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Environment Change of Marine Transportation and Inter-related Development of Shipping and Shipbuilding Industries in Korea

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Abstract

Environment of marine transportation market is changing rapidly. Due to globalization of world economy, marine transportation of cargos, especially trade using container boxes, is increasing dramatically. Fierce competition in the global market of container transportation forces the shipping industry to seek the economy of scale to reduce transportation cost, and drives the merge and alliance of liner shipping companies. Mega-sized container ships, having capacity over 10,000 TEU, were introduced, and appeared recently, in order to reduce the unit transportation cost.

Korean shipping and shipbuilding companies are competitive, and have considerable market share in the global market. Even though both industries are inter-connected through ships and have many common interests in order to enlarge the global market share, inter-relation between two industries is surprisingly insignificant.

In this paper current issues in the process of environmental change of marine cargo transportation are reviewed, and inter-relation of shipping and shipbuilding industries is discussed. Suggestions for inter-related development of Korean shipping and shipbuilding industries are given, and means for mutually beneficial collaboration are suggested.

Keywords: shipping industry, shipbuilding industry, environment change, marine transportation, mega-sized container vessel, inter-related development

1 Introduction

Globalization is the key word in the recent development of world economy. Environment of marine transportation market is changing rapidly. Marine transportation of cargos, especially in container boxes, is increasing dramatically, due to globalization of world economy. Fierce competition forces shipping companies to reduce the transportation cost by realizing economies of scale, and drives the merge and alliance of liner shipping companies. Mega-sized container ships, having capacity over 10,000 TEU, were introduced in order to reduce the unit transportation cost, and appeared recently.

Korean shipping and shipbuilding companies are competitive, and have considerable market share in the global market. Even though both industries are inter-connected through

ships and have many common interests for the enlargement of global market share, interrelation between two industries is surprisingly insignificant.

In this paper current issues in the process of environmental change of marine cargo transportation are reviewed, and inter-relation of shipping and shipbuilding industries is discussed. Suggestions for inter-related development of Korean shipping and shipbuilding industries are given, and means for mutually beneficial collaboration are suggested.

2 Environment change of marine transportation market

2.1 Globalization

Globalization is working as a primary engine for the recent world economic growth and development. Many economies have in the past pursued development strategies that have emphasized self-sufficiency and the protection of domestic markets. However, recently there has been a growing consensus that the route to prosperity lies in integration with the global economy. As a result of this globalization trend, world trade volume has continued to grow with the gradual removal of trade barriers under the World Trade Organization (WTO) and through Regional Trade Agreements (RTA). And the maritime trade volume also has continued to grow with the realization of globalization ideology.

2.2 Containerization

Since Sea-Land Corporation first introduced the full-container ship "Gate Way City", which had operated between Houston and New York Port in 1957, maritime cargo transportation using container has grown dramatically. As more shippers became aware of the benefits of shipping in container boxes, and more ports developed the infrastructure and acquired the handling equipments needed to cater for container vessels, goods that had previously been shipped as loose cargos gradually converted to containers cargos.

By adopting the advanced information and communication technologies (ICT) and e-business tools combined with the shippers' logistics systems, many container shipping companies have extended their services from merely providing port-to-port transportation services to more customized logistics service packages.

And also many liner shipping companies have sought to establish seamless intermodal services, based on integration of land and sea transport, extending their services offering door-to-door transportation. Some shipping companies have transformed from a shipping carrier to a global logistics provider in order to supply more customized logistics service. All this contributed to the explosive growth of international maritime container transportation. During the last decades, world maritime container trade continued to increase at a rate far exceeding that of maritime trade, as shown in Figure 1.

2.3 Emergence of Asian countries

Share of world trade volumes of the three major regional blocks, namely, NAFTA, EU and East Asia, is changing. Volume ratios of EU and NAFTA are expected to decrease, while that of East Asia to increase, as shown in Table 1. East Asian countries have grown as global manufacturing base, since they can produce high quality goods by using relatively inexpensive labors. Free movement of investment funds also contributed the trend. The movement is being accelerated as maritime transport becomes cheaper. As China and East

Asian countries become the global manufacturing base, East Asian region emerges as the center of international shipping market. The volumes to and from China have grown enormously over the decade.

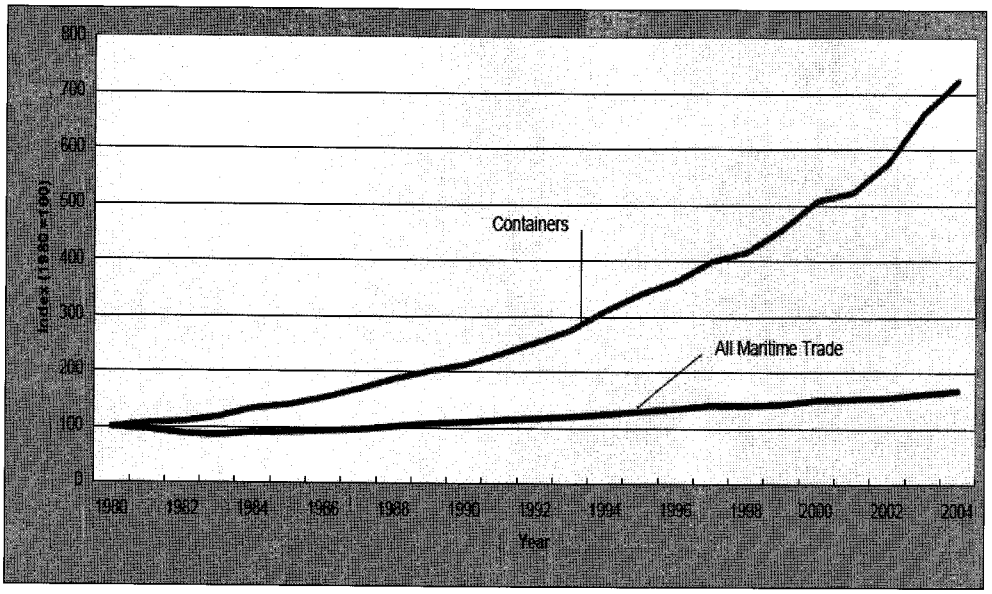

Figure 1: Growth of maritime container transportation compared to the world maritime trade. (Source: Drewry Shipping Consultants; Fearnleys)

2.4 Mega-sized container ships

Since the introduction of container boxes in marine transportation about 50 years ago, the size of container ships has increased dramatically. Until mid-1980s, the size was limited by the dimensional constraints of Panama Canal (33.5 m width, 12.5 m depth, with a usable length of 304.8 m). As the size of a container ship becomes bigger and exceeds the constraints of the Canal, development of the post-Panamax fleet becomes common. Today 30% of the world's fleet is post-Panamax. The largest ship currently on order has the capacity of more than 10,000 TEU, and there are careful prospects for even bigger ships.

There are divided opinions on how big will the mega container vessel would be. Some analysts argue that the search for economies of scale is unavoidable, in order to reduce the unit transportation cost and enlarge the market share, and will drive the vessel size up through 12,000 TEU and beyond within the next decade. Others predict the size of mega carrier will be limited within a certain value for the foreseeable future, considering the economic difficulties to be overcome for the larger vessel.

The size and the appearing time of mega container vessels would greatly influence the environment of shipping and shipbuilding industries, including the port industries, and would exert enormous impact for the restructuring of related industries.

Table 1: Prospect of container trade volume shares for the three regional blocks. (Source : Ocean Shipping Consultants Ltd., World Containerport Outlook to 2015, March, 2003.)

Mil. TEU

Region	1990		2000		2010	
	volume	ratio	volume	ratio	volume	ratio
East Asia	32.3	37.6	105.9	45.3	205.0	48.5
North Amer.	21.6	25.1	48.6	20.8	79.0	18.7
EU (15)	23.1	26.9	55.5	23.7	93.0	22.0
Sub Total	77.0	89.6	210.0	89.9	377.0	89.1
World	85.9	100.0	233.7	100.0	423.0	100.0

3 Current issues of shipping and shipbuilding industries

3.1 Merge and alliance of container shipping companies

The trends of merging to a super-sized shipping company and/or formation of alliances among shipping liner companies are widely accepted in the shipping industries. The trends have been pursued, in order to achieve the economy of scale, to rationalize operations and processes, to enhance efficiency, and to allocate resources efficiently. All these have accelerated the competition in marine container shipping market, accumulating pressure on freight rates, forcing shipping liners to seek greater levels of efficiency, in order to survive the competition.

This became evident when the A.P. Mollar-Maersk group, the leading liner shipping company, announced to buy Royal P&O Nedlloyd, the 3rd liner company, in July 2005. Table 2 shows the capacity of top 10 liner companies, of which total capacity reaches almost 60 % of world total capacity.

Alliance of shipping liners, sharing the worldwide operation – or at least on the main East-West routes – rather than on a single trade lane, would offer significant additional advantages, while allowing shipping companies to retain their distinctive marketing identities and ownership. The quest to attain economies of scale, especially in liner shipping, has resulted in the remarkable increase of container vessel size.

3.2 How big is the mega container vessel

The trend towards a larger ship makes it clear that larger vessels will be dominant, at least in the east-west routes. Even though there are some debates about the container ship size increase, it will be normal on the Asia-Pacific route to see more vessels of bigger than 8,000 TEU in service. As a consequence major port operators have been trying to provide port facilities in order to accommodate mega-sized vessels, aiming at becoming hub ports even though the investment cost of such development is very high. Others must match these efforts just to stay in the game. The size of a mega vessel will grow as larger ships

have lower unit transportation cost than smaller ships assuming the same load factor.

A number of studies in recent years have focused on the potential of a mega container ship, designed for dedicated trades. Recently MOERI performed a feasibility study to design a mega container ship (MOERI-MCS), equipped with single main engine (12-cylinder) and single propeller, and can be operated using infrastructures of the existing ports(Koh et al 2004)

Table 2: Top 10 liner shipping companies and slot capacities in 2005 & 2006 (Source: AXSMarine, as of July 2006)

Rank	Carrier	National	Slot (2006)	Slot (2005)	Increase (%)
1(1)	A. P. Moller	Denmark	1,725,348	1,067,788	62%
2(2)	MSC	Switzerland	944,795	705,841	34%
3(5)	CMA CGM	France	610,420	444,908	37%
4(4)	Evergreen	Taiwan	534,135	457,025	17%
5(16)	Hapag-Lloyd	Germany	465,152	212,454	119%
6(8)	COSCO	China	392,051	305,618	28%
7(9)	CSCL	China	371,204	298,960	24%
8(7)	APL	Singapore	360,676	315,452	14%
9(6)	Hanjin	Korea	343,098	331,145	4%
10(10)	NYK	Japan	320,728	295,063	9%
	World Total		9,887,699	8,650,136	14%

Remark: Rank numbers in parentheses means rank in 2005

Other example includes the Malacca-max concept developed by Wijnolst(2000). It is probably more relevant today to ascertain the largest size of container ship which can offer the same trading flexibility as today's largest ships while delivering the maximum economy of scale. This was the focus of the ultra-large container ship (ULCS 2000) study initiated by Lloyd's Register, in association with Ocean Shipping Consultants Ltd, in 1999.

Recently A.P. Moller-Maersk has announce the sea trial of the world's largest container ship (Emma Maersk) equipped with a 14-cylinder diesel engine of 110,000 BHP. Table 3 shows the size of the existing and proposed mega container ships.

3.3 Problems of mega container vessels

- Economy of mega container vessels

One of the key factors of competitiveness for a shipping company is the cost. Cost advantage means providing the same transportation service at lower price than other competitors, which can be attained by reducing the transportation cost utilizing scale economy and introducing mega container vessels in the trades. Comparison of the unit transportation cost, estimated from the operation of large vessels (4,000 TEU, 5,300 TEU and 9,000 TEU vessels), is given in Table 4, in terms of unit cost of transportation when supposedly operated in Trans-Pacific and Asia-Europe routes.

Table 3: Principal dimensions of existing and proposed mega container ships

Type of Carrier	Cap. (TEU)	L x B x T (m)	Stock (L-Up-W)
Panamax	4,000	294 x 32.2 x 13.5	8–5–13
Post Panmx –I	5,000	275 x 39 x 13.5	8–4–16
Post Panmx –II	6,600	318 x 42 x 14	9–6–17
MOERI-MCS	9,000	307 x 45.6 x 14.5	10–7–18
ULCS	12,500	381 x 57 x 14.5	9–7–22
Double-Wide	15,000	400 x 69 x 14	10–6–28
Malacca-max	18,000	400 x 60 x 12	12–8–23
Emma Maersk	11,000	397 x 56.4 x 15.5	10-9-22

Table 4: Comparison of unit transportation costs for various vessel sizes(Kim 2002)

Vessel size	4,000 TEU	5,300 TEU	9,000 TEU
Rate of cost (%)	100	93	82

Compared to a 4,000 TEU vessel, the 5,300 TEU vessel has a 7% lower unit cost, while a 9,000 TEU vessel has an 18% lower cost. The cost reductions are mainly achieved in items such as port charges, fuel, capital and crew costs.

A study commissioned by Lloyd's Register concluded that Ultra-Large Container Ships (ULCS 2000) of up to 12,500 TEU are entirely feasible, and that the first of these vessels may be in service by 2010. The unit transportation cost of the ULCS is shown to be clearly less than that of an existing 8,800 TEU container ship with single engine and single propeller. Operation speed of 23/24 knots is possible for the ULCS equipped with the currently biggest engine. The unit transportation cost would have a step jump for the higher speed vessel (over 24/25 knots) with twin engines, which would require higher capital and operational costs.

- Obstacles of mega container ship operation

First obstacle in operation of over 10,000 TEU vessels is the water depth of existing container berth. Maximum water depth of most major container ports is 12~14m, while water depth required by mega container vessels is 15~17m. In order to overcome this obstacle, there are some discussions on developing port dredging or construction of floating terminals. However water depth of container terminals will remain as a restriction of the port calls of mega containers.

Secondly, terminal productivity is required to be increased to shorten the turn-around port time for these mega container ships. Some terminals are installing big container cranes that can handle 22~23 rows. Furthermore, major ports are developing a high-tech container handling system to improve loading/discharging productivity in case of calling these mega container ships. As container handling equipments become more efficient, the turn-around port time of the mega container ship would decrease.

Thirdly, collecting huge amount of cargos to the mega ship on weekly schedule would remain as a big burden of the sales department of a shipping company. The scale economy

of a mega vessel is realized with the assumption of same cargos loading factor, regardless of container vessel size. This problem would be alleviated by the progress of merge and alliance of shipping companies.

- Required technologies for building mega vessels

In order to keep the service speed of 25 knots for a mega container vessel, carrying more than 10,000 TEU, bigger engine power than the currently existing power is needed. An engine with 14 cylinders can produce the maximum engine power of 110,000 BHP. Although it appears that single engine can facilitate 12,000TEU vessels with increased number of cylinders, it is highly likely that twin engines are required for larger than 14,000~15,000 TEU vessels. Since the acquisition and operating cost of the ship with twin engines would be far higher than a single engine ship, the size of mega container vessel would be restricted as the maximum size of a ship which can operate with single engine.

Existing single screw ships suffer from cavitation erosion on propellers and rudders which are located in the downstream of propellers. In order to avoid the cavitation problem bigger propeller diameter and/or larger blade area is required, and as a consequence propeller becomes heavier. Since most major propeller manufacturing companies have melting furnace of maximum capacity of 100 ton, and NC milling machines for blade fabricating of maximum diameter of 10 m, the cost for heavier and larger diameter propellers would cost far more compared to a normal size propeller. Some propeller manufacturers are investing to enlarge the facilities of melting furnaces and for bigger NC machines for larger diameter propellers.

There have been many research and development to adopt various propulsors for mega container ships, in order to alleviate cavitation by distributing thrust loading and to add powers to a single propulsor, such as a contra-rotating propulsor using an electric pod propulsor mounted in the rudder stock.

Container boxes need to be structurally strengthened in order to stack more than 9 tiers vertically. Lashing of containers during the rough sea condition is another technical problem to be examined, for higher stacking of container for mega vessels. Transverse acceleration of the stacked containers in rough sea condition needs to be carefully considered.

4 Relation of shipping and shipbuilding industries

4.1 Relation of shipbuilding company, shipping company, shipper and port

Figure 2 shows the relationship among a shipbuilding company, a shipping company and shippers. Shipping industry and shipbuilding industry are inter-related through ships, which play the key role in marine transportation. A shipbuilding company provides a ship to the shipping company, manufactured as described in building specification of the contracted ship. Shippers rely on shipping companies to move their cargos to destinations within predetermined time interval. Shippers are customers of shipping companies. Ports are developed where cargos are located in a way of transportation route. Size and cargo handling equipments of a port are determined by the size and frequency of calling ships.

Shipping companies operate ships to transport marine cargos and have accumulated knowledge on how to operate ships conveniently and efficiently. But they lack the detail knowledge of internal structure and operational theory of ships. Shipbuilders have very detailed knowledge about ships and their operational principles. Since shipbuilders do not operate ships, they can easily neglect the operational efficiency. In many cases

modification requests by a ship acceptance team were not accepted, even though those are necessary for the efficient operation, since requests are filed too late and/or extra charges exceed the limit. R&D teams in shipbuilding companies are concerned more on improvement the performance quality of a ship, rather than increase of operational efficiency.

Both the shipping and shipbuilding industries share common interests and can build-up mutually beneficial relationship by cooperation. Shipping companies have many ideas for the modification of a ship for better usage in marine transportation, but sometimes lack the detailed knowledge for modification and lose proper time for modification during shipbuilding process. Easier communication between the two industries would stimulate ideas for more efficient operation and better performance of ships with minimum effort and cost. It is suggested that shipbuilding companies respond more pro-actively to the requirement of shippers and shipping companies in order to predict the new trends of shipbuilding, especially in the rapid changing environment of marine transportation.

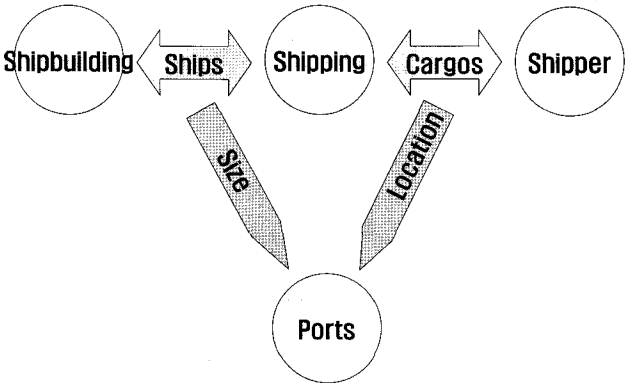

Figure 2: Relationship among shipbuilding company, shipping company, shipper and port.

4.2 Correlation between shipping market and shipbuilding market

Shipping industry and shipbuilding industry are demand and supply sides of a ship. It would be a natural assumption that two industries are quite interrelated and the markets are mutually dependant. Both markets have cyclic nature with a long period.

By nature of container shipping business, it is very difficult to get a single freight rate index of a shipping route, representing the market situation. The Howe Robinson(HR) Index is a globally recognized indicator that shows the charter rate of container ships of 13 representative container ship sizes between 250 TEU to 4,500 TEU capacity. The rate of 1987 is set as HR index 1,000. As of September 6, 2006, HR index is 1,288.

To study the correlation between container shipping market and shipbuilding market, the HR index and the price of a 3,500 TEU vessel are chosen as variables for inter-dependency. Figure 3 shows the variation of HR index and the new-building price of a 3,500 TEU container vessel during 1997~2005, where HR index has sharply increased from a low value of 451 in January 2002, to 937 points in 2003 and 1,543 in 2004.

It is assumed that the logarithmic value of HR index at time t, have a linear correlation with the logarithmic value of the price of the container ship at time t+1. Simple regression is used to derive the relation between two variables as:

$$\log(CONT)_{t+1} = 1.472 + 0.337\log(HR)_t,$$
$$R^2 = 0.554,$$

where $(CONT)$t: Price of container vessel at t+1,
$(HR)_t$: Howe Robinson index at t,
R^2 : Pearson's correlation coefficient, correlating the level of HR index with the price of container vessel.

From the above relation the elasticity of price of vessel to HR index is 0.337. That means if HR index increased 1% at period t, the price of ship would be increased by 0.337% at the next time step. This derived equation shows there is a relation between container ship price and HR index, which may represent freight rate. However, we cannot use this equation for the purpose of predict ship price, since this is not a model for ship price prediction. There are many other variables to consider in order to predict the ship price with reasonable reliability.

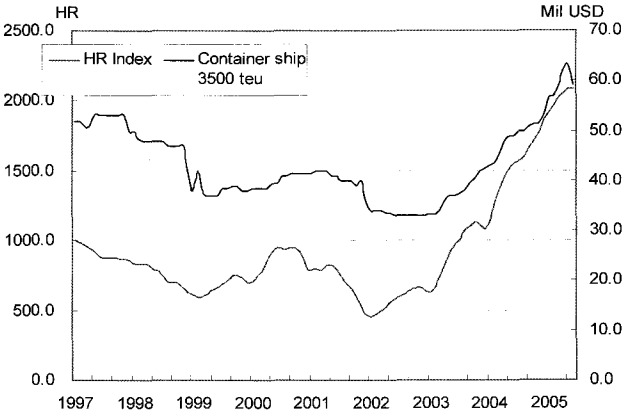

Figure 3: HR container index and building cost of a 3500 TEU container ship

5 Status of Korean shipping and shipbuilding industries

5.1 Korean shipping industry

The Korean shipping industry has been growing at an impressive rate. Starting out with a mere 100,000 GT of fleet tonnage in 1960, Korea ranked eighth in the world in terms of total merchant fleet tonnage in 2005. In the container sector, Hanjin Shipping and Hyundai Merchant Marine ranked 7th and 19th in top 20 shipping companies in 2005, and operate the slots of 3,310,000 TEU and 1,290,000 TEU, respectively.

Korea has steadily introduced liberalization and deregulation policies in the shipping industry, guaranteeing liberalization in the private sector for the purpose of corresponding with the trends of globalization. After enduring tough periods arising from the worldwide excess of shipping tonnage and world economic/financial turmoil, the Korean Shipping industry is now expected to continue to grow, building upon its recovery which began in 1999, as the world shipping industry recovers and cargo volumes rise. Thus, it is forecasted that Korea's export and import cargo volume will rise to 89.2 million tons in 2010 from 56.9 million tons in 2001, and Korean commercial vessel tonnage will grow to 1.95 million GRT.

5.2 Korean shipbuilding industry

The global shipbuilding industry has seen a dramatic rise in new ship orders and completions since 2000, driven both by economic globalization and the consequent increase in maritime cargos and also by last-minute demand from purchasers trying to beat the implementation of new structural regulations. Global shipbuilding capacity has also continued to increase.

New ship orders have been high ever since 2000, with most years posting gross tonnage in excess of 30 million tons and 2003 coming in at a record high of 62.47 million tons. Obviously, completions have seen similar jumps. In 2004, the industry completed 40.17 million tons, 3.65 times production in 1988, the most recent trough.

Meanwhile, ship prices have also shown improvements thanks to the sustained boom in the marine transportation market and the tightness of ship supplies. Prices for tankers (VLCCs) have gone from $65 million in 2000 to $130 million in May 2005. Likewise, the price for bulk carriers (king-size) has improved from $35 million in 2002 to $68 million in May 2005.

Korean shipbuilding industries lead the world shipbuilding market with the share of 40 % of new shipbuilding orders. As shown in the table 6, 7 Korean shipbuilding companies are leading the top 10 world wide shipbuilding companies

5.3 Interrelation of Korean shipping and shipbuilding industries

Even though Korean shipbuilding industry and shipping industry are relatively strong and highly competitive in the global market, interrelation and interdependency between two industries is surprisingly insignificant.

A shipping company needs various types of ships, but Korean shipbuilders are very selective to take orders for higher value-added ships, such as LNG carriers, and mega container ships. Orders from Korean shipping companies are very small portion of total orders. Only 3.3% of total orders of Korean shipbuilding industry are domestic orders, as shown in Table 7.

Shipbuilding companies look after the global shipping companies, and some times do not seriously consider special requests from domestic shipping companies.

Table 5: List and backlog of top 10 shipbuilding companies. (As of Dec. 2006)

Rank	Name of shipbuilder	Back log (K CGT)
1	Hyundai Heavy Ind.	10,620
2	Daewoo Shipbuild. & Marine Eng.	7,740
3	Samsung Heavy Ind.	7,330
4	Hyundai Mipo Dockyard	3,710
5	Hyundai Samho Heavy Ind.	3,290
6	Mitsubishi Heavy Ind.	2,260
7	STX Shipbuild Co.	2,180
8	Hanjin Heavy Ind. & Const.	2,100
9	Tsuneishi corporation	1,840
10	Dalian Shipbuilding Ind.	1,670

Interrelation and collaboration between shipbuilding and shipping industries might lead to mutually beneficial win-win situation for long term perspective, especially in depression period. But such efforts for cooperation and collaboration between two industries were not successful until now. It is suggested that practical means for collaboration be sought for the mutually beneficial relationship.

Table 6: Percentage of domestic order of Korean shipbuilding industry

Thousand G/T, %

Year	Total received order	Domestic order	Percent (%)
2000	19,380	134	0.7
2001	10,832	597	5.5
2002	12,774	56	0.4
2003	28,188	354	1.3
2004	25,735	837	3.3

Source: Korean shipbuilders association

6 Summary and Suggestions

Korea has steadily introduced deregulation policies in the shipping and shipbuilding industries in order to pursue the globalization trend. Direct governmental support for the industries is not only prohibited under the WTO and OECD shipbuilding talks, but also has minor effect on the market, since the sizes of the industries are too big. Private level talks, seeking common interests and inter-related area in the market, are to be pursued for win-win collaboration.

As we discussed in the previous chapters, inter-dependency between the two Korean industries is surprisingly insignificant. There might be measures to share the common interests and to stimulate collaboration between the two closely inter-related industries.

One immediate inter-active item for beneficial cooperation is the share of information in global market analysis. Both industries keep the market analysis model and data for the prediction of price and timing point of shipbuilding order. Since ships are primary assets of shipping companies, prediction of price and order timing for a ship is one of most interests of a shipping company. For a shipbuilding company the point of reception timing of shipbuilding order is also crucial interest.

A more realistic and predictable ship price prediction model can be developed by collaboration of two industries. Not only the theory of mathematical economics, but also practical knowledge in shipping and shipbuilding area, would contribute for the development of an accurate prediction model for ship price. Since both markets have cycles, and collaboration and active business sales to secure the shipbuilding orders is especially crucial for depression period.

In order to secure the risk of ordering/building ships in depression period, long term contract of cargo transportation of big companies, such as KEPCO (Korea Electric Power Corporation) and POSCO (Pohang Steel Corporation, Ltd.) be necessary. Contract for

ordering ships for long term planning would provide flexibility for stable order of shipbuilding.

Since 2003 Korea raises Ship Investment Funds(SIF) similar to the KG funds in Germany. The purpose of this fund is inducing investors and ship owners through granting various benefits, such as preferential tax treatment and deregulation of ship investment companies. The ship titleholder will be the ship investment company with the single purpose of owning and leasing a ship. The Fund aims to achieve capital growth and a high profit to redeem loans and distribute earnings through the acquisition, operation, investment management and charter of a single vessel. Strengthening of the interrelation between two industries might be realized by inducing the shipbuilding companies to invest in SIF. Competitiveness of shipping industry, strengthened by the shipbuilder's investments, would secure the new shipbuilding orders.

Development of a high performance ship, matching the rapidly changing shipping market requirements, is an urgent item to collaborate between two industries. Accumulated knowledge of a shipping company, on the operation and the requirement for a high performance ship, would contribute for the design improvement of a higher performance ship. Frank exchange of ideas and close collaboration between shipping and shipbuilding companies would contribute the development of the highest performance ship. By developing the highest performance ship, shipbuilding companies can secure the shipbuilding orders, and shipping companies can strengthen the competitiveness of cargo receiving and handling.

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