent system of many elements, it is imperative that all parties concerned, i.e. KNR, KMPA, the Department of Transport, the shipping lines, the trucking companies and freight forwarders come together and cooperate in order to achieve the greatest efficiency and lowest cost in the distribution of container traffic.

8.4 PROPOSAL FOR A BETTER INTERMODAL TRANSPORT POLICY

There is a need for the Korean government to follow a more open policy which encourages ocean carriers, both domestic and foreign, to offer through transport services. Under such a policy the merchant haulage option would still remain available in Korea although operations under carrier haulage would probably be much improved. This is because it allows the advantages of through transport systems to be fully obtained (see section 2.3). At the present time, several Korean shipping companies, Hanjin, Hyundai, Choyang, etc have been providing intermodal transport around the world, especially in North America where intermodal transport is actively used, operating double stack trains across the long distances of the North American continent. Unlike this situation, however, the Korean government has not allowed ocean carriers to penetrate in inland transport until recently. Now the position is starting to change but the changes are limited to cargoes on B/L with place of delivery shown as Seoul only.

As a result of present policies, most containers are moved by road by small scale freight forwarders using their own or rented trucks and their own container yards. There is only a modest use of the rail mode. Thus inland transport is not as effective as it should be. This was not a great problem when the volume of container transport was not very large and competition was not great in the international market. But as the demand for container transport in Korea has been rapidly increasing during the last two decades (see table 3-13), the inefficiency has become a major problem for the intermodal operations of import and export cargoes (see section 6.6). That is to say, the costs arising from inefficient intermodal operations have become a serious problem in a highly competitive international trade environment. Therefore, the Korean government should pay more attention to the needs of efficient intermodal transport of containers with a more positive open approach.

8.5 RECOMMENDATIONS FOR FUTURE RESEARCH

We shall now turn to the implications for future research. The task should extend the results presented in this thesis. This study confirmed that the use of rail and rail/road methods of inland distribution would be economic for serving the north of the country and for improving the efficiency of container transport systems in Korea. In order to fully develop these findings, first of all, further study concerning the service quality aspects of rail transport must be undertaken using other variables such as time, speed, reliability, accuracy and safety, etc as well as costs. Secondly, expansion of the rail network must be considered as an important technique for improvement of the efficiency of rail transport.

APPENDIX 4. ANALYSIS OF TEU TRANSPORT CAPACITY ON MAJOR ROUTES SERVING KOREA'S TRADES

APPENDIX 4-1: ANALYSIS OF TEU TRANSPORT CAPACITY BY SHIPS CALLING AT A PORT IN KOREA ON THE FE/NORTH AMERICA ROUTE

FE/WCNA

CARRIERS	TYPE	TEU SLOTS	SPEED	SERVICE FREQUENCY	ROUNDTRIP (DAYS)	NO.of ONEWAY	CAPACITY PER ANNUM	ROUND DISTANCE

* sub-subroute:Jap,Kor,PNW

** Itinerary:Seattle>Vancouver>Busan>Osaka>Nagoya>Shimizu>Tokyo>Seattle

CARRIERS	TYPE	TEU SLOTS	SPEED	SERVICE FREQUENCY	ROUNDTRIP (DAYS)	NO.of ONEWAY	CAPACITY PER ANNUM	ROUND DISTANCE
Gearbulk	*BC*	*1404*	*14.5*	*weekly*	*91.0*	*8.0*	*11232*	*10122*
(USA)	*BC*	*1404*	*14.5*	*weekly*	*91.0*	*8.0*	*11232*	*10122*
	BC	*1404*	*14.5*	*weekly*	*91.0*	*8.0*	*11232*	*10122*
	BC	*1404*	*14.5*	*weekly*	*91.0*	*8.0*	*11232*	*10122*
	BC	*1404*	*14.5*	*weekly*	*91.0*	*8.0*	*11232*	*10122*
	BC	*1404*	*14.5*	*weekly*	*91.0*	*8.0*	*11232*	*10122*
	BC	*1404*	*14.5*	*weekly*	*91.0*	*8.0*	*11232*	*10122*
	BC	*1392*	*14.5*	*weekly*	*91.0*	*8.0*	*11136*	*10122*
	BC	*1392*	*14.5*	*weekly*	*91.0*	*8.0*	*11136*	*10122*
	BC	*1392*	*14.5*	*weekly*	*91.0*	*8.0*	*11136*	*10122*
	BC	*1392*	*14.5*	*weekly*	*91.0*	*8.0*	*11136*	*10122*
	BC	*1392*	*14.5*	*weekly*	*91.0*	*8.0*	*11136*	*10122*
	BC	*1392*	*14.5*	*weekly*	*91.0*	*8.0*	*11136*	*10122*
*Subtotal*ASS:1398						104.0	145440	

* sub-subroute:Jap,Kor,HK,TW,PSW

** Itinerary: Long Beach>Oakland>Yokohama>Kobe>Busan>HK>Kaohsiung>Busan>Kobe>Nagoya>Yokohama>Long Beach

CARRIERS	TYPE	TEU SLOTS	SPEED	SERVICE FREQUENCY	ROUNDTRIP (DAYS)	NO.of ONEWAY	CAPACITY PER ANNUM	ROUND DISTANCE
Sea-Land	*FC*	*2510*	*20.7*	*weekly*	*49.0*	*14.9*	*37399*	*12877*
(USA)	*FC*	*2510*	*20.7*	*weekly*	*49.0*	*14.9*	*37399*	*12877*
	FC	*2510*	*20.7*	*weekly*	*49.0*	*14.9*	*37399*	*12877*
	FC	*2510*	*20.7*	*weekly*	*49.0*	*14.9*	*37399*	*12877*
	FC	*2510*	*20.7*	*weekly*	*49.0*	*14.9*	*37399*	*12877*
	FC	*2510*	*20.7*	*weekly*	*49.0*	*14.9*	*37399*	*12877*
	FC	*2510*	*20.7*	*weekly*	*49.0*	*14.9*	*37399*	*12877*
*Subtotal*ASS:2510						104.3	261793	

* sub-subroute:Jap,Kor,PNW

** Itinerary: Hakata>Busan>Osaka>Kobe>Nagoya>Shimizu>Tokyo>Seattle>Vancouver

CARRIERS	TYPE	TEU SLOTS	SPEED	SERVICE FREQUENCY	ROUNDTRIP (DAYS)	NO.of ONEWAY	CAPACITY PER ANNUM	ROUND DISTANCE
Westwood	*BC*	*2029*	*15*	*weekly*	*28.0*	*26.1*	*52957*	*10122*
(USA)	*BC*	*2029*	*15*	*weekly*	*28.0*	*26.1*	*52957*	*10122*
	BC	*2029*	*15*	*weekly*	*28.0*	*26.1*	*52957*	*10122*
	BC	*2029*	*15*	*weekly*	*28.0*	*26.1*	*52957*	*10122*
*Subtotal*ASS:2029						104.4	211828	

*sub-subroute:HK,TW,Kor,Jap,PNW

** Itinerary :HK>Kaohsiung>Busan>Kobe>Shimizu>Nagoya>Tokyo>Tacoma>Portland>Tokyo>Nagoya>Kobe>HK

K-Line	*FC*	*2257*	*20*	*weekly*	*35.0*	*20.9*	*47171*	*11375*
(Jap)	*FC*	*2257*	*20*	*weekly*	*35.0*	*20.9*	*47171*	*11375*
	FC	*2245*	*20*	*weekly*	*35.0*	*20.9*	*46921*	*11375*
	FC	*2257*	*20.6*	*weekly*	*35.0*	*20.9*	*47171*	*11375*
	FC	*2258*	*21.5*	*weekly*	*35.0*	*20.9*	*47192*	*11375*

*Subtotal*ASS:2255 104.5 235626

*sub-subroute:HK,TW,Kor,Jap,PNW
** Itinerary :HK>Kaohsiung>Keelung>Busan>Kobe>Nagoya>Shimizu>Tokyo>Seattle>Vancouver>Portland>Tokyo>Nagoya>Kobe>Keelung>HK

MOL	*FC*	*1892*	*22.3*	*weekly*	*42.0*	*17.4*	*32921*	*11663*
(Jap)	*FC*	*1960*	*20.5*	*weekly*	*42.0*	*17.4*	*34104*	*11663*
	FC	*1928*	*22.3*	*weekly*	*42.0*	*17.4*	*33547*	*11663*
NYK	*FC*	*2619*	*21*	*weekly*	*42.0*	*17.4*	*45571*	*11663*
(Jap)	*FC*	*2704*	*21*	*weekly*	*42.0*	*17.4*	*47050*	*11663*
	FC	*2709*	*21*	*weekly*	*42.0*	*17.4*	*47137*	*11663*

Subtotal 104.4 240330

*sub-subroute:Sng,TW,HK,Kor,Jap,PSW
** Itinerary :Sng>Kaohsiung>HK>Busan>Kobe>Nagoya>Tokyo>LA>Oakland>Tokyo>Sng

MOL	*FC*	*2512*	*21.3*	*weekly*	*42.0*	*17.4*	*43709*
	FC	*2512*	*21.3*	*weekly*	*42.0*	*17.4*	*43709*
	FC	*2512*	*21.3*	*weekly*	*42.0*	*17.4*	*43709*
	FC	*2542*	*21.6*	*weekly*	*42.0*	*17.4*	*44231*
	FC	*2912*	*21.6*	*weekly*	*42.0*	*17.4*	*50669*
	FC	*2912*	*21.6*	*weekly*	*42.0*	*17.4*	*50669*

*Subtotal*ASS:2650 104.4 276696

*sub-subroute:Kor,Jap,PSW
** Itinerary :Busan>Kobe>Nagoya>Shimizu>Yokohama>Long Beach>Oakland>Yokohama>Nagoya>Kobe>Busan

Nippon	*FC*	*1919*	*21.4*	*weekly*	*63.0*	*11.6*	*22260*	*11748*
(Jap)	*FC*	*1928*	*20.3*	*weekly*	*63.0*	*11.6*	*22365*	*11748*
	FC	*1834*	*22.8*	*weekly*	*63.0*	*11.6*	*21274*	*11748*
NOL	*FC*	*1863*	*23*	*weekly*	*63.0*	*11.6*	*21611*	*11748*
(Sng)	*FC*	*1757*	*23*	*weekly*	*63.0*	*11.6*	*20381*	*11748*
	FC	*2024*	*21*	*weekly*	*63.0*	*11.6*	*23478*	*11748*
OOCL	*FC*	*2518*	*21*	*weekly*	*63.0*	*11.6*	*29209*	*11748*
(HK)	*FC*	*2556*	*19.5*	*weekly*	*63.0*	*11.6*	*29650*	*11748*
	FC	*2523*	*21*	*weekly*	*63.0*	*11.6*	*29267*	*11748*

Subtotal 104.4 219495
* OOCL provides joint service with Nippon Liner and NOL.

*sub-subroute:Kor,Jap,PSW
** Itinerary :Busan>Kobe>Nagoya>Tokyo>LA>Oakland>Tokyo>Shimizu>Nagoya>Kobe>Busan

NYK	*FC*	*2340*	*21*	*weekly*	*35.0*	*20.9*	*48906*	*11748*

	FC	2555	21	weekly	35.0	20.9	53400	11748
	FC	2105	20.3	weekly	35.0	20.9	43995	11748
	FC	1826	20.5	weekly	35.0	20.9	38163	11748
	FC	1859	20.5	weekly	35.0	20.9	38853	11748

*Subtotal*ASS:2340 104.5 223317

*sub-subroute:Kor,HK,TW,PNW
** Itinerary :Inchon>Hongkong>Keelung>Busan>Seattle>Inchon

Hanjin	FC	1184	17.6	weekly	42.0	17.4	20602	12278
(Kor)	FC	1702	18.6	weekly	42.0	17.4	29615	12278
	FC	1184	17.2	weekly	42.0	17.4	20602	12278
	FC	1520	18.0	weekly	42.0	17.4	26448	12278
	FC	1799	18.0	weekly	42.0	17.4	31303	12278
	FC	2678	22.0	weekly	42.0	17.4	46597	12278

*sub-subroute:HK,TW,Kor,PSW
** Itinerary :HK>Keelung>Busan>LA>Oakland>Busan>Keelung>HK

	FC	1150	16.9	weekly	35.0	20.9	24035	12733
	FC	1126	18	weekly	35.0	20.9	23533	12733
	FC	1662	19	weekly	35.0	20.9	34736	12733
	FC	1150	16.9	weekly	35.0	20.9	24035	12733
	FC	1150	17	weekly	35.0	20.9	24035	12733

*Subtotal*ASS:1482 209.0 305541

*sub-subroute:HK,TW,Kor,Jap,USWC
** Itinerary :HK>Kaohsiung>Busan>Kobe>Yokohama>Long Beach>Oakland>
Seattle>Busan>HK

Hyundai	FC	2984	21.7	weekly	49.0	14.9	44462	13592
(Kor)	FC	2984	21.7	weekly	49.0	14.9	44462	13592
	FC	2984	21.7	weekly	49.0	14.9	44462	13592
	FC	2984	21.7	weekly	49.0	14.9	44462	13592
	FC	2984	21.7	weekly	49.0	14.9	44462	13592
	FC	2984	21.7	weekly	49.0	14.9	44462	13592
EAC	FC	2984	21.7	weekly	49.0	14.9	44462	13592

*Subtotal*ASS:2984 104.3 311234

*sub-subroute:PSW,Kor,TW,Phil,HK
** Itinerary: Long Beach>San Francisco>Busan>Keelung>Manila>HK>Kaohsiung>
Keelung>Busan>Long Beach

NSCP	SC	560	17	14 days	42.0	17.4	9744	13673
(Phil)	SC	560	17	14 days	42.0	17.4	9744	13673
	SC	560	17	14 days	42.0	17.4	9744	13673

*Subtotal*ASS:560 52.2 29232

*sub-subroute:USWC,Jap,HK,TW,Kor
** Itinerary ;Long Beach>Yokohama>Osaka>HK>Keelung>Busan>Hiroshima>
Osaka>Yokohama>Long Beach

TMM	BC	1792	17.5	10 days	60.0	12.2	21862	12458
(Mexico)	BC	1792	17.5	10 days	60.0	12.2	21862	12458

	BC	2069	18.6	10 days	60.0	12.2	25242	12458
	BC	2069	18.6	10 days	60.0	12.2	25242	12458
	BC	2069	18.6	10 days	60.0	12.2	25242	12458
	BC	2069	18.6	10 days	60.0	12.2	25242	12458

*Subtotal*ASS:1977 73.2 144692

FE/ECNA

CARRIERS	TYPE	TEUP SLOTS	SPEED	SERVICE FREQUENCY	ROUNDTRIP (DAYS)	NO.of ONEWAY	CAPACITY PER ANNUM	ROUND DISTANCE

*sub-subroute:Sng,HK,TW,Kor,Jap,ECNA
** Itinerary :Sng>HK>Kaohsiung>Busan>Osaka>Tokyo>Panama>Charleston>NY>Halifax>via suez>Sng

CARRIERS	TYPE	TEUP SLOTS	SPEED	SERVICE FREQUENCY	ROUNDTRIP (DAYS)	NO.of ONEWAY	CAPACITY PER ANNUM	ROUND DISTANCE
K-Line	FC	2901	22.4	weekly	35.0	20.9	60631	26919
(Jap)	FC	2901	22.4	weekly	35.0	20.9	60631	26919
NOL	FC	2966	21.6	weekly	35.0	20.9	61989	26919
(Jap)	FC	2966	21.6	weekly	35.0	20.9	61989	26919
OOCL	FC	2829	22.4	weekly	35.0	20.9	59126	26919

*Subtotal*ASS:2934 104.5 304366

*sub-subroute:ECNA,Jap,Kor,HK,TW,Sng,E.Asia
** Itinerary :NY>Norfolk>Baltimore>Boston>Savannah>Jacksonville>Miami>Houston>New Orleans>Long Beach>Yokohama>Osaka>Busan>HK>Kaohsiung>Sng>Manila>Bangkok>Jakarata>NY

CARRIERS	TYPE	TEUP SLOTS	SPEED	SERVICE FREQUENCY	ROUNDTRIP (DAYS)	NO.of ONEWAY	CAPACITY PER ANNUM	ROUND DISTANCE
OOCL	FC	3161	20.5	weekly	35.0	20.9	66065	
	FC	3161	20.5	weekly	35.0	20.9	66065	
	FC	3161	20.5	weekly	35.0	20.9	66065	
	FC	3161	20.5	weekly	35.0	20.9	66065	
	FC	3218	20.5	weekly	35.0	20.9	67256	

Subtotal 104.5 331516

*sub-subroute:USEC/GC,Med,Mid-East,Sng,TW,Kor,Jap
** Itinerary :Houston>New Orleans>Savannah>Wilmington>Baltimore>NY>Halifax>Jeddah>Dammam>Sng>Port Kelang>Keelung>Busan>Kobe>Nagoya>Yokohama>Sng>Jeddah>NY>Houston

CARRIERS	TYPE	TEUP SLOTS	SPEED	SERVICE FREQUENCY	ROUNDTRIP (DAYS)	NO.of ONEWAY	CAPACITY PER ANNUM	ROUND DISTANCE
NSCSA	RC	2100	18	20 days	120	6.1	12810	28160
(Saudi)	RC	2100	18	20 days	120	6.1	12810	28160
	RC	2100	18	20 days	120	6.1	12810	28160
	RC	2100	18	20 days	120	6.1	12810	28160
	RC	2150	17.5	20 days	120	6.1	13115	28160
	RC	2150	17.5	20 days	120	6.1	13115	28160

*Subtotal*ASS:2117 36.6 77470

*sub-subroute:HK,TW,Kor,Jap,PSW,USEC
** Itinerary :HK>Keelung>Busan>Kobe>Yokohama>LA>NY>Savannah>LA>Busan>Keelung>HK

Hanjin	*FC*	*2668*	*20.2*	*weekly*	*56.0*	*13.0*	*34684*	*23062*
(Kor)	*FC*	*2668*	*20.2*	*weekly*	*56.0*	*13.0*	*34684*	*23062*
	FC	*2668*	*20.2*	*weekly*	*56.0*	*13.0*	*34684*	*23062*
	FC	*2668*	*20.2*	*weekly*	*56.0*	*13.0*	*34684*	*23062*
	FC	*2668*	*20.2*	*weekly*	*56.0*	*13.0*	*34684*	*23062*
	FC	*2668*	*20.2*	*weekly*	*56.0*	*13.0*	*34684*	*23062*
	FC	*2662*	*20.2*	*weekly*	*56.0*	*13.0*	*34606*	*23062*
	FC	*2662*	*20.2*	*weekly*	*56.0*	*13.0*	*34606*	*23062*

*Subtotal*ASS:2667 104.0 277316

*sub-subroute:Jap,Kor,TW,HK,Sng,EC,USEC,RTW(WB)
** Itinerary :NY>Norfolk>Charleston>Kingston>Panama>LA>Tokyo>Nagoya>
Osaka>Busan>Keelung>Kaohsiung>HK>Sng>Hamburg>Felixstowe>
Rotterdam>Antwerp>Le Havre>NY

Evergreen	*FC*	*3428*	*20.7*	*6 days*	*78.0*	*4.7*	*16112*	*25816*
(TW)	*FC*	*3428*	*20.7*	*6 days*	*78.0*	*4.7*	*16112*	*25816*
	FC	*3428*	*20.7*	*6 days*	*78.0*	*4.7*	*16112*	*25816*
	FC	*3428*	*20.7*	*6 days*	*78.0*	*4.7*	*16112*	*25816*
	FC	*3428*	*20.7*	*6 days*	*78.0*	*4.7*	*16112*	*25816*
	FC	*3428*	*20.7*	*6 days*	*78.0*	*4.7*	*16112*	*25816*
	FC	*3428*	*20.7*	*6 days*	*78.0*	*4.7*	*16112*	*25816*
	FC	*3428*	*20.7*	*6 days*	*78.0*	*4.7*	*16112*	*25816*
	FC	*3428*	*20.7*	*6 days*	*78.0*	*4.7*	*16112*	*25816*
	FC	*3428*	*20.7*	*6 days*	*78.0*	*4.7*	*16112*	*25816*
	FC	*3428*	*20.7*	*6 days*	*78.0*	*4.7*	*16112*	*25816*
	FC	*3428*	*20.7*	*6 days*	*78.0*	*4.7*	*16112*	*25816*
	FC	*2728*	*20.5*	*6 days*	*78.0*	*4.7*	*12822*	*25816*

*sub-subroute:Sng,HK,TW,Kor,Jap,USWC,USEC,EC,RTW(EB)
** Itinerary :Sng>HK>Kaohsiung>Keelung>Busan>Osaka>Nagoya>Shimizu>Tokyo>
LA>Charleston>Baltimore>NY>Le Havre>Antwerp>Rotterdam>
Felixstowe>Hamburg>Colombo>Port Kelang>Sng

	FC	*2728*	*20.5*	*weekly*	*84.0*	*4.4*	*12003*	*26300*
	FC	*2728*	*20.5*	*weekly*	*84.0*	*4.4*	*12003*	*26300*
	FC	*2728*	*20.5*	*weekly*	*84.0*	*4.4*	*12003*	*26300*
	FC	*2728*	*20.5*	*weekly*	*84.0*	*4.4*	*12003*	*26300*
	FC	*2728*	*20.5*	*weekly*	*84.0*	*4.4*	*12003*	*26300*
	FC	*2728*	*20.5*	*weekly*	*84.0*	*4.4*	*12003*	*26300*
	FC	*2728*	*20.5*	*weekly*	*84.0*	*4.4*	*12003*	*26300*
	FC	*2728*	*20.5*	*weekly*	*84.0*	*4.4*	*12003*	*26300*
	FC	*2728*	*20.5*	*weekly*	*84.0*	*4.4*	*12003*	*26300*
	FC	*2728*	*20.5*	*weekly*	*84.0*	*4.4*	*12003*	*26300*
	FC	*2728*	*20.5*	*weekly*	*84.0*	*4.4*	*12003*	*26300*
	FC	*2728*	*20.5*	*weekly*	*84.0*	*4.4*	*12003*	*26300*

*Subtotal*ASS:3064 113.9 350202

*sub-subroute:Sng,HK,TW,Kor,Jap,USWC,USEC
** Itinerary :Sng>HK>Kaohsiung>Keelung>Busan>Kobe>Yokohama>LA>Savannah>
NY>Baltimore>Wilmington>Houston>LA>Yokohama>Kobe>Busan>
Keelung>Kaohsiung>HK>Sng

Yangming	*FC*	*1940*	*21.6*	*weekly*	*120*	*6.1*	*11834*	*26326*
(TW)	*FC*	*1940*	*21.6*	*weekly*	*120*	*6.1*	*11834*	*26326*
	FC	*1940*	*21.6*	*weekly*	*120*	*6.1*	*11834*	*26326*
	FC	*1940*	*21.4*	*weekly*	*120*	*6.1*	*11834*	*26326*
	FC	*1940*	*21.4*	*weekly*	*120*	*6.1*	*11834*	*26326*
	FC	*1940*	*21.4*	*weekly*	*120*	*6.1*	*11834*	*26326*

	FC	1940	21.4	weekly	120	6.1	11834	26326
	FC	1940	21.4	weekly	120	6.1	11834	26326
	FC	1940	21.4	weekly	120	6.1	11834	26326
	FC	1940	21.4	weekly	120	6.1	11834	26326
	FC	3090	20.5	weekly	120	6.1	18849	26326
	FC	3090	20.5	weekly	120	6.1	18849	26326
	FC	3090	20.5	weekly	120	6.1	18849	26326
	FC	3090	20.5	weekly	120	6.1	18849	26326
	FC	3090	20.5	weekly	120	6.1	18849	26326
	FC	3090	20.5	weekly	120	6.1	18849	26326
	FC	3090	20.5	weekly	120	6.1	18849	26326
	FC	3090	20.5	weekly	120	6.1	18849	26326

*Subtotal*ASS:2451 109.8 269132

*sub-subroute:Sng,HK,TW,Kor,Jap,USWC,USEC
** Itinerary :Sng>HK>Kaohsiung>Keelung>Busan>Kobe>Nagoya>Yokohama>LA>
Savannah>Baltimore>NY>Houston>New Orleans>LA>Yokohama>
Kobe>Busan>Keelung>Kaohsiung>HK>Sng

BBS	RR	2750	20	15 days	135	5.4	14850	26253
(Norway)	RR	2750	20	15 days	135	5.4	14850	26253
	RR	2750	20	15 days	135	5.4	14850	26253
	RR	2000	20.5	15 days	135	5.4	10800	26253
	RR	2000	20.5	15 days	135	5.4	10800	26253
	RR	2000	20.5	15 days	135	5.4	10800	26253
	RR	2000	20.5	15 days	135	5.4	10800	26253
	RR	2000	20.5	15 days	135	5.4	10800	26253
	RR	1400	18	15 days	135	5.4	7560	26253

*Subtotal*ASS:2183 48.6 106110

*sub-subroute:EC,Sng,TW,Kor,Jap,USWC,USEC,RTW(EB)
** Itinerary :Antwerp>Felixstowe>Bremerhaven>Rotterdam>Sng>Kaohsiung>
Busan>Osaka>Yokohama>SF>LA>Jacksonville>Wilmington>Antwerp

Senator	FC	1923	18	14 days	84.0	4.4	8461	25769
(W.Ger)	FC	1923	18	14 days	84.0	4.4	8461	25769
	FC	1743	18	14 days	84.0	4.4	7669	25769
	FC	1743	18	14 days	84.0	4.4	7669	25769
	FC	1706	18	14 days	84.0	4.4	7506	25769
	FC	1706	18	14 days	84.0	4.4	7506	25769

*sub-subroute:EC,USEC,USWC,Jap,Kor,TW,HK,Sng,RTW(WB)
** Itinerary :Felixstowe>Bremerhaven>Rotterdam>Antwerp>Philadelphia>
Wilmington>LA>SF>Yokohama>Busan>Kaohsiung>HK>Sng>Felixstowe

	FC	1074	19	14 days	84.0	4.4	4726	29795
	FC	1074	19	14 days	84.0	4.4	4726	29795
	FC	1743	18	14 days	84.0	4.4	7669	29795
	FC	1228	18	14 days	84.0	4.4	5403	29795
	FC	1061	19	14 days	84.0	4.4	4668	29795
	FC	956	17	14 days	84.0	4.4	4206	29795

*Subtotal*ASS:1490 52.8 78670

*sub-subroute:Med,ECNA,USWC,Jap,TW,HK,Kor
** Itinerary :Haifa>Piraeus>Barcelona>Halifax>NY>Hampton Road>Savannah>
Kingston>Long Beach>SF>Yokohama>Osaka>Kaohsiung>HK>Keelung>
Busan>Yokohama>Osaka>Long Beach>Kingston>Savannah>NY>
Halifax>Med>Haifa

Zim	*FC*	*1721*	*18.5*	*9 days*	*99.0*	*7.4*	*12735*	*36500*
(Israel)	*FC*	*1721*	*18.5*	*9 days*	*99.0*	*7.4*	*12735*	*36500*
	FC	*1721*	*18.5*	*9 days*	*99.0*	*7.4*	*12735*	*36500*
	FC	*1721*	*18.5*	*9 days*	*99.0*	*7.4*	*12735*	*36500*
	FC	*1746*	*18.5*	*9 days*	*99.0*	*7.4*	*12920*	*36500*
	FC	*1746*	*18.5*	*9 days*	*99.0*	*7.4*	*12920*	*36500*
	FC	*2224*	*18.5*	*9 days*	*99.0*	*7.4*	*16458*	*36500*
	FC	*2224*	*18.5*	*9 days*	*99.0*	*7.4*	*16458*	*36500*
	FC	*2224*	*18.5*	*9 days*	*99.0*	*7.4*	*16458*	*36500*
	FC	*2462*	*18*	*9 days*	*99.0*	*7.4*	*18219*	*36500*
	FC	*2462*	*18*	*9 days*	*99.0*	*7.4*	*18219*	*36500*
*Subtotal*ASS:1997						81.4	162592	

Summary of the Route Analysis on the FE/NA trade calling at Korean port
by TEU Transport Capacity

SUBROUTE	FE/WCNA	FE/ECNA	TOTAL
Estimates by this study(1989)	2,605,224	1,957,374	4,562,598

APPENDIX 4-2: ANALYSIS OF TEU TRANSPORT CAPACITY BY SHIPS CALLING AT A PORT IN KOREA ON THE FE/EUROPE ROUTE

CARRIERS	TYPE	TEU SLOTS	SPEED	SERVICE FREQUENCY	ROUNDTRIP (DAYS)	NO.of ONEWAY	CAPACITY PER ANNUM	ROUND DISTANCE
TRIO Group								
*sub-subroute:EC,Med,Kor,Jap,Sng								
** Itinerary :Hamburg>Bremerhaven>Rotterdam>Le Havre>Southampton>Jeddah>Busan>Kobe>Nagoya>Tokyo>Sng>Jeddah>Rotterdam>Hamburg								
P&OCL	*FC*	*2961*	*21*	*weekly*	*63.0*	*11.6*	*34348*	*26523*
(UK)	*FC*	*2961*	*23*	*weekly*	*63.0*	*11.6*	*34348*	*26523*
	FC	*2968*	*23*	*weekly*	*63.0*	*11.6*	*34429*	*26523*
BLC (UK)	*FC*	*3032*	*23*	*weekly*	*63.0*	*11.6*	*35171*	*26523*
H-L	*FC*	*2950*	*23*	*weekly*	*63.0*	*11.6*	*34220*	*26523*
(W.Ger)	*FC*	*2950*	*23*	*weekly*	*63.0*	*11.6*	*34220*	*26523*
NYK	*FC*	*2324*	*23.3*	*weekly*	*63.0*	*11.6*	*26958*	*26523*
(Jap)	*FC*	*2226*	*23.4*	*weekly*	*63.0*	*11.6*	*25822*	*26523*
MOL (Jap)	*FC*	*2872*	*23*	*weekly*	*63.0*	*11.6*	*33315*	*26523*
Subtotal ASS:2805						104.4	292831	
*sub-subroute:EC,Sng,HK,Jap,Kor,TW								
** Itinerary :Southampton>Le Havre>Rotterdam>Hamburg>Sng>HK>Shimizu>Tokyo>Kobe>Busan>Kaohsiung>HK>Sng>Southampton								
H-L	*FC*	*2950*	*23*	*weekly*	*63.0*	*11.6*	*34220*	*25359*
	FC	*2950*	*23*	*weekly*	*63.0*	*11.6*	*34220*	*25359*
	FC	*3430*	*23*	*weekly*	*63.0*	*11.6*	*39788*	*25359*
NYK	*FC*	*3618*	*23*	*weekly*	*63.0*	*11.6*	*41969*	*25359*
	FC	*3618*	*23*	*weekly*	*63.0*	*11.6*	*41969*	*25359*
MOL	*FC*	*3613*	*23.5*	*weekly*	*63.0*	*11.6*	*41911*	*25359*
P&OCL	*FC*	*2910*	*23*	*weekly*	*63.0*	*11.6*	*33756*	*25359*
	FC	*3610*	*23*	*weekly*	*63.0*	*11.6*	*41876*	*25359*
	FC	*3610*	*23*	*weekly*	*63.0*	*11.6*	*41876*	*25359*
Subtotal ASS:2927						104.4	351585	
SCAN DUTCH Group								
*sub-subroute:EC,Sng,HK,Kor,Jap								
** Itinerary :Gothenburg>Hamburg>Bremerhaven>Rotterdam>Le Havre>Sng>HK>Busan>Kobe>Nagoya>Shimizu>Tokyo>HK>Sng>Le Havre>Rotterdam>Hamburg>Gothenburg								
Nedl	*FC*	*2952*	*23*	*weekly*	*56.0*	*13.0*	*38376*	*24541*
(Dutch)	*FC*	*2952*	*23*	*weekly*	*56.0*	*13.0*	*38376*	*24541*
	FC	*2700*	*23*	*weekly*	*56.0*	*13.0*	*35100*	*24541*
EAC	*FC*	*2821*	*24*	*weekly*	*56.0*	*13.0*	*36673*	*24541*
(Denmark)	*FC*	*2821*	*24*	*weekly*	*56.0*	*13.0*	*36673*	*24541*
MISC	*FC*	*2770*	*24*	*weekly*	*56.0*	*13.0*	*36010*	*24541*
(Malaysia)	*FC*	*2770*	*24*	*weekly*	*56.0*	*13.0*	*36010*	*24541*
CGM	*FC*	*2960*	*23*	*weekly*	*56.0*	*13.0*	*38480*	*24541*

(France)

Subtotal ASS:2843 104.0 295698

*sub-subroute:EC,Mid-East,Sng,HK,Kor,Jap
** Itinerary :Gdynia>Rostock>Hamburg>Bremerhaven>Antwerp>Sng>HK>Busan>Kobe>Tokyo>HK>Sng>Antwerp>Hamburg>Gdynia

DSR	*FC*	*1164*	*19*	*14 days*	*112*	*6.5*	*7566*	*27226*
(E.Ger)	*FC*	*1164*	*19*	*14 days*	*112*	*6.5*	*7566*	*27226*
	FC	*1164*	*19*	*14 days*	*112*	*6.5*	*7566*	*27226*
	FC	*1164*	*19*	*14 days*	*112*	*6.5*	*7566*	*27226*
	FC	*946*	*18*	*14 days*	*112*	*6.5*	*6149*	*27226*
	FC	*946*	*18*	*14 days*	*112*	*6.5*	*6149*	*27226*
	FC	*896*	*16*	*14 days*	*112*	*6.5*	*5824*	*27226*
	FC	*896*	*16*	*14 days*	*112*	*6.5*	*5824*	*27226*

Subtotal ASS:1043 52.0 54210

*sub-subroute:EC,Sng,HK,Kor,Jap,TW
** Itinerary :Antwerp>Rotterdam>Bremerhaven>Hamburg>Sng>HK>Busan>Kobe>Tokyo>Keelung>HK>Sng>Antwerp

Maersk	*FC*	*2040*	*24*	*weekly*	*70.0*	*10.4*	*21216*	*23105*
(Denmark)	*FC*	*2040*	*24*	*weekly*	*70.0*	*10.4*	*21216*	*23105*
	FC	*2064*	*24*	*weekly*	*70.0*	*10.4*	*21466*	*23105*
	FC	*3000*	*23*	*weekly*	*70.0*	*10.4*	*31200*	*23105*
	FC	*3000*	*23*	*weekly*	*70.0*	*10.4*	*31200*	*23105*
	FC	*2200*	*20*	*weekly*	*70.0*	*10.4*	*22880*	*23105*
	FC	*2200*	*20*	*weekly*	*70.0*	*10.4*	*22880*	*23105*
	FC	*2700*	*23*	*weekly*	*70.0*	*10.4*	*28080*	*23105*
	FC	*2500*	*23*	*weekly*	*70.0*	*10.4*	*26000*	*23105*
	FC	*2500*	*23*	*weekly*	*70.0*	*10.4*	*26000*	*23105*

Subtotal ASS:2424 104.0 252138

*sub-subroute:EC,Sng,HK,TW,Jap,Kor
** Itinerary :Felixstowe>Rotterdam>Sng>HK>Kaohsiung>Busan>Kobe>Yokohama>Kaohsiung>HK>Sng>Le Havre>Rotterdam>Hamburg>Bremerhaven>Felixstowe

Choyang	*FC*	*2650*	*21*	*weekly*	*63.0*	*11.6*	*30740*	*23128*
(Kor)	*FC*	*2698*	*22*	*weekly*	*63.0*	*11.6*	*31297*	*23128*
	FC	*2698*	*22*	*weekly*	*63.0*	*11.6*	*31297*	*23128*
	FC	*1648*	*21*	*weekly*	*63.0*	*11.6*	*19117*	*23128*
Hanjin	*FC*	*2678*	*22*	*weekly*	*63.0*	*11.6*	*31065*	*23128*
(Kor)	*FC*	*2678*	*22*	*weekly*	*63.0*	*11.6*	*31065*	*23128*
	FC	*1600*	*19.5*	*weekly*	*63.0*	*11.6*	*18560*	*23128*
	FC	*1600*	*19.5*	*weekly*	*63.0*	*11.6*	*18560*	*23128*
	FC	*2668*	*22*	*weekly*	*63.0*	*11.6*	*30949*	*23128*

Subtotal 104.4 242650
* Choyang provides joint service with Hanjin.

*sub-subroute:EC,Mid-East,Sng,HK,TW,Kor,Jap
** Itinerary :Rotterdam>Hamburg>Felixstowe>Antwerp>Le Havre>Marseilles>Naples>Jeddah>Mina Qaboos>Sng>HK>Keelung>Busan>Kobe>Yokohama>Keelung>HK>Kaohsiung>Sng>Colombo>Jeddah>Marseilles>Rotterdam

CMA	*FC*	*1924*	*18*	*10 days*	*90.0*	*8.1*	*15584*	*26910*
(France)	*FC*	*1924*	*18*	*10 days*	*90.0*	*8.1*	*15584*	*26910*
	FC	*1597*	*17.2*	*10 days*	*90.0*	*8.1*	*12936*	*26910*
	FC	*1597*	*17.2*	*10 days*	*90.0*	*8.1*	*12936*	*26910*
	FC	*1597*	*17.2*	*10 days*	*90.0*	*8.1*	*12936*	*26910*
	FC	*1597*	*17.2*	*10 days*	*90.0*	*8.1*	*12936*	*26910*
	FC	*1597*	*17.2*	*10 days*	*90.0*	*8.1*	*12936*	*26910*
	FC	*1797*	*17.2*	*10 days*	*90.0*	*8.1*	*14556*	*26910*
	FC	*1797*	*17.2*	*10 days*	*90.0*	*8.1*	*14556*	*26910*

Subtotal ASS:1714 72.9 124960

*sub-subroute:EC,Mid-East,Sng,HK,Kor,Jap,TW
** Itinerary:Hamburg>Rotterdam>Le Havre>Piraeus>Jeddah>Abu Dhabi>Karachi>Sng>HK>Busan>Osaka>Nagoya>Yokohama>Keelung>HK>Sng>Colombo>Piraeus>Jeddah>Rotterdam>Hamburg

Norasia	*FC*	*1742*	*17*	*weekly*	*91.0*	*8.0*	*13936*	*27078*
(Swiss)	*FC*	*1742*	*17*	*weekly*	*91.0*	*8.0*	*13936*	*27078*
	FC	*1742*	*17*	*weekly*	*91.0*	*8.0*	*13936*	*27078*
	FC	*1742*	*17*	*weekly*	*91.0*	*8.0*	*13936*	*27078*
	FC	*1940*	*17*	*weekly*	*91.0*	*8.0*	*15520*	*27078*
	FC	*1940*	*17*	*weekly*	*91.0*	*8.0*	*15520*	*27078*
	FC	*1940*	*17*	*weekly*	*91.0*	*8.0*	*15520*	*27078*
	FC	*1940*	*17*	*weekly*	*91.0*	*8.0*	*15520*	*27078*
	FC	*1893*	*17.5*	*weekly*	*91.0*	*8.0*	*15144*	*27078*
	FC	*1893*	*17.5*	*weekly*	*91.0*	*8.0*	*15144*	*27078*
Sea-Land	*FC*	*2088*	*21.2*	*weekly*	*91.0*	*8.0*	*16704*	*27078*
(USA)	*FC*	*2448*	*20.1*	*weekly*	*91.0*	*8.0*	*19584*	*27078*
	FC	*1924*	*18*	*weekly*	*91.0*	*8.0*	*15392*	*27078*

Subtotal ASS:2153 104.0 199792
* Sea-Land provides joint service with Norasia.

*sub-subroute:Jap,Kor,TW,Sng,EC,USEC,RTW(WB)
** Itinerary :NY>Norfolk>Charleston>Kingston>Panama>LA>Tokyo>Nagoya>Osaka>Busan>Keelung>Kaohsiung>HK>Sng>Hamburg>Felixstowe>Rotterdam>Antwerp>Le Havre>NY

Evergreen	*FC*	*3428*	*20.7*	*6 days*	*78.0*	*4.7*	*16112*	*25816*
(TW)	*FC*	*3428*	*20.7*	*6 days*	*78.0*	*4.7*	*16112*	*25816*
	FC	*3428*	*20.7*	*6 days*	*78.0*	*4.7*	*16112*	*25816*
	FC	*3428*	*20.7*	*6 days*	*78.0*	*4.7*	*16112*	*25816*
	FC	*3428*	*20.7*	*6 days*	*78.0*	*4.7*	*16112*	*25816*
	FC	*3428*	*20.7*	*6 days*	*78.0*	*4.7*	*16112*	*25816*
	FC	*3428*	*20.7*	*6 days*	*78.0*	*4.7*	*16112*	*25816*
	FC	*3428*	*20.7*	*6 days*	*78.0*	*4.7*	*16112*	*25816*
	FC	*3428*	*20.7*	*6 days*	*78.0*	*4.7*	*16112*	*25816*
	FC	*3428*	*20.7*	*6 days*	*78.0*	*4.7*	*16112*	*25816*
	FC	*3428*	*20.7*	*6 days*	*78.0*	*4.7*	*16112*	*25816*
	FC	*3428*	*20.7*	*6 days*	*78.0*	*4.7*	*16112*	*25816*
	FC	*2728*	*20.5*	*6 days*	*78.0*	*4.7*	*12822*	*25816*

*sub-subroute:Sng,HK,TW,Kor,Jap,USWC,USEC,EC,RTW(EB)
** Itinerary :Sng>HK>Kaohsiung>Keelung>Busan>Osaka>Nagoya>Shimizu>Tokyo>LA>Charleston>Baltimore>NY>Le Havre>Antwerp>Rotterdam>Felixstowe>Hamburg>Colombo>Port Kelang>Sng

	FC	*2728*	*20.5*	*weekly*	*84.0*	*4.4*	*12003*	*26300*

	FC	*2728*	*20.5*	*weekly*	*84.0*	*4.4*	*12003*	*26300*
	FC	*2728*	*20.5*	*weekly*	*84.0*	*4.4*	*12003*	*26300*
	FC	*2728*	*20.5*	*weekly*	*84.0*	*4.4*	*12003*	*26300*
	FC	*2728*	*20.5*	*weekly*	*84.0*	*4.4*	*12003*	*26300*
	FC	*2728*	*20.5*	*weekly*	*84.0*	*4.4*	*12003*	*26300*
	FC	*2728*	*20.5*	*weekly*	*84.0*	*4.4*	*12003*	*26300*
	FC	*2728*	*20.5*	*weekly*	*84.0*	*4.4*	*12003*	*26300*
	FC	*2728*	*20.5*	*weekly*	*84.0*	*4.4*	*12003*	*26300*
	FC	*2728*	*20.5*	*weekly*	*84.0*	*4.4*	*12003*	*26300*
	FC	*2728*	*20.5*	*weekly*	*84.0*	*4.4*	*12003*	*26300*
	FC	*2728*	*20.5*	*weekly*	*84.0*	*4.4*	*12003*	*26300*

Subtotal ASS:3064 113.9 350202

*sub-subroute:EC,Sng,TW,Kor,Jap,USWC,USEC,RTW(EB)
** Itinerary :Antwerp>Felixstowe>Bremerhaven>Rotterdam>Sng>Kaohsiung>Busan>Osaka>Yokohama>SF>LA>Jacksonville>Wilmington>Antwerp

Senator	*FC*	*1923*	*18*	*14 days*	*84.0*	*4.4*	*8461*	*25769*
(W.Ger)	*FC*	*1923*	*18*	*14 days*	*84.0*	*4.4*	*8461*	*25769*
	FC	*1743*	*18*	*14 days*	*84.0*	*4.4*	*7669*	*25769*
	FC	*1743*	*18*	*14 days*	*84.0*	*4.4*	*7669*	*25769*
	FC	*1706*	*18*	*14 days*	*84.0*	*4.4*	*7506*	*25769*
	FC	*1706*	*18*	*14 days*	*84.0*	*4.4*	*7506*	*25769*

*sub-subroute:EC,USEC,USWC,Jap,Kor,TW,HK,Sng,RTW(WB)
** Itinerary :Felixstowe>Bremerhaven>Rotterdam>Antwerp>Philadelphia>Wilmington>LA>SF>Yokohama>Busan>Kaohsiung>HK>Sng>Felixstowe

	FC	*1074*	*19*	*14 days*	*84.0*	*4.4*	*4726*	*29795*
	FC	*1074*	*19*	*14 days*	*84.0*	*4.4*	*4726*	*29795*
	FC	*1743*	*18*	*14 days*	*84.0*	*4.4*	*7669*	*29795*
	FC	*1228*	*18*	*14 days*	*84.0*	*4.4*	*5403*	*29795*
	FC	*1061*	*19*	*14 days*	*84.0*	*4.4*	*4668*	*29795*
	FC	*956*	*17*	*14 days*	*84.0*	*4.4*	*4206*	*29795*

Subtotal ASS:1490 52.8 78670

*sub-subroute:Jap,Kor,TW,HK,Sng,Mid-East,Eur
** Itinerary :Yokohama>Kobe>Busan>Keelung>Kaohsiung>HK>Sng>Colombo>Jeddah>Genoa>Hamburg>Rotterdam>Felixstowe>Antwerp>Le Havre>Genoa>Jeddah>Colombo>Sng>HK>Yokohama

Yangming	*FC*	*1940*	*21.6*	*weekly*	*120*	*6.1*	*11834*
(TW)	*FC*	*1940*	*21.6*	*weekly*	*120*	*6.1*	*11834*
	FC	*1940*	*21.6*	*weekly*	*120*	*6.1*	*11834*
	FC	*1940*	*21.6*	*weekly*	*120*	*6.1*	*11834*
	FC	*1940*	*21.6*	*weekly*	*120*	*6.1*	*11834*
	FC	*1940*	*21.6*	*weekly*	*120*	*6.1*	*11834*
	FC	*1940*	*21.6*	*weekly*	*120*	*6.1*	*11834*
	FC	*1940*	*21.6*	*weekly*	*120*	*6.1*	*11834*
	FC	*1940*	*21.6*	*weekly*	*120*	*6.1*	*11834*
	FC	*1940*	*21.6*	*weekly*	*'120*	*6.1*	*11834*
	FC	*3090*	*20.5*	*weekly*	*120*	*6.1*	*18849*
	FC	*3090*	*20.5*	*weekly*	*120*	*6.1*	*18849*
	FC	*3090*	*20.5*	*weekly*	*120*	*6.1*	*18849*
	FC	*3090*	*20.5*	*weekly*	*120*	*6.1*	*18849*
	FC	*3090*	*20.5*	*weekly*	*120*	*6.1*	*18849*
	FC	*3090*	*20.5*	*weekly*	*120*	*6.1*	*18849*
	FC	*3090*	*20.5*	*weekly*	*120*	*6.1*	*18849*

FC	*3090*	*20.5*	*weekly*	*120*	*6.1*	*18849*

*Subtotal*ASS:2451 109.8 269132

Summary of the Route Analysis on the FE/Europe trade with a call in Korea port by TEU Transport Capacity

TOTAL(Estimate by the study at the end of 1989)	2,511,868

APPENDIX 4-3: ANALYSIS OF TEU TRANSPORT CAPACITY BY SHIPS CALLING AT PORTS IN KOREA ON THE FE/AUSTRALIA AND NEW ZEALAND ROUTE

CARRIERS	TYPE	TEU SLOTS	SPEED	SERVICE FREQUENCY	ROUNDTRIP (DAYS)	NO.of ONEWAY	CAPACITY PER ANNUM	ROUND DISTANCE
*sub-subroute:Aust,Jap,Kor								
** Itinerary :Sydney>Melbourne>Adelaide>Brisbane>Yokohama>Nagoya>Osaka>Busan>Sydney								
AJCL	*FC*	*1228*	*23*	*weekly*	*21.0*	*34.8*	*42734*	*11880*
(UK)	*FC*	*1748*	*24*	*weekly*	*21.0*	*34.8*	*60380*	*11880*
Nippon	*FC*	*1919*	*21.4*	*weekly*	*21.0*	*34.8*	*66781*	*11880*
Subtotal						104.4	170345	
*sub-subroute:Aust,Jap,Kor								
** Itinerary :Sydney>Melbourne>Brisbane>Yokohama>Osaka>Busan>Sydney								
BLP	*FC*	*636*	*16*	*14 days*	*42.0*	*17.4*	*11066*	*10836*
(Aust)	*SC*	*676*	*15.5*	*14 days*	*42.0*	*17.4*	*11762*	*10836*
	SC	*676*	*15.5*	*14 days*	*42.0*	*17.4*	*11762*	*10836*
Subtotal ASS:662						52.2	34590	
*sub-subroute:Kor,Aust								
** Itinerary :Busan>Townsville>Brisbane>Sydney>Melbourne>Adelaide>Busan								
Choyang (Kor)	*FC*	*796*	*18*	*10 days*	*20.0*	*36.5*	*29054*	*12926*
K-Line	*FC*	*1830*	*19.4*	*10 days*	*20.0*	*36.5*	*66795*	*12926*
* Subtotal*						70.0	95849	
*sub-subroute:Jap,Kor,TW,HK,Aust								
** Itinerary :Yokohama>Osaka>Busan>Keelung>Kaohsiung>Brisbane>Sydney>Melbourne>Yokohama								
EAC-HIL	*FC*	*1128*	*16*	*14 days*	*42.0*	*17.4*	*19627*	*10521*
(UK)	*FC*	*1128*	*16*	*14 days*	*42.0*	*17.4*	*19627*	*10521*
	FC	*1107*	*20*	*14 days*	*42.0*	*17.4*	*19262*	*10521*
Subtotal ASS:1121						52.2	58516	
*sub-subroute:Kor,TW,Aust(east)								
** Itinerary :Busan>Keelung>Sydney>Melbourne>Keelung>Busan								
Hanlim	*SC*	*342*	*12.5*	*monthly*	*90.0*	*8.1*	*2770*	*10120*
(Kor)	*SC*	*342*	*12.5*	*monthly*	*90.0*	*8.1*	*2770*	*10120*
	SC	*304*	*12.5*	*monthly*	*90.0*	*8.1*	*2462*	*10120*
Subtotal ASS:329						24.3	8002	
*sub-subroute:Jap,Kor,NZ								
** Itinerary :Tokyo>Nagoya>Kobe>Busan>Auckland>Wellington>Lyttelton>Tokyo								
JNJC	*FC*	*1138*	*17.5*	*14 days*	*42.0*	*17.4*	*19801*	*11783*

	FC	*1466*	*22.4*	*14 days*	*42.0*	*17.4*	*25508*	*11783*
	FC	*1570*	*21.6*	*14 days*	*42.0*	*17.4*	*27318*	*11783*

Subtotal ASS:1391 52.2 72627

*sub-subroute:Jap,Kor,Aust(east)
** Itinerary :Yokohama>Nagoya>Osaka>Busan>Brisbane>Sydney>Melbourne>
Adelaide>Yokohama

MOL	*FC*	*2020*	*19.3*	*weekly*	*42.0*	*17.4*	*35148*	*12368*
(Jap)	*FC*	*1588*	*21.5*	*weekly*	*42.0*	*17.4*	*27631*	*12368*
NLS (Jap)	*FC*	*1588*	*21*	*weekly*	*42.0*	*17.4*	*27631*	*12368*
NYK (Jap)	*FC*	*1584*	*21*	*weekly*	*42.0*	*17.4*	*27562*	*12368*
P&O	*FC*	*1228*	*18*	*weekly*	*42.0*	*17.4*	*21367*	*12368*
(UK)	*FC*	*1748*	*19*	*weekly*	*42.0*	*17.4*	*30415*	*12368*

Subtotal 104.4 169844

*sub-subroute:Jap,Kor,NZ
** Itinerary :Tokyo>Nagoya>Kobe>Moji>Busan>Auckland>Wellington>Lyttelton>
Port Chalmers>Tokyo

MOL	*FC*	*1466*	*22.4*	*14 days*	*70.0*	*10.4*	*15246*
	FC	*1570*	*21.6*	*14 days*	*70.0*	*10.4*	*16328*
	FC	*711*	*15.5*	*14 days*	*70.0*	*10.4*	*7394*
	FC	*485*	*15.5*	*14 days*	*70.0*	*10.4*	*5044*
	FC	*722*	*15.5*	*14 days*	*70.0*	*10.4*	*7509*

Subtotal 52.0 51521

*sub-subroute:NZ,TW,Kor,Jap
** Itinerary :Auckland>Timaru>Napier>Tauranga>Keelung>Busan>Nagoya>Osaka>
Yokohama>Auckland

Tasman	*SC*	*800*	*16*	*15 days*	*60.0*	*12.2*	*9760*	*12191*
(NZ)	*SC*	*800*	*16*	*15 days*	*60.0*	*12.7*	*9760*	*12191*
	SC	*606*	*15*	*15 days*	*60.0*	*12.2*	*7393*	*12191*
	SC	*606*	*15*	*15 days*	*60.0*	*12.2*	*7393*	*12191*

Subtotal ASS:703 48.8 34306

Summary of TEU Transport Capacity on the FE/Australia and New Zealand
Trade calling at Korean port

TOTAL(Estimate by the study at the end of 1989)	695,600

APPENDIX 4-4: ANALYSIS OF TEU TRANSPORT CAPACITY ON KOREA/JAPAN ROUTE

CARRIERS	TYPE	TEU SLOTS	SPEED	SERVICE FREQUENCY	ROUNDTRIP (DAYS)	NO.of ONEWAY	CAPACITY PER ANNUM	ROUND DISTANCE
** Itinerary :Busan>Yokohama>Tokyo>Busan								
Choyang	*FC*	*126*	*13*	*2 a week*	*7.0*	*104.3*	*13142*	*1312*
(Kor)	*FC*	*126*	*13*	*2 a week*	*7.0*	*104.3*	*13142*	*1312*
*Subtotal*ASS:126						208.6	26284	
Chunkyung	*FC*	*157*	*12*	*12 a month*	*7.0*	*104.3*	*16375*	*1312*
(Kor)	*FC*	*157*	*12*	*12 a month*	*7.0*	*104.3*	*16375*	*1312*
	SC	*80*	*12.5*	*12 a month*	*7.0*	*104.3*	*8344*	*1312*
	SC	*80*	*12.5*	*12 a month*	*7.0*	*104.3*	*8344*	*1312*
Subtotal ASS:119						417.2	49438	
** Itinerary :Kobe>Inchon>Kobe								
Choyang	*SC*	*108*	*9.7*	*weekly*	*14*	*52.1*	*5627*	*1414*
(Kor)	*SC*	*108*	*10.4*	*weekly*	*14*	*52.1*	*5627*	*1414*
Subtotal ASS:108						104.2	11254	
** Itinerary :Busan>osaka>Kobe>Busan								
Choyang	*SC*	*108*	*10*	*2 a week*	*7.0*	*104.3*	*11264*	*736*
** Itinerary :Busan>Yokohama>Nagoya>Busan								
KMTC	*FC*	*150*	*12*	*2 a week*	*7.0*	*104.3*	*15645*	*736*
(Kor)	*FC*	*128*	*12*	*2 a week*	*7.0*	*104.3*	*13350*	*736*
** Itinerary :Busan>Kobe>Osaka>Busan								
	FC	*150*	*12*	*2 a week*	*7.0*	*104.3*	*15645*	*736*
	FC	*250*	*15.3*	*2 a week*	*7.0*	*104.3*	*26075*	*736*
Subtotal ASS:186						417.2	70715	
Kukjae	*RR*	*98*	*24*	*11 a month*	*7.0*	*104.3*	*10221*	*736*
(Kor)	*RR*	*98*	*24*	*11 a month*	*7.0*	*104.3*	*10221*	*736*
Subtotal ASS:98						208.6	20442	
Namsung	*FC*	*132*	*12*	*12 a month*	*7.0*	*104.3*	*13768*	*736*
(Kor)	*FC*	*132*	*12*	*12 a month*	*7.0*	*104.3*	*13768*	*736*
Subtotal ASS:132						208.6	27536	
Pan Cont	*FC*	*106*	*12*	*2 a week*	*7.0*	*104.3*	*11056*	*736*
(Kor)	*FC*	*175*	*15*	*2 a week*	*7.0*	*104.3*	*18253*	*736*

Subtotal ASS:141 208.6 29309

** Itinerary :Kobe>Osaka>Busan>Kobe

Pan Ocean	*FC*	*108*	*9.5*	*weekly*	*14*	*52.1*	*5627*	*1472*
(Kor)	*FC*	*279*	*11*	*weekly*	*14*	*52.1*	*14536*	*1472*

** Itinerary :Kobe>Osaka>Yokohama>Busan>Kobe

	FC	*182*	*11.5*	*weekly*	*14*	*52.1*	*9482*	*1472*
	FC	*279*	*12*	*weekly*	*14*	*52.1*	*14536*	*1472*

** Itinerary :Yokohama>Tokyo>Kobe>Osaka>Busan>Yokohama

Pan Ocean	*SC*	*108*	*9.5*	*weekly*	*14.0*	*52.1*	*5627*
	RR	*152*	*11*	*weekly*	*14.0*	*52.1*	*7919*

Subtotal 312.6 57727

** Itinerary :Busan>Kobe>Busan

Maersk	*FC*	*436*	*16*	*weekly*	*7.0*	*104.3*	*45475*	*716*

** Itinerary :Busan>Yokohama>Busan

APL	*FC*	*1400*	*23.5*	*weekly*	*7.0*	*104.3*	*146020*	*1292*
Hanjin	*FC*	*760*	*15.5*	*weekly*	*7.0*	*104.3*	*79268*	*1292*
Namsung	*SC*	*78*	*12*	*10 a month*	*7.0*	*104.3*	*8135*	*1292*
	SC	*78*	*11.5*	*10 a month*	*7.0*	*104.3*	*8135*	*1292*
	SC	*78*	*11.5*	*10 a month*	*7.0*	*104.3*	*8135*	*1292*
	SC	*78*	*11.5*	*10 a month*	*7.0*	*104.3*	*8135*	*1292*
	SC	*78*	*12*	*10 a month*	*7.0*	*104.3*	*8135*	*1292*

Subtotal ASS:78 521.5 40675

** Itinerary :Nagoya>Busan>Nagoya

Chunkyung	*SC*	*80*	*12.5*	*6 a month*	*7.0*	*104.3*	*8344*	*1010*
	BB	*40*	*12*	*6 a month*	*7.0*	*104.3*	*4172*	*1010*

Subtotal ASS:60 208.6 12516

** Itinerary: Keihn>Busan>Keihn

Heung-A	*FC*	*120*	*14.6*	*2 a week*	*7.0*	*104.3*	*12516*	*1010*
(Kor)	*FC*	*84*	*12.5*	*2 a week*	*7.0*	*104.3*	*8761*	*1010*

** Itinerary: Busan>Nagoya>Busan

Heung-A	*FC*	*106*	*14.6*	*weekly*	*7.0*	*104.3*	*11056*	*1010*

Subtotal 312.9 32333

** Itinerary :Osaka>Kobe>Busan>Inchon>Osaka

Chunkyung	*SC*	*40*	*12.5*	*4 a month*	*14.0*	*52.1*	*2084*	*2888*
	SC	*40*	*12.5*	*4 a month*	*14.0*	*52.1*	*2084*	*2888*

** Itinerary :Nagoya>Busan>Nagoya

	SC	*80*	*12.5*	*6 a month*	*14.0*	*52.1*	*4168*
	BB	*29*	*12*	*6 a month*	*14.0*	*52.1*	*1511*
Subtotal						208.4	9847

Summary of TEU Transport Capacity on the Korea/Japan Trade

TOTAL(Estimate by the study at the end of 1989)	670,103

APPENDIX 4-5: ANALYSIS OF TEU TRANSPORT CAPACITY BY SHIPS CALLING AT PORTS IN KOREA ON THE INTRA-ASIAN ROUTE

CARRIERS	TYPE	TEUD SLOTS	SPEED	SERVICE FREQUENCY	ROUNDTRIP (DAYS)	NO.of ONEWAY	CAPACITY PER ANNUM	ROUND DISTANCE

*sub-subroute:Bang,HK,Jap,Kor
** Itinerary :Chalna>HK>Yokohama>Kobe>Inchon>HK>Chalna

Atlas	*SC*	*200*	*13.3*	*2 a month*	*30.0*	*24.3*	*4860*	*9573*
(Bang)	*SC*	*260*	*15*	*2 a month*	*30.0*	*24.3*	*6318*	*9573*
Subtotal ASS:230						48.6	11178	

*sub-subroute:Jap,Kor,TW,HK,Mal,Sng
** Itinerary :Tokyo>Yokohama>Busan>Keelung>HK>Port Kelang>Sng>HK>Keelung> Tokyo

Cheng Lie	*FC*	*716*	*16*	*weekly*	*28.0*	*26.1*	*18688*	*5839*
(TW)	*FC*	*716*	*16*	*weekly*	*28.0*	*26.1*	*18688*	*5839*
	SC	*746*	*16*	*weekly*	*28.0*	*26.1*	*19471*	*5839*
	SC	*746*	*16*	*weekly*	*28.0*	*26.1*	*19471*	*5839*
Subtotal ASS:731						104.4	76318	

*sub-subroute:Jap,Kor,TW,HK,Sng
** Itinerary :Tokyo>Kobe>Busan>Keelung>HK>Sng>Istanbul>Alexandria>Tokyo>

Concord	*SC*	*711*	*15.5*	*weekly*	*63.0*	*11.6*	*8248*	*5772*
(Jap)	*SC*	*485*	*15.5*	*weekly*	*63.0*	*11.6*	*5626*	*5772*
	SC	*722*	*15.5*	*weekly*	*63.0*	*11.6*	*8375*	*5772*
	SC	*756*	*16.0*	*weekly*	*63.0*	*11.6*	*8770*	*5772*
	SC	*756*	*16.0*	*weekly*	*63.0*	*11.6*	*8770*	*5772*
	SC	*756*	*16.0*	*weekly*	*63.0*	*11.6*	*8770*	*5772*
	SC	*928*	*17*	*weekly*	*63.0*	*11.6*	*10765*	*5772*
	SC	*928*	*17*	*weekly*	*63.0*	*11.6*	*10765*	*5772*
Subtotal ASS:756						92.8	69909	

*sub-subroute:Kor,TW,HK,SE Asia
**Itinerary:Inchon>Busan>Keelung>HK>Jakarta>Penang>Port Kelang>Sng>Inchon

Dongnama	*FC*	*480*	*14.5*	*4 a month*	*28.0*	*26.1*	*12528*	*7306*
(Kor)	*FC*	*480*	*14.5*	*4 a month*	*28.0*	*26.1*	*12528*	*7306*
	FC	*586*	*14*	*4 a month*	*28.0*	*26.1*	*15295*	*7306*
	FC	*672*	*15.2*	*4 a month*	*28.0*	*26.1*	*17539*	*7306*
Subtotal ASS:555						104.4	57890	

*sub-subroute:Kor,TW,HK
** itinerary :Inchon>Busan>Keelung>HK>Inchon

Dongnama	*FC*	*250*	*13*	*10 days*	*30.0*	*24.3*	*6075*	*2584*
(Kor)	*FC*	*250*	*13*	*10 days*	*30.0*	*24.3*	*6075*	*2584*
	FC	*274*	*12.5*	*10 days*	*30.0*	*24.3*	*6658*	*2584*

Subtotal ASS:258 72.9 18808

*sub-subroute:Jap,Kor,TW,HK,Thai
**Itinerary:Osaka>Kobe>Moji>Busan>Keelung>Kaohsiung>HK>Bangkok>Kaohsiung>

Evergreen	*FC*	*964*	*17*	*7 days*	*35.0*	*20.9*	*20148*	*5496*
(TW)	*FC*	*956*	*17*	*7 days*	*35.0*	*20.9*	*19980*	*5496*
	FC	*956*	*17*	*7 days*	*35.0*	*20.9*	*19980*	*5496*
	CC	*926*	*16*	*7 days*	*35.0*	*20.9*	*19353*	*5496*
	CC	*926*	*16*	*7 days*	*35.0*	*20.9*	*19353*	*5496*

Subtotal ASS:946 104.5 98814

*sub-subroute:HK,TW,PRC,Kor
** Itinerary :HK>Keelung>Shangai>Qindao>Busan>HK

Fairweather	*FC*	*330*	*13*	*14 days*	*42.0*	*17.4*	*5742*	*2546*
(HK)	*FC*	*342*	*17*	*14 days*	*42.0*	*17.4*	*5951*	*2546*
	CC	*436*	*18*	*14 days*	*42.0*	*17.4*	*7586*	*2546*

Subtotal ASS:370 52.2 19279

*sub-subroute:Kor,TW,HK,SE Asia
**Itinerary:Busan>Inchon>Keelung>HK>Bangkok>Sng>Port Kelang>Manila>Busan

Heung-A	*FC*	*420*	*13*	*2 days*	*24.0*	*30.4*	*12768*	*6943*
(Kor)	*FC*	*284*	*14*	*2 days*	*24.0*	*30.4*	*8634*	*6943*
	FC	*250*	*12.7*	*2 days*	*24.0*	*30.4*	*7600*	*6943*
	SC	*256*	*13*	*2 days*	*24.0*	*30.4*	*7782*	*6943*
	SC	*206*	*14*	*2 days*	*24.0*	*30.4*	*6262*	*6943*
	SC	*188*	*16.8*	*2 days*	*24.0*	*30.4*	*5715*	*6943*
	SC	*188*	*16.8*	*2 days*	*24.0*	*30.4*	*5715*	*6943*
	SC	*292*	*15.5*	*2 days*	*24.0*	*30.4*	*8877*	*6943*
	SC	*292*	*13.5*	*2 days*	*24.0*	*30.4*	*8877*	*6943*
	SC	*184*	*15*	*2 days*	*24.0*	*30.4*	*5594*	*6943*
	SC	*132*	*12.7*	*2 days*	*24.0*	*30.4*	*4013*	*6943*
	SC	*354*	*13*	*2 days*	*24.0*	*30.4*	*10762*	*6943*

Subtotal ASS:254 364.8 92599

*sub-subroute:Kor,TW,HK,Phil
** Itinerary :Busan>Inchon>Keelung>Kaohsiung>HK>Manila>Busan

Kien Hung	*FC*	*569*	*15*	*weekly*	*35.0*	*20.9*	*11892*	*3511*
(TW)	*FC*	*324*	*14*	*weekly*	*35.0*	*20.9*	*6772*	*3511*
	CC	*414*	*14*	*weekly*	*35.0*	*20.9*	*8653*	*3511*
	CC	*212*	*13*	*weekly*	*35.0*	*20.9*	*4431*	*3511*
	SC	*271*	*13.5*	*weekly*	*35.0*	*20.9*	*5664*	*3511*

Subtotal ASS:358 104.5 37412

*sub-subroute:Jap,Kor,TW,HK,Sng,SE Asia
** Itinerary :Tokyo>Yokohama>Nagoya>Kobe>Shimizu>Busan>Keelung>Kaohsiung>HK>Sng>Port Kelang>Jakarta>Sng>Kaohsiung>Keelung>Tokyo

NYK	*FC*	*1165*	*22*	*weekly*	*21.0*	*34.8*	*40542*	*8151*
(Jap)	*FC*	*1036*	*22*	*weekly*	*21.0*	*34.8*	*36053*	*8151*
	SC	*672*	*16*	*weekly*	*21.0*	*34.8*	*23386*	*8151*

Subtotal ASS:958 104.4 99981

*sub-subroute:Jap,Kor,TW,HK,Sng,SE Asia
** Itinerary :Yokohama>Nagoya>Kobe>Busan>Keelung>Kohsiung>HK>Sng>Jakarta>Yokohama

Pacific	*FC*	*1152*	*17*	*12 days*	*24.0*	*30.4*	*35021*	*6940*
(Sng)	*FC*	*1152*	*17*	*12 days*	*24.0*	*30.4*	*35021*	*6940*

Subtotal ASS:1152 60.8 70042

*sub-subroute:HK,Kor
** Itinerary :HK>Busan>HK

Seapak	*SC*	*176*	*12*	*weekly*	*21.0*	*34.8*	*6125*	*1856*
(HK)	*SC*	*172*	*12.3*	*weekly*	*21.0*	*34.8*	*5986*	*1856*
	SC	*259*	*11.5*	*weekly*	*21.0*	*34.8*	*9013*	*1856*

Subtotal ASS:202 104.4 21124

*sub-subroute:Jap,Kor,TW,HK,Sng,SE Asia
** Itinerary :Osaka>Kobe>Busan>Keelung>Kaohsiung>Manila>Sng>Port Kelang>Sng>Manila>Kaohsiung>Keelung>Osaka

Uniglory	*FC*	*964*	*16.5*	*7 days*	*21.0*	*34.8*	*33547*	*6446*
(TW)	*FC*	*956*	*16.5*	*7 days*	*21.0*	*34.8*	*33173*	*6446*
	FC	*956*	*16.5*	*7 days*	*21.0*	*34.8*	*33173*	*6446*

Subtotal ASS:960 104.4 99893

*sub-subroute:HK,TW,Kor
** Itinerary :HK>Kaohsiung>Keelung>Busan>HK

Wan Hai	*FC*	*444*	*14.5*	*7 days*	*14.0*	*52.1*	*23132*	*1856*
(TW)	*FC*	*431*	*13*	*7 days*	*14.0*	*52.1*	*22455*	*1856*

Subtotal ASS:438 104.2 45587

Summary of TEU Transport Capacity on the Intra-Asian Trade
calling at Korean port

TOTAL(Estimate by the study at the end of 1989) 818,834

APPENDIX 5. COMPUTATION OF CONTAINERSHIP VOYAGE COSTS ON THE SAMPLED ROUTES

APPENDIX 5. NOTES ON COMPUTATION OF VOYAGE COSTS FOR CONTAINERSHIPS

Numbers in ( ) represent column code in Appendices 5-1, 5-2, 5-3, 5-4, 5-5 and 5-6.

(1) Ship Size(TEUs)

(2) Ship speed(knots)

(3) Ship's capital cost(US$million)

(4) Annuity factor

(5) Annual ship capital cost(US$m)

(6) Daily ship capital cost(US$) = (5)/350(ship's operating day per annum)

(7) Crew numbers

(8) Annual crew cost(US$) per man

(9) Daily crew cost(US$) = (8) X (7)/350

(10) Annual maintenance and insurance cost(US$m) = (3) X 0.06

(11) Daily maintenance and insurance cost(US$) = (10)/350

(12) Daily operating cost(US$) = (9) + (11)

(13) Actual Installed BHP

(14) Service BHP = (13) X 0.85

(15) Daily MFO cost(US$) = Fuel bunker(tonnes) X per ton

(16) Daily Lubricating oil cost(US$) = (14) X 24/1000000 X 250

(17) Daily Marine Diesel oil cost(US$) = 3 X 170 or 3.5 X 170

(18) Daily Fuel cost(US$) at sea = (15) + (16) + (17)

(19) Daily cost at sea(US$) = (6) + (12) + (18)

(20) Roundtrip distance(nautical miles)

(21) Ship's time at sea(days) = (20)/(2) X 24

(22) Load factor(90%)

(23) Boxes carried on board = (1) X (22)

(24) Ship's time in port(days)

(25) Cost per trip at sea(US$) = (19) X (21)

(26) Cost per TEU at sea(US$)(oneway) = (25)/(23)/2

(27) Daily fuel cost in port(US$) = 4.5 or 5.0 X 170

(28) Daily ship cost in port(US$) = (6) + (12) + (27)

(29) Cost per trip in port (US$) = (28) X (24)

(30) Cost per TEU in port(oneway)(US$) = (29)/(23)/2

(31) Ship cost per TEU(US$)(oneway) without cont. and inventory = (30) + (26)

(32) Total roundtrip time(days) = (21) + (24)

(33) Daily container(TEU) cost(US$)

(34) Containers cost(US$) = (33) X containers(%) X days(delay)

(35) Total ship costs(US$) per trip with container = (25) + (29) + (34) + port charges

5-1. COMPUTATION OF VOYAGE COST ON THE WCNA-FE ROUTE (EXISTING ITINERARY)

Ships sampled	(1) Ship size (TEUs)	(2) Speed (knots)	(3) Capital cost (US$m)	(4) Annuity factor	(5) Annual capital (US$m)	(6) Daily capital (US$)	(7) Crew NO.	(8) Annual crew (US$)	(9) Daily crew (US$)
Ship A1	5300	22.0	105.0	8.5134	12.3	35143	16	50000	2286
Ship B1	4340	24.3	100.0	8.5134	11.8	33714	16	50000	2286
Ship C1	4000	24.0	93.0	8.5134	10.9	31143	16	50000	2286
Ship D1	3428	20.8	75.0	8.5134	8.8	25143	16	50000	2286
Ship E1	2670	21.7	64.0	8.5134	7.5	21429	16	50000	2286

	(10) Annual M & I (US$m)	(11) Daily M & I (US$)	(12) Daily oper. (US$)	(13) Installed BHP	(14) Service BHP	(15) Daily MFO (US$)	(16) Daily Lub. (US$)	(17) Daily MDO (US$)	(18) Daily Fuel at sea	(19) Daily cost at sea
A1	6.3	18000	20286	56960	48416	12200	291	595	13086	68515
B1	6.0	17143	19429	56960	48416	12200	291	595	13086	66229
C1	5.6	16000	18286	57643	48997	11665	294	595	12554	61983
D1	4.5	12857	15143	23180	19703	6040	118	595	6753	47039
E1	3.8	10857	13143	28350	24098	6760	145	510	7415	41987

	(20) Route length (NM)	(21) Time at sea (days)	(22) Load factor (90%)	(23) Boxes carried (TEUs)	(24) Time in port (days)	(25) Cost at sea (US$)	(26) Cost per TEU at sea(US$) (oneway)	(27) Daily fuel in port(US$)	(28) Daily ship in port
A1	13138	24.9	0.9	4770	13.8	1706024	178.8	850	56279
B1	13138	22.6	0.9	3906	12.0	1496775	191.6	850	53993
C1	13138	22.8	0.9	3600	11.4	1413212	196.3	850	50279
D1	13138	26.4	0.9	3085	10.3	1241830	201.3	850	41136
E1	13138	25.2	0.9	2403	8.9	1058072	220.2	765	35337

	(29) Cost per trip in port(US$)	(30) Cost/TEU in port (oneway)	(31) Ship cost per TEU(US$) (oneway)	(32) Roundtrip time (days)	(33) Daily container(TEU) cost(US$)
A1	776650	81.4	260.2	38.7	1.395
B1	647916	82.9	274.5	34.6	1.395
C1	573181	79.6	275.9	34.2	1.395
D1	423701	68.7	270.0	36.7	1.395
E1	314499	65.4	285.6	34.1	1.395

	(34) Containers cost (US$)	(35) Total ship costs(US$) per trip with container
A1	4806	2514047
B1	3935	2172025
C1	3627	2011119
D1	3108	1688365
E1	2421	1389386

5-2. COMPUTATION OF VOYAGE COSTS ON THE WCNA-FE ROUTE(DIVERSION CASE)

Ships sampled	(1) Ship size (TEUs)	(2) Speed (knots)	(3) Capital cost (US$m)	(4) Annuity factor	(5) Annual capital (US$m)	(6) Daily capit. (US$)	(7) Crew NO.	(8) Annual crew (US$)	(9) Daily crew (US$)	(10) Annual M & I (US$m)
Ship A1	5300	22.0	105.0	8.5134	12.3	35143	16	50000	2286	6.3
Ship B1	4340	24.3	100.0	8.5134	11.8	33714	16	50000	2286	6.0
Ship C1	4000	24.0	93.0	8.5134	10.9	31143	16	50000	2286	5.6
Ship D1	3428	20.8	75.0	8.5134	8.8	25143	16	50000	2286	4.5
Ship E1	2670	21.7	64.0	8.5134	7.5	21429	16	50000	2286	3.8

	(11) Daily M&I(US$)	(12) Daily oper.(US$)	(13) Installed BHP	(14) Service BHP	(15) Daily MFO(US$)	(16) Daily Lub(US$)	(17) Daily MDO(US$)	(18) Daily fuel at sea(US$)
A1	18000	20286	46960	48416	12200	291	595	13086
B1	17143	19429	56960	48416	12200	291	595	13086
C1	16000	18286	57643	48997	11665	294	595	12554
D1	12857	15143	23180	19703	6040	118	595	6753
E1	10857	13143	28350	24098	6760	145	510	7415

	(19) Daily cost at sea	(20) Route length (NM)	(21) Time at sea (days)	(22) Load factor (90%)	(23) Boxes carried (TEUs)	(24) Time in port (days)	(25) Cost at sea (US$)	(26) Cost/TEU at sea(US$) (oneway)	(27) Daily fuel in port (US$)
A1	68515	13905	26.3	0.9	4770	15.8	1801945	188.9	850
B1	66229	13905	23.9	0.9	3906	14.0	1582873	202.6	850
C1	61983	13905	24.1	0.9	3600	13.4	1493790	207.5	850
D1	47039	13905	27.9	0.9	3085	12.3	1312388	212.7	850
E1	41987	13905	26.7	0.9	2403	10.9	1121053	233.3	765

	(28) Daily ship cost in port(US$)	(29) Cost per trip in port(US$)	(30) Cost/TEU in port (oneway)	(31) Ship cost per TEU (oneway)	(32) Roundtrip Time (days)	(33) Daily container (TEU) cost (US$)
A1	56279	889208	93.2	282.1	42.1	1.395
B1	53993	755902	96.7	299.3	37.9	1.395
C1	50279	673739	93.5	301.0	37.5	1.395
D1	41136	501859	81.3	294.0	40.2	1.395
E1	35337	385173	80.1	313.4	37.6	1.395

	(34) Container cost (US$)	(35) Total ship costs(US$) per trip with container
A1	9612	2736960
B1	7870	2379487
C1	7254	2205191
D1	6216	1849418
E1	4842	1531621

5-3. COMPUTATION OF VOYAGE COST ON THE WCNA-FE ROUTE (INCHON PLUS BUSAN)

Ships sampled	(1) Ship size (TEUs)	(2) Speed (knots)	(3) Capital cost (US$m)	(4) Annuity factor	(5) Annual capit. (US$m)	(6) Daily capit. (US$)	(7) Crew NO.	(8) Annual crew (US$)	(9) Daily crew (US$)	(10) Annu. M & I (US$m)
Ship A1	5300	22.0	105.0	8.5134	12.3	35143	16	50000	2286	6.3
Ship B1	4340	24.3	100.0	8.5134	11.8	33714	16	50000	2286	6.0
Ship C1	4000	24.0	93.0	8.5134	10.9	31143	16	50000	2286	5.6
Ship D1	3428	20.8	75.0	8.5134	8.8	25143	16	50000	2286	4.5
Ship E1	2670	21.7	64.0	8.5134	7.5	21429	16	50000	2286	3.8

	(11) Daily M&I(US$)	(12) Daily op. (US$)	(13) Installed BHP	(14) Service BHP	(15) Daily MFO	(16) Daily Lub.(US$)	(17) Daily MDO(US$)	(18) Daily fuel at sea(US$)
A1	18000	20286	56960	48416	12200	291	595	13086
B1	17143	19429	56960	48416	12200	291	595	13086
C1	16000	18286	57643	48997	11665	294	595	12554
D1	12857	15143	23180	19703	6040	118	595	6753
E1	10857	13143	28350	24098	6760	145	510	7415

	(19) Daily cost at sea	(20) Route length (NM)	(21) Time at sea (days)	(22) Load factor (90%)	(23) Boxes carried (TEUs)	(24) Time in port (days)	(25) Cost at sea (US$)	(26) Cost/TEU at sea(US$) (oneway)	(27) Daily fuel in port (US$)
A1	68515	13921	26.4	0.9	4770	16.8	1808796	189.6	850
B1	66229	13921	23.9	0.9	3906	15.0	1582873	202.6	850
C1	61983	13921	24.2	0.9	3600	14.4	1499989	208.3	850
D1	47039	13921	27.9	0.9	3085	13.2	1312388	212.7	850
E1	41987	13921	26.7	0.9	2403	11.9	1121053	233.3	765

	(28) Daily ship(US$) in port	(29) Cost per trip in port(US$)	(30) Cost/TEU in port(US$) (oneway)	(31) Ship cost/ TEU(US$) (oneway)	(32) Roundtrip time(days)	(33) Daily cont. (TEU) (US$)
A1	56279	945487	99.1	288.7	43.2	1.395
B1	53993	809895	103.6	306.2	38.9	1.395
C1	50279	724018	100.5	308.8	38.6	1.395
D1	41136	542995	88.0	300.7	41.1	1.395
E1	35337	420510	87.5	320.8	38.6	1.395

	(34) Containers cost (US$)	(35) Total ship costs(US$) per trip with container
A1	14418	2831463
B1	11805	2460814
C1	10881	2286395
D1	9324	1913388
E1	7263	1583773

5-4. COMPUTATION OF VOYAGE COSTS ON THE EUROPE-FE ROUTE(EXISTING ITINERARY)

Ships sampled	(1) Ship size (TEUs)	(2) Speed (knots)	(3) Capital cost (US$m)	(4) Annuity factor	(5) Annual capit. (US$m)	(6) Daily capit. (US$)	(7) Crew NO.	(8) Annual crew (US$)	(9) Daily crew (US$)	(10) Annu. M & I (US$m)
Ship A1	5300	22.0	105.0	8.5134	12.3	35143	16	50000	2286	6.3
Ship B1	4340	24.3	100.0	8.5134	11.8	33714	16	50000	2286	6.0
Ship C1	4000	24.0	93.0	8.5134	10.9	31143	16	50000	2286	5.6
Ship D1	3428	20.8	75.0	8.5134	8.8	25143	16	50000	2286	4.5
Ship E1	2670	21.7	64.0	8.5134	7.5	21429	16	50000	2286	3.8

	(11) Daily M&I(US$)	(12) Daily op. (US$)	(13) Installed BHP	(14) Service BHP	(15) Daily MFO	(16) Daily Lub.(US$)	(17) Daily MDO(US$)	(18) Daily fuel at sea(US$)
A1	18000	20286	56960	48416	12200	291	595	13086
B1	17143	19429	56960	48416	12200	291	595	13086
C1	16000	18286	57643	48997	11665	294	595	12554
D1	12857	15143	23180	19703	6040	118	595	6753
E1	10857	13143	28350	24098	6760	145	510	7415

	(19) Daily cost at sea	(20) Route length (NM)	(21) Time at sea (days)	(22) Load factor (90%)	(23) Boxes carried (TEUs)	(24) Time in port (days)	(25) Cost at sea (US$)	(26) Cost/TEU at sea(US$) (oneway)	(27) Daily fuel in port (US$)
A1	68515	23154	43.9	0.9	4770	13.8	3007809	315.3	850
B1	66229	23154	39.8	0.9	3906	12.0	2635914	337.4	850
C1	61983	23154	40.2	0.9	3600	11.4	2491717	346.1	850
D1	47039	23154	46.5	0.9	3085	10.3	2187314	354.5	850
E1	41987	23154	44.5	0.9	2403	8.9	1868422	388.8	765

	(28) Daily ship(US$) in port	(29) Cost per trip in port(US$)	(30) Cost/TEU in port(US$) (oneway)	(31) Ship cost/ TEU(US$) (oneway)	(32) Roundtrip time(days)	(33) Daily cont. (TEU)(US$)
A1	56279	776650	81.4	396.7	57.7	1.395
B1	53993	647916	82.9	420.3	51.8	1.395
C1	50279	573181	79.6	425.7	51.6	1.395
D1	41136	423701	68.7	423.2	56.8	1.395
E1	35337	314499	65.4	454.2	53.4	1.395

	(34) Containers cost (US$)	(35) Total ship costs(US$) per trip with container
A1	2957	3813983
B1	2422	3309651
C1	2232	3088229
D1	1913	2632654
E1	1490	2198805

5-5. COMPUTATION OF VOYAGE COSTS ON THE EUROPE-FE ROUTE(DIVERSION CASE)

Ships sampled	(1) Ship size (TEUs)	(2) Speed (knots)	(3) Capit. cost (US$m)	(4) Annuity factor	(5) Annual capit. (US$m)	(6) Daily capit. (US$m)	(7) Crew NO.	(8) Annual crew (US$)	(9) Daily crew (US$)	(10) Annual M & I (US$m)
Ship A1	5300	22.0	105.0	8.5134	12.3	35143	16	50000	2286	6.3
Ship B1	4340	24.3	100.0	8.5134	11.8	33714	16	50000	2286	6.0
Ship C1	4000	24.0	93.0	8.5134	10.9	31143	16	50000	2286	5.6
Ship D1	3428	20.8	75.0	8.5134	8.8	25143	16	50000	2286	4.5
Ship E1	2670	21.7	64.0	8.5134	7.5	21429	16	50000	2286	3.8

	(11) Daily M&I(US$)	(12) Daily op.(US$)	(13) Installed BHP	(14) Service BHP	(15) Daily MFO(US$)	(16) Daily Lub.	(17) Daily MDO(US$)	(18) Daily fuel at sea(US$)
A1	18000	20286	56960	48416	12200	291	595	13086
B1	17143	19429	56960	48416	12200	291	595	13086
C1	16000	18286	57643	48997	11665	294	595	12554
D1	12857	15143	23180	19703	6040	118	595	6753
E1	10857	13143	28350	24098	6760	145	510	7415

	(19) Daily cost at sea	(20) Route length (NM)	(21) Time at sea (days)	(22) Load factor (90%)	(23) Boxes carried (TEUs)	(24) Time in port (days)	(25) Cost at sea (US$)	(26) Cost/TEU at sea(US$) (oneway)	(27) Daily fuel in port (US$)
A1	68515	23921	45.3	0.9	4770	15.8	3103730	325.3	850
B1	66229	23921	41.1	0.9	3906	14.0	2722012	348.4	850
C1	61983	23921	41.5	0.9	3600	13.4	2572295	357.3	850
D1	47039	23921	48.0	0.9	3085	12.3	2257872	365.9	850
E1	41987	23921	45.9	0.9	2403	10.9	1927203	401.1	765

	(28) Daily ship(US$) in port	(29) Cost per trip in port(US$)	(30) Cost/TEU in port(US$) (oneway)	(31) Ship cost/ TEU(US$) (oneway)	(32) Roundtrip time (days)	(33) Daily cont. (TEU) (US$)
A1	56279	889208	93.2	418.5	61.1	1.395
B1	53993	755902	96.7	445.1	55.1	1.395
C1	50279	673739	93.5	450.8	54.9	1.395
D1	41136	501859	81.3	447.2	60.3	1.395
E1	35337	385173	80.1	481.2	56.8	1.395

	(34) Containers cost (US$)	(35) Total ship costs(US$) per trip with container
A1	5915	4035048
B1	4844	3515600
C1	4464	3280906
D1	3826	2792512
E1	2980	2335909

5-6. COMPUTATION OF VOYAGE COST ON THE EUROPE-FE ROUTE(INCHON PLUS BUSAN)

Ships sampled	(1) Ship size (TEUs)	(2) Speed (knots)	(3) Capit. cost (US$m)	(4) Annuity factor	(5) Annual capit. (US$m)	(6) Daily capit. (US$m)	(7) Crew NO.	(8) Annual crew (US$)	(9) Daily crew (US$)	(10) Annual M & I (US$m)
Ship A1	5300	22.0	105.0	8.5134	12.3	35143	16	50000	2286	6.3
Ship B1	4340	24.3	100.0	8.5134	11.8	33714	16	50000	2286	6.0
Ship C1	4000	24.0	93.0	8.5134	10.9	31143	16	50000	2286	5.6
Ship D1	3428	20.8	75.0	8.5134	8.8	25143	16	50000	2286	4.5
Ship E1	2670	21.7	64.0	8.5134	7.5	21429	16	50000	2286	3.8

	(11) Daily M&I(US$)	(12) Daily op.(US$)	(13) Installed BHP	(14) Service BHP	(15) Daily MFO(US$)	(16) Daily Lub.	(17) Daily MDO(US$)	(18) Daily fuel at sea(US$)
A1	18000	20286	56960	48416	12200	291	595	13086
B1	17143	19429	56960	48416	12200	291	595	13086
C1	16000	18286	57643	48997	11665	294	595	12554
D1	12857	15143	23180	19703	6040	118	595	6753
E1	10857	13143	28350	24098	6760	145	510	7415

	(19) Daily cost at sea	(20) Route length (NM)	(21) Time at sea (days)	(22) Load factor (90%)	(23) Boxes carried (TEUs)	(24) Time in port (days)	(25) Cost at sea (US$)	(26) Cost/TEU at sea(US$) (oneway)	(27) Daily fuel in port (US$)
A1	68515	23937	45.4	0.9	4770	16.8	3110581	326.1	850
B1	66229	23937	41.1	0.9	3906	15.0	2722012	348.4	850
C1	61983	23937	41.6	0.9	3600	14.4	2578493	358.1	850
D1	47039	23937	48.1	0.9	3085	13.2	2262576	366.7	850
E1	41987	23937	46.0	0.9	2403	11.9	1931402	401.9	765

	(28) Daily ship(US$) in port	(29) Cost per trip in port(US$)	(30) Cost/TEU in port(US$) (oneway)	(31) Ship cost/ TEU(US$) (oneway)	(32) Roundtrip time (days)	(33) Daily con. (TEU)(US$)
A1	56279	945487	99.1	425.2	62.2	1.395
B1	53993	809895	103.6	452.0	56.1	1.395
C1	50279	724018	100.5	458.6	56.0	1.395
D1	41136	542995	88.0	454.7	61.3	1.395
E1	35337	420510	87.5	489.4	57.9	1.395

	(34) Containers cost (US$)	(35) Total ship costs(US$) per trip with container
A1	8871	4127701
B1	7266	3595414
C1	6696	3360714
D1	5739	2859991
E1	4470	2391329