# Port Development in relation to the Economies of Scale in Tanker and Container Shipping

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# DECLARATION

This is to certify that dissertation was submitted in order to obtain dual degrees of Master of Business Administration from the Department of Shipping Management at the Graduate School of Korea Maritime University

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# Port Development in Relation to the Economies of Scale in Tanker and Container Shipping

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# 1. Introductions

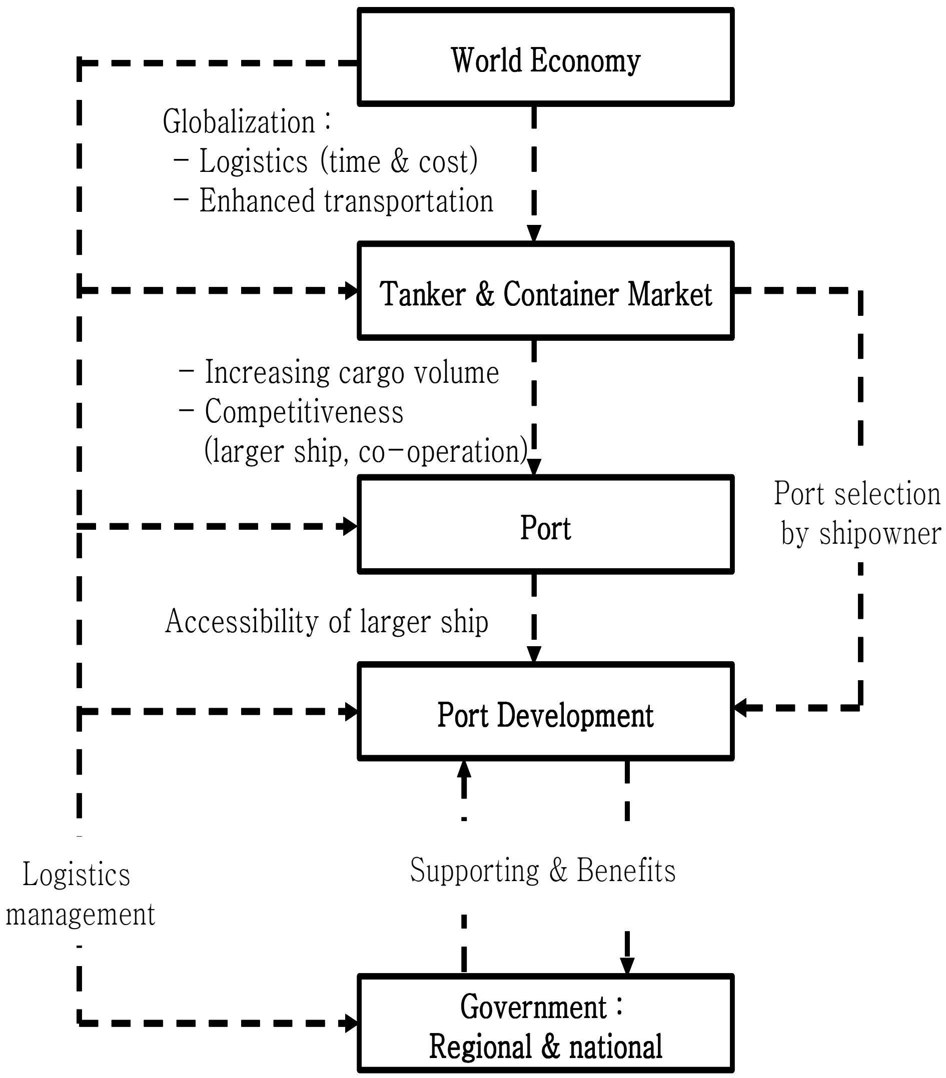
Seaborne trade is obviously a main transportation method. Any environmental and technical advancement must follow changes in growth in order to prevent barriers to growth. Nowadays, the shipping industry is undergoing changes and stimulating by structural changes in the world economy. Due to these changes, ship size is getting bigger and bigger as one method of achieving operational and managerial competitiveness. Moreover, logistics management, which has evolved as a result of globalization process, has enhanced the performance expectation from different transport sectors.

Port which is handling shipping cargo and distributing them to other places is obviously one major gateway in cargo flow. Moreover, port creates the value-added service through efficient performance of their tasks and provide economic gains to regional and national government. In the past, port could increase production capability including regional or national economic gains through reformation of port management system, development of port facilities and so on. Nowadays, with the increase in the bargaining power of the port users and growth of the shipping industry, the need to improve the performance efficiency and to cope up with the competitiveness has become a matter of greater significance than ever before.

This paper studies the impact on port development in relation to the economies of scale[1] in container and tanker markets. The study is based on the situations of world economy, factors affecting shipping industry and the strategic decisions of shipowner, which are dealt in chapter 1. Furthermore, current arising situations in shipping market and world economy are discussed in chapter 2. In chapter 3, it is examined shipowner's strategic choice under current changing market. In chapter 4, prospects on tanker and container shipping is argued and trend toward larger vessel is also examined. The possibility of large vessel on port development is discussed, in chapter 5. Figure 1.1 illustrates the structure of this study.

1)Economies of scale: A reduction in long run unit costs, which arise from an increase in production. Economies of scale occur when larger firms are able to lower their unit costs. This may happen for a variety of reasons. A larger firm may be able to buy in bulk, it may be able to organize production more efficiently, it may be able to raise capital cheaper and more efficiently. All of these represent economies of scale.

Figure 1.1 Structure of study




Source : presented by researcher

# 2. Changes in Shipping Industry and World Economy

Sea trade is one of major transportation method in world trade movement which is influenced by world economic changes. Obviously, these facts suggest that shipping industry depends on world economic situations such as world economic growth regional growth, world organizations policy decisions and so on. In this chapter, prospect of the world economy and shipping industry is introduced.

## 2.1 The growth of world economy

Current changes in world economy is influenced by cost reduction of transportation and communication by the advancement of science and technology, establishment of international economic organizations for adjusting economic co-operation and increasing regional economic growth. Reduction of entry barriers, which played a major key role in the process of globalization, has also stimulated regional concentration for production and trade movements for consumption between continents, with contributing to the expansion of the world trade volume. Moreover, economic growth in developing countries have led to structural changes of world economy and world capital flow. Lower labor costs in developing countries have invited foreign direct investment (FDI) more than ever and offered new opportunities for efficient performance of production.

According to world economic organizations, in 2005 and 2006, the world trade volume will decrease than the previous years due to several reasons; such as lower growth rate in China and world economy, expansion by 8.4% and 7.4% in 2005 (See table 2.1). But it shows that world trade will grow continuously and then shipping industry will be influenced by this growth.

Table 2.1 Growth rate of world trade

(Annual percentage change)

| | 2002 | 2003 | 2004 | 2005 | 2006 |
|---|---|---|---|---|---|
| World Bank | 3.7 | 5.5 | 10.2 | 8.4 | 7.8 |
| IMF | 3.5 | 5.5 | 9.1 | 7.4 | |

Sources: 1. World Bank, 2004.
2. IMF, *World Economic Outlook*, 2004.

## 2.2 Seaborne trade and future of shipping environment

In accordance with changes in the world economic environment and the structure of world trade, seaborne trade volume and movement have also increased gradually. Namely, during globalization these increases are influenced by different production and consumption areas, regional economic growth and increased needs for feeder fleets among regional ports. Table 2.2 provides the data on the world seaborne trade volume in terms of ton-miles[2]. In 2003, it reached 24,589 billion ton-miles, expanding by 5.9%. On the other hand, seaborne trade volume in terms of tons increased only by 3.7% with 6,168 million tons (UNTAD 2004). Difference in growth rate between ton-miles and tons suggests increased distance during the year, namely longer distances between cargo origins and destinations.

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2) Ton-miles: unit of measure equal to the movement of one ton over one mile.

Table 2.2 World seaborne trade in ton- miles, selected years

(Unit: billions of ton-miles)

| Year | Oil | | | Iron ore | Coal | Grain | 5 main dry bulks | Other dry cargoes | World total |
|---|---|---|---|---|---|---|---|---|---|
| | Crude | Products | Total | | | | | | |
| 1970 | 5,597 | 890 | 6,487 | 1,093 | 481 | 475 | 2,049 | 2,118 | 10,654 |
| 1980 | 8,385 | 1,020 | 9,405 | 1,613 | 952 | 1,087 | 3,652 | 3,720 | 16,777 |
| 1990 | 6,261 | 1,560 | 7,821 | 1,978 | 1,849 | 1,073 | 5,259 | 4,041 | 17,121 |
| 2000 | 8,180 | 2,085 | 10,265 | 2,545 | 2,509 | 1,244 | 6,638 | 6,113 | 23,016 |
| 2001 | 8,074 | 2,105 | 10,179 | 2,575 | 2,552 | 1,322 | 6,782 | 6,280 | 23,241 |
| 2002 | 7,848 | 2,050 | 9,898 | 2,731 | 2,549 | 1,241 | 6,879 | 6,440 | 23,217 |
| 2003 | 8,330 | 2,155 | 10,485 | 3,030 | 2,700 | 1,335 | 7,429 | 6,675 | 24,589 |

Source: UNCTAD, *Review of Maritime Transport 2004*, 2004.

Recently, indicators of environmental changes in the shipping industry are due to China effects, expansion of EU, economic growth of developing countries, deployment of larger vessels, port congestion in some regions, security issues in the supply chain and safety issues in tanker shipping. Herein, the main task would be how to create a balance among various indicators while providing satisfaction to all parties.

Increases in ship size are aimed at increasing cost efficiency, especially, through the reduction of operation and capital costs. According to Clarkson, 41 containerships over 7,500 TEU and 655 Capesize drybulk carriers were put into service on some main routes in 2004. 159 containerships over 7,500 TEU were already ordered and will be placed into service in near future based on the order book of October 2004. A delivery fleet capacity of very large crude oil carrier (VLCC) in oil tankers will reach 9.6 million deadweight based on the order book of 2005. These facts show notable increases in ship size and therefore illustrate the need for sufficient infrastructures of port.

Port congestion in several ports has posed a problem in the recent past. In the United States, congestion in the ports of Los Angeles and Long Beach has been resolved slightly in 2004 but congestion prevails over all of western America. The main ports of Europe, China and India also suffer from port congestion. Moreover, Brazil has congestion problem in both container ports and bulk ports. The main cause of congestion in Europe and the United States is due to increased import volume from China. A massive cargo volume transported by large vessels also contributes to temporary port congestion.

In recent years, World Customs Organization(WCO), Organization for Economic Co-operation and Development (OECD) and United States have perceived the importance of security in the supply chain. Security measures will apply to all players in the supply chain such as vessels, ports and inland transportation. In addition, security issues have certainly increased operating costs as it has become a new issue. Some shipping liners such as Maersk Sealand[3], OT Africa Line (OTAL)[4], NYK[5], IPBCC[6] and FEFC[7] and some ports such as port of Charleston and Hutchison UK terminal have already levied security charges to cover their security costs in 2004. Eventually, several international agreements have made sailing restrictions of single hulled tankers, which will come into force from 2005. This restriction will hit the tanker market because about 40% of current tanker fleets are single hulled vessels.

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3) Maesk Sealand: being applied FEFC, IPBCC as conferences tariff.

4) OTAL: applied from October 25th 2004. 1 container 10.7 euro, vehicles of less than 3 tons 1.5 euro and breakbulk or vehicles exceeding 3 0.5 euro per container.

5) NYK: applied from September 24th 2004. (a) All export and import cargo on deep sea vessels through the ports of Hamburg, Bremerhaven, Rotterdam and Antwerp (including transshipment cargo): Euro 12.00 per container (b) All export cargo (including transshipment cargo) moving on deep sea vessels through the ports of Southampton, Thamesport, Tilbury and Felixstowe: GBP 7.00 per container.

6) India Pakistan Bangladesh Ceylon Conference (IPBCC): effected from September 15th 2004. (a) For Containers moved to or from Ports in North Europe, the Mediterranean, Scandinavia and the Baltic. € 5.00 per Container(b) For containers moved to, or from the ports of Felixstowe, Thamesport, Tilbury and Southampton where Lines recover the Security Charge from shippers/consignees □ 1.50 per Container(c) For Containers moved to, or from all other ports in the United Kingdom □ 3.50 per Container.

7) Far Eastern Freight Conference(FEFC): effected from September 15th 2004(a) Containers moved to or from Ports in the North Continent of Europe, Scandinavia, the Baltic and the Mediterranean Euro 5.00 (b) Containers moved to or from Ports of Felixstowe, Thamesport, Tilbury and Southampton where Lines recover the Security Charge from shippers/consignees GBP 1.50.

In the recent past, China who has become a large consumer market and production centre has become the main variable on world economy and trade, with both negative and positive effects. The boom in the Chinese economy called 'China Effect' stimulated the world economies and the shipping industry in the recent past. On the other hand, it is also true that an economic soft landing and/or economic policy decision in China called 'China Shock' can create negative effects in world economy and shipping industry.

In May 2004, 10 countries in Eastern Europe were incorporated as new members of EU. This will provide a good opportunity to become a major economic leader in the world. New members offering the low labor costs and broad acres will stimulate the changes of economic structure within EU, creating logistical challenges for use of them at the same time.

Brazil, Russia, India and China (BRICs) are major developing countries in the world. They are the new economic groups in the world economy. Their population totaled 2,673 million and GDP reached 29,346 hundred million U.S. dollars in 2003. Lower labor costs and massive available resources in these countries give advanced economies more attractive opportunities to make profits. FDI (Foreign Direct Investment) reflecting degree of market attractiveness has increased by 690 hundred million U.S. dollars in 2003. Goldman Sachs (GS) on *Dreaming With BRICs: The Path to 2050* in October 2003 forecasted that BRICs economies will grow into a larger economic group and overtake some advanced countries in the near future. Table 2.3 shows the BRICs economies volume trends in 2003.

Table 2.3 BRICs economies volume in comparison with EU, Japan and U.S.A in 2003

| | EU 15 | Japan | U.S.A | BRICs | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Brazil | Russia | India | China | Total |
| Gross area (1,000 km2) | 3,243 | 378 | 9,629 | 8,547 | 17,075 | 3,287 | 9,598 | 38,508 |
| Population (million) | 380 | 127 | 291 | 177 | 143 | 1,064 | 1,288 | 2,673 |
| GDP (hundred million $) | 104,827 | 43,264 | 108,816 | 4,923 | 4,335 | 5,990 | 14,099 | 29,346 |
| Trade amount (hundred million $) | 58,203 | 8,547 | 20,269 | 1,237 | 2,086 | 1,267 | 8,510 | 13,100 |
| FDI (hundred million $) | 2,952 | 63 | 298 | 101 | 11 | 43 | 535 | 690 |

Sources: WTO(gross area, population, GDP), World Bank(trade amount), UNCTAD(FDI).

# 3. Choice of Shipowner under Changes: Deployment of Large Vessel

The main reactor of globalization process will be a maritime industry. The pressure for changes in shipping industry have been induced by needs for economic efficiency and logistics needs of shippers generated during globalization process. Therefore, shipowners tried to achieve the cost efficiency as internal strength and the satisfaction of shippers as external strength to accommodate to a changing environment. As solutions, shipowners were interested in operating larger vessels and/or expansion of operating fleet because it can reduce cost per unit slot and the role of ports to be efficient to satisfy the shippers have become inevitable. At the same time, shipping conglomerates, a few shipowners operating a massive fleet capacity and shipping alliances are enough to create a strong negotiation power against shipping communities such as banks, port operators and international maritime organizations. In this chapter, reasons for trying economies of scale in shipping will be studied.

## 3.1 Internal competitiveness : achieving the cost efficiency

Economies of scale occur when larger firms are able to lower their unit costs. This may happen for a variety of reasons. A large firm may be able to buy in bulk, it may be able to organize production efficiently and it may be able to raise capital at a cheaper ROI effectively.

In shipping market, ships are the main assets of shipping companies and the main source of income or profit. Therefore, an efficient vessel operation is essential to make a profit. Based on this fact, large vessels can offer one way to achieve operational and capital efficiency. Purchasing large vessels provides an efficient capital composition and cargo volume served by one large ship is enough to provide the reduction of unit cost per slot and.

Table 2.4 shows the capital costs per slot for a selected range of container ship sizes. New building price of 8,000 TEU is 45 million U.S.dollars and cost per slots is 11.25 thousand U.S. dollars. These are lower than 6,000 TEU class, providing the reduction of slot cost to 0.30 thousand U.S.dollars. 10,000 TEU containership shows a reduced 10.5 % of cost per slots in comparison with 6,000 TEU. This fact is sufficient evidence to explain why shipowners prefer to choose larger vessels.

Table 3.1 Capital costs per slot for a selected range of container ship sizes

| Vessel (TEU) | New building price (Million U.S. dollars) | Cost per slot (Thousand U.S. dollars) |
|---|---|---|
| 4,000 | 45 | 11.25 |
| 6,000 | 63 | 10.50 |
| 8,000 | 82 | 10.20 |
| 10,000 | 94 | 9.40 |

Source: Drewry Shipping Consultants Ltd., *Post - Panamax Containership - The Next Generation*, 2001.

On the other side, deployment of large containership creates more operational cost efficiency linked to economies of scale. Table 2.5 presents the operational costs of Panamax, Super-Post-Panamax and Mega-Post-Panamax ships. Costs per slot decrease when vessel size increases, showing 2.32 million dollars of 4,000TEU, 1.97 million dollars of 6,000TEU and 1.45 million dollars of 10,000TEU. In case of deployment of 10,000TEU class, 37% of costs per slot can be saved in comparison with 4,000TEU.

Table 3.2 Operational costs of Panamax, post-panamax and Mega - post - panamax ships

| Cost items | 4,000 TEU | 6,000 TEU | 10,000 TEU |
|---|---|---|---|
| Manning | 850 | 850 | 850 |
| Maintenance | 900 | 1,025 | 1,150 |
| Insurance | 800 | 1,000 | 1,700 |
| Stores and lubes | 250 | 300 | 350 |
| Administration | 175 | 175 | 175 |
| Fuel | 4,284 | 5,722 | 7,269 |
| Port charges | 2,000 | 2,700 | 3,000 |
| Total | 9,259 | 11,822 | 14,494 |
| Cost per slot | 2,315 | 1,970 | 1,449 |

Remarks: Based on fuel cost of US$ 135/ton and 22.5 knots.
Source: Drewry Shipping Consultants Ltd., *Post-Panamax : The Next Generation*, August, 2001.

## 3.2 External competitiveness: satisfying shipper's needs for efficient logistics management

Economies of scope occur when it is cheaper to combine two or more products/services in one production system than to produce them separately. Greater business value is achieved by jointly producing different outputs.

Based on the concept of economies of scope, creation of external competitiveness depends on how companies benefit externally and how to satisfy shipper's need for an appropriate logistics management. Generally, it is a matter of creating synergy by coordination of business units externally. To achieve this external strength, shipping companies, especially shipowners and even non-shipping players, try to create a joint group within the shipping industry and diversify their business areas. These try-outs appear as several types of groups such as shipping conferences, shipping alliances, shipping pools and shipping conglomerate through mergers and acquisitions. As a result, this enlarged scope of operation and business in shipping companies, it is enough to achieve a high degree of market share, returns against investment and negotiation power for loans. These groups may be evolve from shipping conference.

After the formation first shipping conference for the purpose of charging the same freight rates, which originated in 1875, a lot of shipping conferences were structured to provided shipping services widely. These conferences aimed to reach the common freight rate, deployments of vessels into different sections of the trade and pooling of cargo and/or pooling of revenue. And then, while conferences declined, shipping companies tried to reform their business through alliances and/or mergers and/or acquisitions. As a result, a few large shipping companies and alliances could control the shipping market, with a high portion of market share. For example, in September 2003, Grand Alliance structured in January 1998 reached 919,904 TEU as total slots capacity among member lines. New World Alliance formed in 1997 provided 538,698 TEU and CHKY/United Alliance offered 915,589 TEU. Moreover, shipping companies, even though not leaders in the field have tried to diversify their operations by acquiring enterprises and/or mergers widely in varied industries. This created shipping conglomerates, for example China Shipping operate five specialized shipping fleets of oil tankers, tramps, passenger ships, container vessels and special cargo ships, and manage the diversified businesses of integrated logistics, terminal management, finance and investment, engineering and labor service, supply and trading, and information technology. These diversified business units are used to separate the risk in operation and management and negotiate with other parties.

## 3.3 Summary

As studied in chapter 2 and 3, results of changes in shipping industry and world economy are an important role of shipping firms in logistics management and to have competitiveness under a keen market situation than ever before.

Under these trends, shipping companies tried to solve these barriers to changes through operation of large ships and organizing shipping group because it can offer an enough possibility to achieve cost efficiency and high market position.

# 4. Analysis on Tanker and Container Market

In this chapter, reaction of tanker and container market under changes in shipping industry and world economy will be introduced. Some variables affecting these two markets will also be studied.

## 4.1 Tanker market

The tanker market can be distinguished from other shipping markets as it transports special goods. Tankers have been carrying the basic energy fuel such as liquid natural gas and oil in the international shipping industry. Generally, a definite origin area and destination area exist because of the limited production areas on one side and the widely spread consumption areas on the other side. Most importantly, tankers transporting dangerous cargo with the risk of oil pollution and explosion need to follow more strict safety procedures.

### 4.1.1 Oil tankers

The oil tanker market is about the transport of crude oil to refineries and of refined products to storage or other refineries. The variables in the current oil tanker market would be the import volume in China and India, supply volume of crude oil by OPEC and the balance timing of supply and demand for tonnage. China has been growing into the major oil consumption country in the world, ranked in the second position in 2004. The world oil production was forecasted to reach 345 million barrels per day in 2005, expanding 1.6 % over the previous year. On the other hand, IEA stated that the oil consumption will increase to 607 million barrels per day in 2005, expanding 10.6 % over the previous year. This fact shows that crude oil trade will increase continuously in near future and obviously it affects oil trade volume by sea.

Demand for tonnage can be explained as trade volume though it depends on the situation of oil consumption and production volume. For the last 5 years, seaborne oil trade has been increasing gradually though the growth rate is small. Oil trade volume reached 2,085 million tons in 2003 and is expected to reach 2,189 million tons in 2005, increasing about 2.4% over the previous year. Ton-mile representing movement of oil tankers per mile, exactly the demand of trade, is expected to reach 11,090 billion in 2005, expanding 3.5% over the previous year. Table 4.1 presents the world oil trade by sea.

Table 4.1 World oil trade by sea

(Unit: million tons, billion ton-miles)

| | Crude oil | | Oil products | | Total | |
|---|---|---|---|---|---|---|
| | Tons | Ton-miles | Tons | Ton-miles | Tons | Ton-miles |
| 2000 | 1,680 | 8,180 | 419 | 2,085 | 2,024 | 10,420 |
| 2001 | 1,592 | 8,074 | 425 | 2,105 | 2,017 | 10,179 |
| 2002 | 1,588 | 7,848 | 414 | 2,050 | 2,002 | 9,888 |
| 2003 | 1,650 | 8,330 | 435 | 2,155 | 2,085 | 10,485 |
| 2004 | 1,690 | 8,495 | 448 | 2,220 | 2,138 | 10,715 |
| 2005 | 1,725 | 8,790 | 464 | 2,300 | 2,189 | 11,090 |

Remark: 2004 and 2005 were estimated.

Sources:

1. Fearnleys, Review, each year and Fearnleys, World Bulk Trade, each year.
2. KMI, *World shipping outlook 2005*, 2004.

It is true that world oil consumption is growing gradually and at the same time, demand for oil tankers is also increasing. Total fleet capacity has been growing in response to the needs for oil tanker demand, expanding fleets from 6,168 ships in 1985 to 7,118 in July 2004 but 1,511 of these ships are smaller than 500 gross tonnage. As shown in Table 3.3, delivered capacities did not follow the scrapped capacities and this also offered an opportunity to expand total fleets. For the past 5 years, tonnage surplus reached 23.6 million deadweights in 2002 and is forecasted to decrease to 17.5 million deadweights in 2005. Table 4.2 presents the tonnage surplus situation in the oil tanker market.

Table 4.2 Tonnage surplus in the oil tanker fleet

(Unit: million deadweight)

| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|
| Supply (A) | 235.4 | 237.3 | 237.6 | 242.1 | 247.7 | 259.6 |
| Demand (B) | 219.5 | 220.1 | 213.9 | 225.3 | 236.4 | 242.1 |
| Surplus (A-B) | 15.9 | 17.2 | 23.6 | 16.8 | 11.3 | 17.5 |
| Surplus rate ((A-B)/A, %) | 6.8 | 7.2 | 10.0 | 6.9 | 4.5 | 6.7 |

Sources:

1. Fearnleys, Review, each year and Fearnleys, World Bulk Trade, each year.
2. KMI, *World shipping outloo*k *2005*, 2004.

Table 4.3 presents that the delivery and scrapping capacities per class. Delivered VLCC since the past 5 years accounted for around 48% of total delivered capacity. 9.6 million deadweight in VLCC class, accounting for 41.5 % of total delivery, will be delivered and put into service in 2005. Moreover, scrapping rate of VLCC is lower than rate of other classes. For the last two decades, total delivered oil tankers above 150,000 deadweight were 523 ships. Delivered oil tankers comprises of 32 ships between the years 1984 to 1988, 137 ships between 1989 to 1993, 109 ships between 1994 to 1998 and 245 ships between 1999 to 2003. These facts are sufficient to show that oil tanker sizes are getting larger and larger.

Table 4.3 Delivery and scrapping capacities per each class

(Unit: million deadweight)

| | | VLCC | Suexmax | Aframax | Panamax | Total |
|---|---|---|---|---|---|---|
| 2000 | Delivery | 12.2 | 3.3 | 2.2 | 1.1 | 18.8 |
| | Scrapping | 7.1 | 2.5 | 1.7 | 0.3 | 11.6 |
| 2001 | Delivery | 7.8 | 2.5 | 1.5 | 0.3 | 12.1 |
| | Scrapping | 8.6 | 4.0 | 1.4 | 0.4 | 14.3 |
| 2002 | Delivery | 12.3 | 3.7 | 3.8 | 0.6 | 20.4 |
| | Scrapping | 10.9 | 1.6 | 1.5 | 0.4 | 14.3 |
| 2003 | Delivery | 11.8 | 3.8 | 8.3 | 1.6 | 25.5 |
| | Scrapping | 10.0 | 2.2 | 3.3 | 1.1 | 16.6 |
| 2004 | Delivery | 8.3 | 4.2 | 5.6 | 2.9 | 21.0 |
| | Scrapping | 1.8 | 1.6 | 2.6 | 1.3 | 7.2 |
| 2005 | Delivery | 9.6 | 3.9 | 6.6 | 3.0 | 23.1 |
| | Scrapping | 3.6 | 1.0 | 3.4 | 2.1 | 10.1 |

Source: Clarkson, World Shipyard Monitor, monthly.

### 4.1.2 Chemical tankers

A chemical tanker is a tanker used for the carriage of any liquid flammable bulk product. Notable features of the chemical tanker market are the fragmented ownership of fleets, chemical carrier pools in operation and a dull increase in ship size.

The ownership of the chemical tanker fleets is more fragmented than in other shipping sectors. For example, the top 10 major owners in the market owned 138 ships, consisting of only 7,054 thousand deadweight in comparison with 38,489 thousand deadweight as a market total. Table 4.4 presents the situation of chemical tanker owners. As illustrated in Table 3.4, the largest shipowners ranked in the top 3 are Stolt-Nielsen, Odfjell Mitsui O.S.K and Totalt, sharing only 10% of total fleet capacity in terms of deadweight and only 5.1% of total ships. Stolt-Nielsen and Odfjell own tankers range in size from 4,600 deadweight to 40,100 and from 6,000 deadweight to 46,000 deadweight. On the other hand, smaller owners such as Novoship owns very restricted deadweight range concentrated on local or regional markets. As some owners, especially the large owners, provide oceangoing service and other small owners operate regionally. Chemical carrier pools which are organized by market leaders such as the Brostrom pool, Jo Tankers pool, Odfjell-Ahrenkiel pool and Odfjell Asia pool aim for operational efficiency and separation of risk

Regarding fleet development, while the total chemical tanker fleet larger than 500 gross tonnages totaled 2,277 vessels, equivalent to 37.5 million deadweight, in July 2004, changes in ship size is minimal. Tankers above 60,000 deadweight comprise most of the total fleet capacity and most of them were built 14 or 19 years ago. But currently, the order book for chemical tankers is in between 37,000-38,000, 46,000-47,000 and 50,000-51,000 deadweight ranges. These facts represent that shipowners who owns a chemical tanker, prefer operational efficiency through joint group than profits associated with economies of scale because of a smaller market size in comparison with other shipping markets.

Table 4.4 Chemical tanker owners

| | | Capacity (thousand deadweight) | Ships (No.) |
|---|---|---|---|
| 1 | Stolt-Nielsen | 1,477 | 55 |
| 2 | Odfjell Mitsui O.S.K. | 1,407 | 45 |
| 3 | Totalt | 945 | 45 |
| 4 | Tesma holdings | 716 | 12 |
| 5 | Odfjell J.O. | 679 | 26 |
| Others | | 30,461 | 2,608 |
| Total | | 38,489 | 2,869 |

Source: Lloyd's Register-Fairplay Research, *Shipping Market Forecast*, 2004.

### 4.1.3 LNG tankers

The LNG carriers are made of a special aluminum alloy and are heavily insulated to carry natural gas in its liquid state at a temperature of -285° F. Nowadays, LNG shipping market is showing strong growth although most of the gas is distributed through pipeline, PNG (piped natural gas).

The pattern of demand for natural gas determines the route of tanker and design of tanker capacity. Production of natural gas increased to 19.13 trillion cubic feet in 2003 and is forecasted at annual growth of 20.49 in 2010 to 21.97 trillion cubic feet in 2020, with 0.6% of average annual change. Average annual change in consumption is forecasted at 1.5%. This fact shows that more trade from origin to destination will arise. Thanks to growing demand in the United States, Europe, Japan and China, prospects are looking good in the near future.

A few owners own most of the LNG fleet. These shipowners, Shell, Nigeria LN, Abu Dhabi Oil, Petronas and Mitsui, own about 42% of the 164 ships in world total fleet in July 2004. World fleet capacity reached 19.1 million $m^3$ in July 2004. 10 LNG ships were delivered in 2004 and none will be demolished. . Especially, the LNG fleet increased by 69 ships and doubled its capacity between 1995 and 2004 and an annual growth rate of 8.7% since the last 5 years.

### 4.1.4 Summary

The tanker market has distinct characteristics in ship size, type of vessel, feature of cargo, different loading/unloading facilities including distribution infrastructures and regulations concerned.

In oil tanker market, ship size is getting bigger due to increasing consumption volume in China and some Asian regions. Most importantly, trading route is trending toward consumption areas from origin. Otherwise, in tanker, chemical and LNG market, shipowners are not interested in ship' s size but co-operation among them.

One of the main challenges faced by the tanker market is the restriction of the single hull[8] and due to that, structure of

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8) Under a revised regulation of Annex I of MARPOL, the final phasing-out date for Category 1 tankers (pre-MARPOL tankers, 19 VLCC in July 2004) is brought forward to 2005, from 2007 [2]. The final phasing-out date for category 2 and 3 tankers (MARPOL tankers and smaller tankers, 161 VLCC in July 2004) is brought forward to 2010, from 2015, although exceptions are being made to certain Category 2 and 3 tankers allowing these vessels to be operated beyond 2010 subject to certain conditions such as having carried out satisfactory Condition Assessment Scheme (CAS). The Condition Assessment Scheme (CAS) was also made applicable to all single-hull tankers which are 15 years old, or older. Previously CAS was applicable to all Category 1 vessels

fleet will be also reformed. Single hull VLCC comprises of 180 ships in comparison with world total fleet of 439 ships in July 2004.

Generally, trade routes of tanker ships, especially crude oil tankers and liquid gas tankers, are influenced by demand for consumption. Hence, increase in tanker size requires that ports located within consumption ranges provide efficient inland transportation networks and ensure port safety. An oil refinery can make more attractive port and can create value-added service. Hence, if port does not offer sufficient stowage facilities and other infrastructures, calling of large tanker is impossible.

## 4.2 Analysis on container market

### 4.2.1 Market indicators reflecting market situation

Container market indicators, which are generally used to analyze the market conditions and make forecasts, are HR (Howe Robinson) container index, freight rate, container handling activity and traffic. HR container index provides predictable indicator of demand and supply of containership. It shows that container fleet capacity does not follow container demand. Freight indices can be predicted by changes in HR

continuing to trade after 2005 and all Category 2 vessels after 2010.

container index but changes in freight present balance of demand and supply. High freight rates during the recent past have been caused due to shortage of container vessels. The growth rate of container handling activity and traffic volume also reflects container market situations.

### 4.2.2 Container market prospects on demand

Prospects of market demand can be explained as the world container handling activities, traffic volume and HR Container Index. Figure 4.1 shows the growth of world container handling activity volume[9]. It has increased from 145.1 million TEU in 1995 to 317.0 million TEU in 2003. Volume in 2005 will reach 393.0 million TEU in comparison with 354.0 million TEU in 2004, expanding 11% over the previous year. Major marine consulting organizations forecasted that the regional handling volume will account for more than 50% in Asia, about 10% in North America and 19% in EU. But generally, they forecasted that the growth rate of handling volume will decrease by 3 - 4 % in 2005 because of low growth rate in world economy, a rise in the rate of international interest, the sudden rise in oil prices and the soft-landing of Chinese economy. (see Figure 4.1 and Table 4.5)

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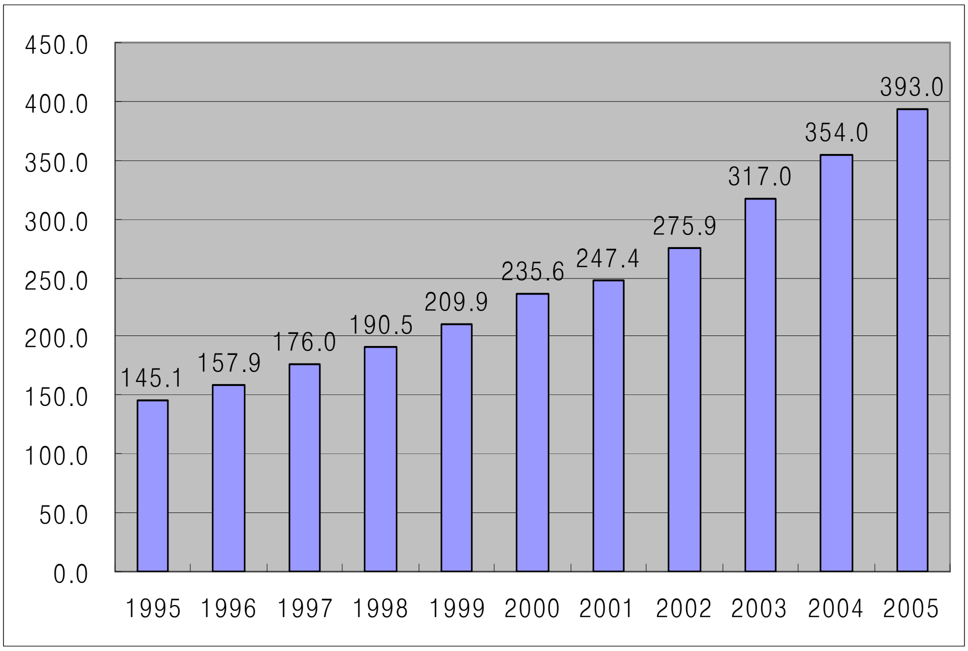
9) Container handling activity includes container traffics (actual quantity of container handled within terminal) and movement within terminal.

Container traffic presents actual quantity of container handled, increase in volume showed a rise from 46 million TEU in 1995 to 90.9 million TEU, expanding by 49.4%. Expected container traffic in 2005 is 112.5 million TEU a growth of 11.5 % over the previous year. This growth will be caused due to increases of demand for containerships and the enhanced feeder traffic regionally by the deployment of large vessels and reduction of port calls. (see Figure 4.2)

Figure 4.1 World container handling activity

(Unit: million TEU)




Sources:

1. Drewry Shipping Consultants Ltd, *Annual Container market Review and Forecast 2004/05*, 2004.
2. Clarkson, container Intelligence, Monthly.

Table 4.5 Regional container handling activity prospects in 2005

(Unit: million TEU)

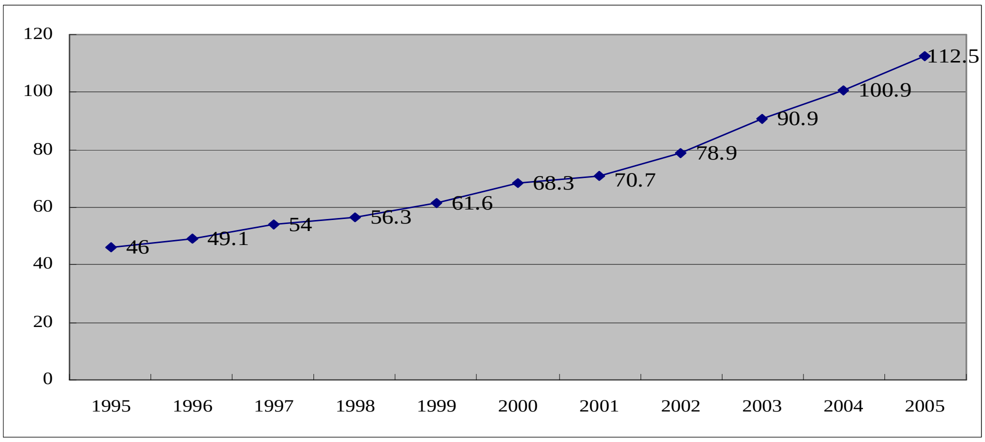
| | Drewry | Clarkson | KMI |
|---|---|---|---|
| Europe | 75 | 69 | 73 |
| North America | 43 | 41 | 43 |
| Asia | 204 | 200 | 205 |
| Other | 77 | 52 | 72 |
| World total | 399 | 362 | 393 |

Sources:

1. Drewry Shipping Consultants Ltd, *Annual Container market Review and Forecast 2004/05*, 2004.
2. Clarkson, container Intelligence Monthly.
3. KMI, *World Shipping Outlook 2005* 2004.

Figure 4.2 World container traffic flow and prospects

(Unit: million TEU)

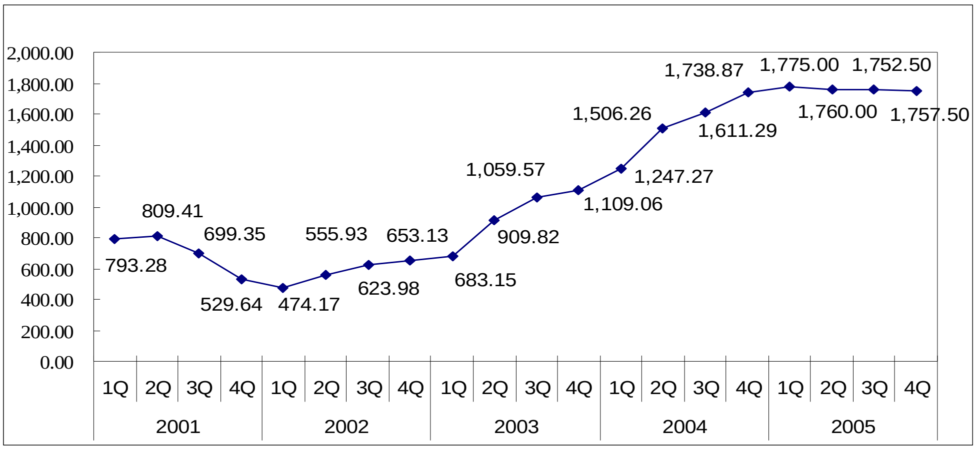



Sources:

1. Drewry Shipping Consultants Ltd, *Annual Container market Review and Forecast 2004/05*, 2004.
2. Clarkson, container Intelligence, Monthly.

Howe Robinson(HR) Container Index provides the situation of demand and supply. As shown in Figure 4.3, the lowest HR container index presents the surplus of containership or the deficit of container traffic in 1Q/2002. HR container index increased dramatically from 793.28 in 1Q/2001 to 1,738.87 in 4Q/2004. It means that container traffic and demand for container tonnage are increasing. It forecasted of being stayed at a stationary high degree for 2005, while maintaining around 1,760 due to needs for additional containerships in China and port congestion areas, especially North America and Europe and need for containerships over 5,000 TEU. But HR container index might decrease as new container vessels on order are to be delivered and put into service in the near future. (see Figure 4.3)

Figure 4.3 Howe Robinson Container Index




Sources:

1. Howe Robinson Container Index.
2. KMI, *Shipping Outlook 2005*, 2004.

### 4.2.3 Container market prospects on supply

Currently, the world containership fleet consists of six generations containerships. (see table 4.6) The first generation-containerships were converted cargo vessels and tankers in pre-1970. The first container vessel was put into service in the 1970s and at the same time, the second generation of containerships was introduced. As the shipping industry recognized the benefit through larger containerships, vessel sizes increased to a limit set by the lock size of the Panama Canal. In the 1980s, this size limit was critical because of the significance of the Canal in moving the growing trade between Europe and the Far East and then these ships can be considered as the third generation of containerships. The fourth generation of containerships during the mid 1980’ s was built larger than the lock limit of the Panama Canal, with hopes for the increased economies of scale that these ships could provide. Moreover, advances in technology made it possible to build ships beyond 5,000 TEU and ship generally called Post-Panamax began to be placed into service in the 1990’ s. Table 4.6 shows the six generations of containerships.

Table 4.6 Six generations of containerships

| Generation | Years produced | Typical Capacity (TEU) | Typical length(m) | Typical draft (m) | Typical speed (knot) |
|---|---|---|---|---|---|
| First | 1960s | 1,000 | 190 | 9 | 16 |
| Second | 1970s | 2,000 | 210 | 10 | 23 |
| Third | 1980s | 3,000 | 210-290 | 11.5 | 23 |
| Fourth | 1984 | 4,000 | 270-300 | 13-14 | 24-25 |
| Fifth | 1992 | 4,900 | 290-320 | 13-14 | 25 |
| Sixth | 1996 | 6,000 | 305-310 | 13.5-14 | 25 |
| | | 8,000 | 320-360 | 14.5 | 26.5 |
| | | 12,500 | 381 | 15 | - |

Source: Korea Maritime Institute, *Global shipping and logistics,* 2000.

Additionally, for the last 10 years, although Panamax ships are still representing the iron share of the world containership fleet with about 40 % market share and the largest Post-Panamax ships in service with capacity approaching 8,000TEU. But nowadays, the Panamax fleet starts to decline, in percentage terms, as the Post-Panamax fleet grows in size. The new generation containerships are feasible, if current market expansion provides the cost efficiency and the ports, necessary container handling capabilities and special berthing basins to these mega-containerships. Based on these facts, challenge to ULCS (Ultra-large container ship) designs as the next generation is feasible. To evaluate the possibility of ULCS, the design challenges associated with the structural issues should be considered, such as the structure of hull, the propulsion system and the maneuverability. The current and forecasted development of the container ports and terminals should be also reflected into the ship’s physical configuration.

Table 4.7 illustrates the fleet of containerships on order by years and by class. For containerships over 4,000 TEU, ordered fleet for 4 years reached 2,388 thousand TEU, accounting for 75.23% of total order fleet. Containerships over 8,000TEU will supply 191 thousand TEU in 2005, 471 thousand TEU in 2006, 210 thousand TEU in 2007 and 24 thousand TEU in 2008 into the market. This fact confirms that the size of container vessels will increase more and more in the future market. Especially, In October 2004, 41 large containerships over 7,500TEU were put into service. Fleet in this class comprise of 25 ships by Maersk Sealand, 6 ships by OOCL, 4 ships by Hapag-Lloyd and 6 ships by other shipowners. Moreover, 159 ships based on order book in October 2004 will be delivered in the near future, which comprises of 28 ships by MSC, 18 ships by Evergreen, 16 ships by CMA CGM, 13ships by CSCL and 84 ships by other major shipowners. This fact definitely shows that containerships are getting larger.

Regarding supply of containerships, ship fleet in 2005 is forecasted to expand 9,229 thousand TEU at an average of prospects by 3 shipping consultant organizations. As predicted, 13.8 % growth by BRS(Barry Rogliano Salles), 14.0 % growth by Drewry and 11.1 % growth by Clarkson. All of them have forecasted that the growth rate will be over 10% and that the growth of capacity will increase till 2007 because new containerships will be delivered for 3 years aheadeasings included.. Table 4.8 shows data on the situation of world container ship fleet.

Table 4.7 Fleet of containerships on order by years and classes

(Unit: thousand TEU)

| | 2005 | 2006 | 2007 | 2008 | Total |
|---|---|---|---|---|---|
| 500-999 | 43 | 20 | 3 | 0 | 86 |
| 1,000-1,499 | 36 | 29 | 4 | 0 | 80 |
| 1,500-1,999 | 33 | 28 | 22 | 0 | 99 |
| 2,000-2,499 | 36 | 5 | 0 | 0 | 69 |
| 2,500-2,999 | 94 | 128 | 55 | 14 | 310 |
| 3,000-3,999 | 18 | 49 | 45 | 7 | 142 |
| 4,000-4,999 | 150 | 169 | 89 | 4 | 474 |
| 5,000-5,999 | 202 | 79 | 51 | 0 | 429 |
| 6,000-6,999 | 39 | 100 | 142 | 6 | 300 |
| 7,000-7,999 | 53 | 79 | 31 | 24 | 232 |
| Over 8,000 | 191 | 471 | 210 | 24 | 953 |
| Total | 895 | 1,157 | 652 | 79 | 3,174 |

Remark: based on September 2004.

Source: Drewry Shipping Consultants Ltd, *Annual Container market Review and Forecast 2004/05*, 2004.

Table 4.8 Prospects of world containership fleet

(Unit: thousand TEU)

| | 2003 | | 2004 | | 2005 | |
|---|---|---|---|---|---|---|
| | Capacity | Growth | Capacity | Growth | Capacity | Growth |
| BRS | 7,323 | 9.6% | 8,277 | 13.0% | 9,419 | 13.8% |
| Drewry | 7,176 | 9.9% | 8,046 | 12.1% | 9,170 | 14.0% |
| Clarkson | 7,508 | 9.4% | 8,189 | 9.0% | 9,100 | 11.1% |

Remark: Clarkson’s prospects including multi-purpose ship

Sources:

1. Drewry Shipping Consultants, *Annual Container market Review and Forecast 2004/05*, 2004.
2. BRS-Alphaliner, *Top 100 of Liner operators*, September 2004.
3. Clarkson, container Intelligence, Monthly

## 4.2.4 Summary

Characteristics of the container market can be associated with a steady growth of trade volume and the increasing numbers of large vessels. The direct impact of these effects would be on the ports. Increase in vessel size requires a high level of port productivity including sufficient port capability and the effective inter-modal services. However, it is difficult for the ports to realize these needs because of the congestion problem. Even though it has a small impact, a massive container cargo from one large vessel will weigh down ports with more congestion because container handling time will be increase for one vessel. Moreover, ports receiving large vessels will create additional social cost in order to achieve high ability of port performance because current port accessibility is not enough to adopt the next generation of containerships.

First of all, most large containerships provide continuous services using a hub and spoke network. Shipping alliances or joint groups support this network system through co-operation in common use of fleet. Under the hub and spoke system, cargoes will be concentrated in hub ports and trans-shipped through them. Although the average shipping cost per TEU decreases on line-haul legs of hub-and-spoke networks, it can generate extra distance, shipping time, port charges and stevedoring charges. Moreover, there are a lot of barriers such as physical, geographical and political accessibilities to ports in the selection of hub port. It is true that large vessels will be concentrate at a few ports within each continent because of port limitation. As a result of this, port congestion is bound to occur in these respective ports.

# 5. Port Development for Tanker and Container Shipping

While world economy was globalizing, shipping industry has followed these globalization processes which resulted in the advent of larger vessels, the growth of seaborne trade, control of the shipping market by a few shipowners and groups and stricter agreements regulating safety and security. Especially, the deployment of large ship are influencing on port planning directly. In this chapter, impacts on port under these changes and direction of port development are studied.

## 5.1 The Concept of port development

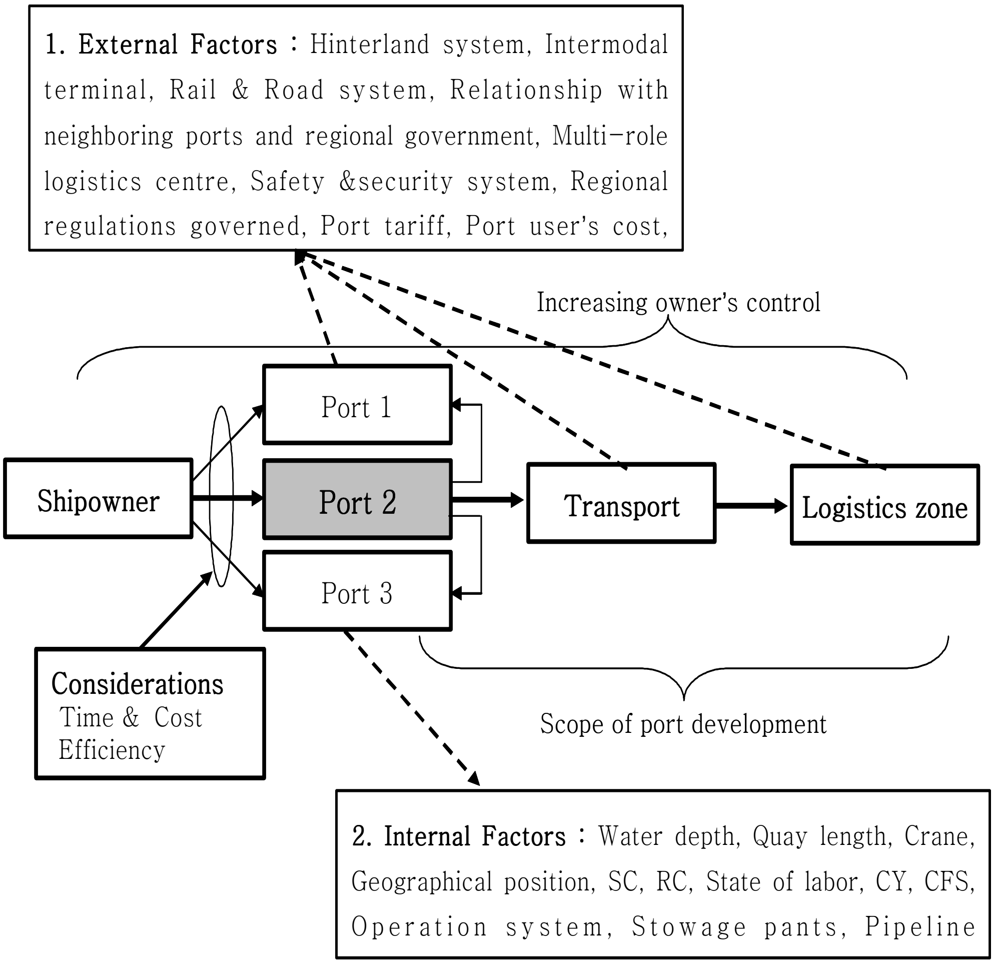
Nowadays, a notable change is taking place in the deployment of large ships in some major route and this trend is spreading rapidly among liners. Influence of large ships on port create competition between neighboring ports as a result of reduction in calling port, efficient feeder service in major port, port accessibility of large ships, temporary port congestion and efficient port management.

Under current situation, direction of port development is to make an attractive port for larger vessels. Flexibility is certainly a keyword in modern shipping market. It implies that seaport facilities should be responsive to the changing demand patterns and levels. The creation of a development plan for seaports requires good knowledge of all basic and relevant tendencies and interrelationships in maritime transport (W. Winkelmans, 2003).

### 5.1.1 Changing scope of port development

Shipowners have enlarged the scope of operations and business units through shipping alliances, acquisitions, mergers and pools. These shipowners and shipping groups try to find the best port based on cost and time efficiency because ports are a main gateway of transportation in the supply chain. The dimensions of port development mean not only the body of the port but also one major player of the integrated transport network in the supply chain. Figure 5.1 illustrates the factors influencing the choice of port by shipowners. The choice factors of port can be explained as 2 types. External factors are hinterland system, intermodal terminal, rail, road, relationship with neighbor ports and regional government, multi-role logistics centre, safety and security system, regional regulations governed, port tariff, tug boat, pilot service and port user's cost. Internal factors are water depth, quay length, geographical position, crane, staddle carrier, reach stacker, state of labor, operation system, pipeline, container yard, container freight yard and stowage plants.

Figure 5.1 Port choice factors by shipowners and the scope of port development




Source: presented by researcher

Nowadays, shipowner can control several different business units through M & A or alliance, which give shipowners stronger bargaining power. Moreover, efficient cargo handling within supply chain is become more important issue because shipping industry has high portion within logistics flow which was arisen from globalization process. Therefore, both shipowner and port are trying to expand the scope of port's role.

Port development should take into consideration how to cover ship size and satisfy shipowners' needs for efficient participation of ports as the main gateway in the supply chain through coordination between port and the nation because there exists some advantages which gives port and the nation common satisfactions.

## 5.2 Applicability of the concept of economies of scale in relation to port development

The most important changes associated with economies of scale in shipping market are increase in ship size and in traffic volume. Port development plan for easier accessibility of large vessels should include physical accessibilities to port, proper management system, building network system with inland transport and secondary ports and guarantee of port security. Most vital factor in new port development is the inclusion and consideration of calling of large vessels.

### 5.2.1 Port capability for attracting large containership

To make more attractive port for large containership can be explained as two approaching concepts, increase of ship's size and shipping cargo volume.

Firstly, in Ship size, as introduced in chapter 4, for nearly 4 years ahead, 953 container ships above 8,000 TEU based on orders booked in September 2004 will be delivered to owners and put into service. At the same time, increase in containership size is happening rapidly and the structure of container fleet will also change. Moreover, several maritime consultant organizations have already studied the applicability of ULCS(Ultra-large container ships) in the container market and forecasted that ULCS will be deployed around 2010 on major routes between continents if container terminals assist and accept the increase in ship size. OOCL, one of the world's largest integrated international container transportation, logistics and terminal companies has 7 containerships above 8,000TEU among 27 containerships in January 2005 and total container fleet capacity of ships above 8,000TEU reached 56,441 TEU. Table 5.1 shows some examples about the particulars of deployed large containerships above 7,000 TEU and ULCS. Regarding some particulars of ships, the principal dimensions of OOCL Long Beach built in 2003 has 8,063 TEU loadable and its L.O.A(length of all) is 322.97meter, beam of 42.8 meter and draught of 14.5 meter. In case of Ultra Large Container Ships (ULCS), OSC s and Lloyd's Register study determined that the maximum principal dimensions of loadable capacity is from 10,770 to 12,500 TEU, beam of 57 meter (22 boxes abreast on deck), length of 381 meter, draught 14.5 meter and ship speed from 23 to 25 knots.

Table 5.1 Particulars of deployed large vessels above 7,000 TEU currently and ULCS

| Shipowner | Vessel name | TEU | Built | L.O.A (m) | Beam (m) | Draught (m) |
|---|---|---|---|---|---|---|
| OOCL | OOCL Long Beach | 8,063 | 2003 | 322.97 | 42.8 | 14.5 |
| OOCL | OOCL Shenzhen | 8,063 | 2003 | 322.97 | 42.8 | 14.5 |
| COSCO | COSCO Long Beach | 7,455 | 2004 | 300.00 | 42.8 | |
| ULCS | | 10,700 - 12,500 | | 381 | 57 | 14.5 |

Sources:

1. http://www.oocl.com/vessels/, February 2005.
2. http://www.cosco.com, February 2005.
3. Lloyd' s Register of shipping, 2001.

Design of containership size has been determined by the receptive capability of container terminals in the past. Hence, design of the next generation of Ultra Large Container Ships (ULCS) probably seems to depend on capabilities of terminal infrastructure. Therefore, planner of container port development should consider the capabilities of container berths, crane outreach and the availability of deepwater. These physical factors of port will be considered in the choice of calling port by shipowners.

Most large containerships above 8,000 TEU, which will be placed and are already placed into service, have length of over

300 meters. The length of ULCS will be about 400 meters. These large containerships will require an efficient berth size and thus may cause shortage of berths at port. The shortage of berths in terms of length may result in longer waiting time, re-movement after berthing and operational difficulties and as a result the shipowner may try to find other ports. Otherwise, calling of one ULCS means that the port has sufficient port competitiveness and opportunities to become a hub port regionally. Finally, non-efficient length of berths will be an obstacle to berth more ULCS and become a feeder port for distributing containers to neighboring ports.

Regarding increase in breadth, major affecting factors may be crane outreach. Large vessels above 7,000 TEU require an outreach of about 60 meters. If terminals can not provide adequate crane outreach, cargo handling time will be longer and decrease ship owner' s satisfaction. Ultra large container cranes for ULCS should certainly be made available. It is also essential for the development of ports. Some container terminals have already invested in container cranes and by the end of 2002, 65 container gantries with a rated outreach in excess of 58 meter were placed.

Large ships transport a massive amount of cargo at a time. This cargo volume can induce temporary port congestion. Efficient operation and portfolio of port facilities will be one solution for this temporary congestion. Container handling equipment such as RTG, RMG, AGV, RS and SC should be arranged based on container handling volume per ship and kept in good condition. A cargo operation plan within the terminal should also be in place. For example, a wireless container controlling system or automated customs clearance procedure can assist smooth container movement and even though these technologies are used commonly, use of advanced technologies in container operation should be considered in the port development plan. These can guarantee time efficiency by ship’s timely departure.

Secondly, in container traffic, world container traffic increased in volume from 235.6 million TEU in 2000 to 354.0 million TEU in 2004 and is forecasted to increase gradually in the future. This growth of volume is enough to induce port congestion. Congestion in container terminals means the limitation of port aspects of container handling and will influence choice of port by shipowners. Shipowners may be interested in the smooth cargo handling aspect of cargo distribution. Cargo distribution depends on existing hinterland network system, accessibilities to intermodal terminal, multi-role logistics centre and relationships between neighboring ports and transportation players. Because of increases in operational scope and concentration on the supply side, shipowners can have strong negotiation power regarding the scope of port tasks. Hence, it is true that they try to be involved with cargo distribution from the primary ports to neighboring ports or destinations in land zone. In port development, these facts should be also considered.

Inland network is essential to transport containers to land zone such as land distribution centre, intermodal terminal and final destination. Namely, the inland network plays an important role in container movement among land zone including port. To construct efficient inland network it requires a huge amount of capital and raises some conflicts between port authority and regional government because of certain limitations in their responsibilities for development of hinterland network. These conflicts can cause delays for constructing or utilizing the hinterland network and finally, one part of port development will be delayed. Hence, a mutual agreement and co-operation between regional authorities is inevitable.

Transportation from primary port to secondary port should also be considered in port development because an ultimate aim of port development is to become a hub-port between continents. Network system among ports can provide shipowners who own large containerships with easier management of container cargo and feeder transport. Sharing information between ports by a network system can help to fulfill shipowners' needs for transporting to and fro efficiently. At the same time, terminals for feeder transport should be constructed. Port operations exclusively for ULCS can generate problems in feeder transport and this may decrease port competitiveness.

### 5.2.2 Port capability for tanker shipping

The total amount of oil tankers comprises 19.1 % in terms of numbers of ships in comparison with the total world fleet in January 2004 but chemical tankers and liquid gas tankers make up only 3.3 % and 2.9 % of the world total fleet. Large ships associated with economies of scale are the oil tankers. Hence, arguments in the capability and design of ports will be focused on oil tankers.

The economy of scale in tanker market was happened in ship size. In world total tanker fleet, average growth rate from 2000 to 2004 was 1.3% in terms of number of ships and 1.8% in terms of deadweight. Oil tanker fleet comprises most of tanker fleet, reaching 91.45%. Oil tankers' size have increased over 300,000 deadweight and total number of ships above 150,000(above VLCC) deadweight was 11,142 ships, with a total of 149.88 million deadweight in January 2004. Principal dimensions of ULCC(ultra large crude carrier) are similar to ULCS(ultra large container ship). As an example, the dimensions of Iwatesan built in 2003 is of the length 330 meters, beam of 60 meters and draught of 29.7 meters.

Based on this, ports should ensure berthing facilities to provide ships with accessibility to port such as deepwater and efficient quay length. Hence, a different concept of port development in comparison with other shipping sectors should be considered. First of all, efficient storage facilities should be ensured at nearby ports, with the guarantee of storage safety and security. Specialized flammable products warehouses, outdoor storages and automated high-rise warehouses for dangerous goods are also important factors in port development. Loading and unloading equipment such as pipeline, jetty, floating offload buoy for liquid gas and refrigerator can facilitate operations, while preventing oil pollution and other unexpected accidents. Inland transportation network is also an important factor because most of oil trade is influenced by demand for consumption. Moreover, efficient tank truck loading racks and tank lorry should be provided to transport to an oil refinery.

Additionally, basic factors such as fire training, protection equipment, accident and emergency preparedness plans, and well-qualified human resources should be taken into account for port development.

# 6. Conclusions

Environmental and structural changes arising from shipping industry and world economy were addressed in chapters 2, 3 and 4, arguing on some variables regarding supply and demand. One of the notable changes in the shipping market is the advent of large ship. In chapter 5, factors affecting port development and economic impacts associated with increase in ship size were discussed.

Based on studies in previous chapters, major impact of increase in ship size, especially containerships and tankers is ports can cover the dimension of large vessel or not and scope of port development should be expanded into range of regional or national policies. In the past, port development was to create a good operational port providing efficient port facilities and infrastructures. Namely, port development was a matter only concerning the shipping community to facilitate shipping and handling of cargo and focused on improvement of the body of port. As ports were reformed, regional governments recognized that value added service can be created through port. Regional governments tried to involve in port development projects, but focused on regional interests for creation of value added service. These regional aims generated conflicts of interest between ports and regional government because of indefinite boundaries of responsibilities in capital investment. But nowadays, port development requires support of both regional and national government regarding capital investment and policy decisions. This is induced by globalization of world economy and strategic decisions of shipping sectors, particularly the advent of large vessels.

*Globalization* means expanded market range, increased world trade volume and efficient transport network needed in supply chain by reduction of world trade blocks. The establishment of the World Trade Organization(WTO) and regional associations including ASEAN and APEC has accelerated liberalization of trade policies. WTO aims at promoting free trade flow, liberalizing trade policies through negotiation and establishing an impartial means of settling disputes. Regional associations including ASEAN and APEC try to adopt policies that reduce barriers to both trade and capital flow. Efforts to liberalize trade policies by WTO and regional associations led to new opportunities to enter new countries providing lower labor costs. Many global and regional corporations relocated some or all of their production with foreign direct investment (FDI) and market range was changed from regional market to global market. As market range was changed, the volume of world trade has increased because of difference between production and consumption areas. The growth of developing countries, particularly BRICs, also accelerated movement of trade by increased consumption of commodities and energy. Increase in world trade volume and movement led to issue of efficient transport network in supply chain. Global players including corporations and shippers would have to apply logistical theories such as "door to door" service and "just in time" (JIT) to their management.

*Strategic decisions of shipping market* are based on achieving internal and external strength in terms of cost and time. Nowadays, shipping alliances, pools and large shipowners including shipping conglomerates basically aim at the creation of benefits through economies of scale and diversification of risks. They can be placed in a high market position through cooperation or M&A (merger and acquisition). But world seaborne trade volume has been increasing continuously and internal strength in terms of cost and benefit was needed to achieve market competitiveness. Deployment of large ships on main routes is chosen as a new strategy to create internal strength and there are many possibilities to reduce operational and capital costs. But this generates a choice problem on trading routes because of limitations of ports in terms of physical and regional accessibility and capabilities to handle capacity of large vessels. But several types of shipping partnerships operating common fleets and large shipping conglomerates managing diversified business units offer an ample cargo volume for large ships. Moreover, it is also possible to use feeder service for distribution or transportation of cargoes shipped on large vessels between neighboring ports. It would be considered as hub and spoke system. But capabilities of ports and logistics management in primary ports are needed to deal with a massive cargo.

*The importance of logistics management* associated with both globalization and strategies of liners have become a notable challenge. Port development projects should be applied to both sides. Operation strategies of shipowners based on a hub and spoke system can provide new opportunities for growth of main logistics point within one continent or region. First of all, the requirements of shipping industry should be considered because the main customer of ports is the shipowner. Therefore port must overcome their limitations associated with increased ship size and sufficient infrastructure.

*Port* is main gateway dealing with input and output of world economy and transportation of cargoes by ships. But sea trade has been transporting over 90% of the input and output of world economy. Hence, ports should follow changes of shipping efficiently, especially increased ship size. It is clear that shipowners who own large vessels choose their main ports based on basic accessibility to port and functional role as main distribution point. The principal dimensions of large vessels have increased incredibly. Draught, beam and L.O.A (length of all) can influence port development. In the past, it was true that vessels were designed based on situation of port and in fact, most ports had sufficient capability to cover vessel size. But nowadays, it is true that port capability influence large vessel' s design though technical or managerial problems were solved. Moreover, as large ships were considered as a way to make a profit, hub and spoke system emerged. Shipowners have the right of port choice based on whether port can cover ship size or not. It means that port should cope with increased dimension of ship if port wants to be primary port (hub port). Additionally, advanced technical operation systems should be introduced to deal with increased volume of cargo from large vessel. It can help to reduce waiting and working time of large vessels.

*Policy* means supports of regional and national government on port development. In the past, conflicts between port and government for several reasons generated delays in port development. Main conflict issues were improvement of inland network and capital construction between them. Entrance roads, railways and network system between logistics zones are important to transport and distribute cargoes efficiently. But in reform and construction, a huge amount of capital is needed and the priorities are different. Ports understood that regional or national matters could influence operations in terms of cargo handling. Governments, including regional, were only interested in their own profits even though they recognized that the regional economy can be stimulated by the port. Hence, it is difficult to achieve a balance between them. Moreover, it is sure that current relationship between port and government is not enough to cover port development project for covering large vessel.

Finally, changes in liners, particularly increases in ship size, and world economy should not be considered as a matter of interest between managers of port development and regional governments, but as a national matter because there are many economic benefits to be had if ports have sufficient capability to handle large vessels. To be chosen as a primary port and logistics point within a continent or region will match the needs of national government and the shipping industry including port. Moreover, several indicators of shipping and global market require ports to improve their current capability. Therefore, governments should take up a positive attitude in port development and ports should solicit the government to help in their port development.

This research detailed strategies of the shipping industry and the scope of port development in line with globalization. But there are some further researches to be done in order to reinforce this study;

1. Leader in port development; port or government or other organization to coordinate?
2. Adequate range of responsibility in port development, between port and government?
3. Negative side in hub and spoke system; shippers think about it improperly?
4. Positive and negative aspects of large ships; are there additional costs to adopt large ships?

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