기술혁신학회지 제16권 4호
2013년 12월 pp.1134~1162

Innovation Strategy for the Korean Shipbuilding Industry Based on Analysis of the Shift in Industrial Leadership

산업주도권 변천과정 분석을 통한 산업주도기업의 혁신전략 도출: 한국 조선산업의 사례

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목 차

국 문 요 약

본 연구는 우리나라 산업주도기업이 지속적으로 선두위치를 유지하게 하는 혁신전략을 도출하는 것이다. 이를 위해 조선산업의 산업주도권 변천과정을 사례로 연구하였다. 조선산업에서 주도기업이 쇠퇴하는 핵심요인은 현상유지적 경영치중, 급증하는 유력제품에서의 혁신부진, 변화에 저항하는 조직관성인 것으로 나타났다. 시장의 승자는 경쟁력의 우위보다는 변화에 누가 빨리 대응하느냐에 달려 있었고 과거의 성공전략으로는 선두위치를 유지할 수 없음도 밝혀졌다. 주도기업 쇠퇴의 근본원인은 과거의 커다란 성공으로 인해 경쟁상황의 변화에도 기존의 전략을 고집하고 대응을 지연시키는 혁신의 실패에 있었다. 연구결과, 우리나라 산업주도기업이 선두를 유지하기 위한 혁신전략으로 현재의 성공에 안주하지 않고 새로운 변화에 적합한 고객지향형 혁신을 중시하는 경영체계를 구축해야 하는 것과 불황기를 잘 대처하지 못해 재성장의 기회를 상실하였으므로 불황기에 대비한 전략수립 등을 제시하였다. 본 연구가 우리나라 다른 산업의 새로운 전략수립에 기여할 것으로 기대한다.

핵심어 : 산업주도권, 혁신전략, 기술혁신, 조직관성, 조선산업

※ 논문접수일: 2013.11.21, 1차수정일: 2013.12.12, 게재확정일: 2013.12.15
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ABSTRACT

The purpose of this paper is to provide an innovation strategy for a leading industrial company. We analyze the process of a shift in industrial leadership using the shipbuilding industry as a case study. This paper explains that the three core factors of decline are immobilization, lack of innovation for major products, and organizational inertia. This study presents that the leader of a market is not decided by strong competitiveness, but by quick reaction to major customers' needs, and that out-of-date strategies do not contribute to maintaining leadership. As a result of this study, it shows that the leading Korean industrial companies shall establish a new innovation-oriented and customer-oriented management system that is flexible enough to anticipate and respond to the changes in new competitive environments. These findings contribute to the formulation of new strategies for other manufacturing industries in Korea.

Key Words : Industrial Leadership, Innovation Strategy, Technical Innovation, Organizational Inertia, Shipbuilding Industry

I. Introduction

Korean companies have grown quickly, securing global competitiveness in manufacturing sectors such as electronics, shipbuilding, and the automobile industry. Recently, however, the Chinese are threatening Korea with rapid product development regarding quality, productivity, and technology.

The Chinese were top ranked in global shipbuilding production (based on GT[1]) in 2010. New innovation strategies are needed for Korean companies. KIET (2011) proposed strategies for product development and the strengthening of industrial infrastructure utilizing existing strategies. However, this proposal did not yield appropriate answers about how to effectively apply previous successful strategies to future business, or if new innovative strategies suitable to new competitive environments are needed.

The purpose of this study is to find a new innovation strategy through the analysis of the decline of leading companies in the past and their decisions made in fighting for market dominance. The process of new entrants taking market share away from old ones is also investigated, and by determining the root cause of the leading companies' decline. For this purpose, the process of the shift of industrial leadership is analyzed using the shipbuilding industry as a case study. Case studies are a proper way to extract meaningful characteristics from industrial development stages (Yin, 2009). Due to the strong dependency of the industry on previous successful strategies, the root causes of decline are distinct. Domestic and foreign literature about the shipbuilding industry is considered, as well as material from the Japanese and Korean Shipbuilders' Association, specialized research centers, and foreign specialists' studies.

Chapters 2 and 3 will show the theoretical background and analytical framework. Chapter 4 and 5 investigates the innovation strategies for the Korean shipbuilding industry through analysis of the industrial leadership shifting process based on two cases from the British and Japanese shipbuilding industry. Finally, the conclusion of this study and the subject of a follow-up study are suggested in chapter 6.

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1) GT (gross tonnage) means the total volume of a ship, expressed in unit of 100 cubic feet and is used as the amount of shipbuilding production.

II. Theoretical Background

1. Industrial Leadership Shift

Industrial leadership is a similar concept to competitive advantage, and it means to be ahead of one's competitors in product or process technology, gives firms an advantage in the world market (Mowery and Nelson, 1999). It also refers to the power that leading companies have (Moe, 2007), and changes indicate the transition of power to another company.

1) Product Cycle Theory and Industry Life Cycle Theory

The product cycle theory (Vernon, 1966) states that newly developed products are produced in advanced countries in the first stage, and then at the maturity stage, they shift to low-cost underdeveloped countries. Industry life cycle theory (Klepper, 1996) states that a company that builds up process R&D on emerging dominant products would be a leading company due to cost advantages and profit-making ability. Vernon and Klepper argued that cost advantages are essential factors in becoming a leading company, but their theories were not enough to explain other patterns that differ from their analysis in a technology-intensive industry.

2) Other Previous Studies

Nelson and Wright (1992) argued that leading companies in the United States that had achieved great success in almost all industrial fields including automobiles, chemistry, and electronics did not manage the tough competitive situation and lost their leadership when Western European and Japanese companies. Malerba and Orsenigo (1994) also studied the computer, semiconductor, and biotechnology industries, in which the US has led for a long time, and argued that if a leading company takes the wrong direction or reacts incorrectly to new technology and changing circumstances, an emerging company would take leadership.

Although these previous studies did not clarify the core decline factors of the leading companies, they showed a three-phase process in which the leading companies are deprived of their initiative, experience great success, followed by changes of competitive situation (including technological and market changes, and new entrants into the market), with a subsequent lack of response, and decline (new entrants' leadership takeover).

2. Innovation Strategy

Since leading companies' present competitive advantages are being rapidly eaten away (Thomas and D'Aveni, 2004), if they want to sustain their positions, they have to change constantly to seek other new competitive advantages and to fundamentally innovate upon their conservative ways (Porter, 1990). This paper is focused on extracting innovation strategies for leading companies, and primarily deals with technical and organizational innovation (Damanpour, 1991; Lim and Sanidas, 2011). Technical innovation is considered through the view of product, process, discontinuity, and product architecture innovation in order to study the decline factors of the leading companies, and organizational innovation through a point of the organizational inertia.

1) Technological Innovation

(1) Product and Process Innovation

Product innovation means changes in the products or services that an organization offers, and process innovation means changes in the ways in which they are created and delivered (Tidd et al., 2005). With regard to the relationship between product and process innovation, Utterback (1996) suggested a pattern that product innovation arises at the early stages of new product development, and process innovation increases after emerging from dominating the product market, while product innovation is downsized. The leading company creates new demand for new products by product innovation, and sells it at a high price, in addition to establishing market predominance (Cohen and Klepper, 1996). Cost advantages and profit-making ability are captured by persistently strengthening the process of R&D (Klepper, 1996). Process Innovation generates more profits than production innovation (Song and Namn, 2011). Additionally, product and process innovation have a complementary synergistic effect, so the leading companies must consider these two types of innovation together.

(2) Discontinuous, Product Architecture and Disruptive Innovation

Discontinuous innovation refers to fundamentally different ways of creating a product and different product forms (Anderson and Tushman, 1990). Product architecture means the scheme by which the function of a product is allocated to physical components (Ulrich, 1995). Through studies on discontinuous and product architecture innovation, Tushman and Anderson (1986), Henderson and Clark (1990) argued that if these innovations occur, since the then-existing knowledge, skill, and competence becomes useless, the leading companies tend to decline due to persisting with the competence that has given them great success, and a lack of response to new technology, while the new companies take a dominant position through the adoption of the new technology rapidly.

Disruptive innovation (Christensen, 1997) means that the technical innovation is abandoned by leading companies due to being less profitable, and their most profitable customers show no interest in it. The new companies that adopted this disruptive innovation gain the lead in the growing market, whereas leading companies lose their positions. Similar to this, previous studies did not do enough to explain that although the leading companies have had sufficient high-tech competence, they could not cope with the changing environments.

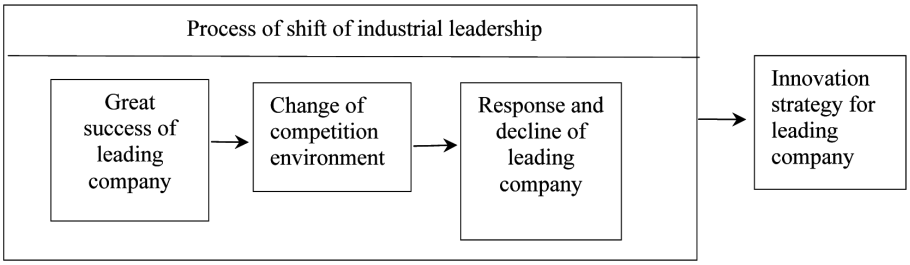
2) Organizational Inertia in Organizational Innovation

Organizational inertia is a persistent organizational resistance to changing architectural features (Hannan et al., 2002). The focus of organizational inertia is as a core factor for leading companies not to respond to the changes in key environments. Tushman and Anderson (1986) argued that new entrants that were unconstrained by prior technologies and organizational inertia partake in competence-destroying discontinuities. Henderson and Clark (1990) stated that the leading companies become inert and hard to change because they are embedded in conventional routines and channels. Miller and Chen (1994) argued that competitive inertia emerges from an organization that has had superior performance, which is also a negative factor for the organizational performance at the time of the change with mounting market diversity. The resistance should be properly managed in order to be successful in innovation (Ban and Kim, 2012).

As a result of the analysis of the previous studies, they showed that the core factors of leading industrial company's decline are great success, technological and market change, entering new entrant and their successful technological innovation, and innovation fail of leading companies (including immobilization, lack of product and process innovation, organization inertia).

III. Analytic Framework

The analytical framework for this study that connects the three stages of the shift of



(Fig. 1) Analytic Framework Frameworkework

〈Table 1〉 The features of the analytical framework

Stage	Core factors	Analyzing Features
Great success of leading company	Great success	• Long-term sustaining number one in the marketplace • Successful technological innovation Product innovations such as discontinuous, or product architecture, or disruptive etc. Process innovation such as methods, facilities of production
Change of Competitive environment	Technological and market change	• Appearance of new technologies and products • Market changes
	Entering New entrants and their successful technological innovation	• Entrance of the new competitors • The new competitors' successful technological innovation
Response and decline of leading company	Innovation fail	• Immobilization • Lack of product and process innovation • Organizational inertia

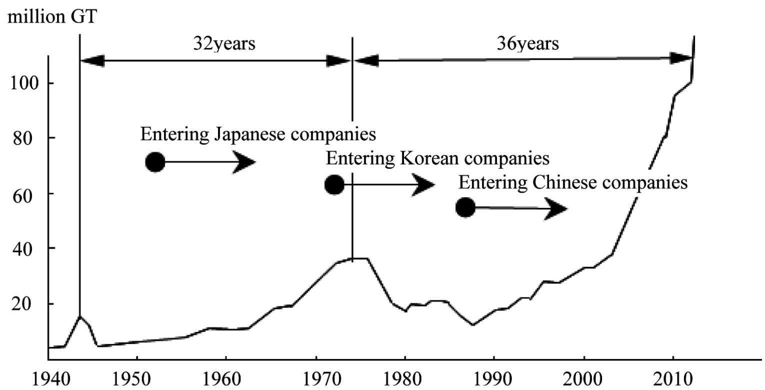
industrial leadership is repeated (see (Fig. 1)). A summary of the analysis applying various factors in innovation based on the analytical framework used in this research is shown in 〈Table 1〉.

IV. A Case Study: Shipbuilding Industry

In this case study, the innovation strategies of the Korean shipbuilding industry are extracted from the analytical framework, and two cases in the British and Japanese shipbuilding industry from 1858 to 2002 are analyzed to determine the features of shifts in the industrial leadership.

1. Industrial Characteristics of Shipbuilding

The shipbuilding industry has two characteristics globally. First of all, the shipbuilding industry has a 32 to 36-year peak cycle, as shown in (Fig. 2). Since World War II, there have been two great peaks in the shipbuilding industry from 1940 to 2011 connected with world economic growth. The peaks arose due to a ship's life of 25 to 30 years, in addition to world economic growth.



Source: KOSHIPA Statistics; 1940~1949 launched, 1950~ completed (Originally, Lloyd's Register of Shipping, Annual Shipping Returns).

(Fig. 2) World shipbuilding production (GT)

The industrial leadership of shipbuilding tends to move from a country's national supporting strategic groups to other ones. In the case of Japan, Korea, and China, the great companies entered the shipbuilding market with similar strategies and state support from each country. To analyze a specific industry, a strategic group must be approached as a business group that tactically pursues a similar strategy to those of others (Porter, 1980). So, the analysis of this study mainly considers the industry at the national level, but, if necessary, it can be applied to the company level.

2. Case 1: British shipbuilding industry (1858 to 1956)

1) Great success

Britain had stunning success and kept first place for 98 consecutive years, from 1858 to 1955 (Pollard, 1957; JMC, 2003). The market share for Britain was 63% in 1900, 49% in 1930, and 38% in 1950 (JMC, 2003).

When the immigration rush from Europe to the New World began in the mid-1800s, demand for passenger ships increased sharply. Britain began constructing large-scale iron ships[2] that were available to provide high speed, on-time arrivals, and comfort. British shipbuilders built large high-tech passenger ships applying discontinuous innovation through the transformation from wooden hulls to iron ones (Harley, 1973), and product architecture innovation by installing screw propellers and steam compound engines as

〈Table 2〉 British technological innovation (19^{th} to early 20^{th} century)

Innovation	Content	Year
Discontinuous	• Iron ship (the transformation from wooden hull to iron one with riveting)	Early 1830s
Product architecture	• Screw propeller ship • Compound engine ship • Steam turbine engine ship • Tanker(crude oil carrier)	1836~1837 1830~1848 1905~ Mid-19th
Process	• Modern shipbuilding production facilities (large steel plate, mechanical riveters, drills, heavy cranes etc.) • Fabrication shop construction of boiler and steam engine • Efficiency improvement of steam engine (70% reduction of coal)	1860~1910 1821~1881 1880~1890

Source: Harley (1973), Geels (2002), Pollard (1957), Burton (1994), Knauerhase (1967)

2) Iron ship means the ship transformed the iron with riveting method from a wooden hulled ship.

the propulsion system (Geels, 2002).

In the 1850s, the price of wooden ships was less than half that of iron ships (Harley, 1973). Since the 1860s, Britain made steady progress to innovate its process through the use of a modern shipbuilding system (see ⟨Table 2⟩). The wooden shipbuilding declined rapidly due to process innovation, which led to the price of British iron ships dropping by about 40% between 1856 and 1887 (Harley, 1973).

2) Change of competitive environment

(1) Technological and Market changes (welding technology and large tanker)

Cammell Laid, a British company, built a whole vessel using welding technology for the first time in 1920. Welding showed promise for saving labor and iron materials (The Northern Advocate press, 1920), but the ship-owners of the time distrusted the technology due to its brittle fracture characteristics (Parkinson, 1960).

In World War II, the United States constructed 2,458 standard Liberty cargo ships, which were all-welded ships. The production labor that was 1,160,000 man-hours[3)] (MH) per ship in 1941 was reduced to 480,000 MH per ship by 1943 (Lucas, 1993). These dramatic increases in labor productivity were achieved by process innovations based on welding technologies, including the application of the automatic welding machine, new prefabrication techniques for major components, major section (blocks[4)]) production methods, and transport by rails or movable crane. The occurrence of weld cracking defects was reduced to 13% in the delivered ships, which was achieved by welding design changes, welder training (Thompson, 2001).

The next factor was the fast-growing global market and the tanker boom. After World War II, the major world energy source was shifted from coal to oil, and the trade volume of crude oil from the Middle East to the United States had increased significantly. As a result, the demand for tankers to carry crude-oil increased rapidly. In 1956, the world shipping capacity was 95.1 million GT, representing an increase of 20.1 million GT compared with the capacity in 1950. Tankers represented 54% of the increasing capacity (Broadbrige, 1965).

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3) 1 Man-hour means one hour of work for one worker.

4) Block means a major section that a ship's hull is divided into.

(2) The entrance of Japanese companies and their successful technological innovations

In 1951, Japan joined the race supported by its government. In those days, Japan could not compete with Britain. This was because the cost of materials such as steel and engines was 1.6 times higher than in Britain, and although wages were 46% of Britain's, its production efficiency was so low that the man-hours per ship was 1.9 times higher (Sofue, 2006).

On the other hand, Japan had excessive facilities that had been used to build large warships during World War II. While Britain needed 4.6 years for its leading delivery time, Japan needed only 1.8 years. In the 1950s the Japanese shipbuilding industry had grown rapidly by obtaining a large amount of urgent orders for tankers and bulkers that were aimed to cope with the growth of global demand for crude oil, and the demand due to the Korean War (Tominomori, 1969).

In order to provide quick delivery and to solve problems with high cost, Japan brought in a mass production system and technical experience from the United States (JMC, 2003). This solved the problems of delivery and cost through American-style process innovation, such as the block production method based on welding technology and large tower cranes (see 〈Table 3〉).

With these process innovations, Japan had cut the MH per ship by 56%, the quantity of steel consumed by 23%, and the leading delivery time by 60% from 1949 to 1959, and finally began to compete with Britain on equal ground in the late 1950s (Sofue, 2006). They also focused on the product innovations for large-sized tankers and bulkers,

〈Table 3〉 Japanese process and product innovation (1944 to 1956)

Innovation	Content	Time
Process	• Welding adoption ratio : 1948, 25% → 1955, 100% • Introducing Automatic welding machine from US. • Gas cutting ratio : 1944, 5% → 1956, 95% • Block production, • Installing the large tower crane 100tons and 50 tons etc.	~1955 1950~ 1950~1955 1950~
Product	• Completion of the first Japanese large tanker (26,503 DWT[5]). Completion of the high speed bulker carrier (10,300 DWT, 19knots) • Completion of the world's largest tanker (84,730 DWT, length 256 m)	1953 1954 1956

Source: Motora (1997), Ikehata (1997), Yoshiki (2004, 2005)

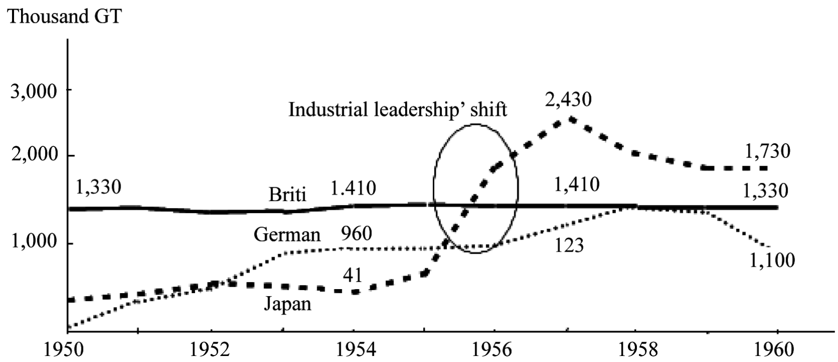
5) DWT (Deadweight tonnage) means a measure of maximum cargo weight in a ship. 1DWT is 1metric ton.

and had built the world's largest tanker in 1956.

3) British's Lack of response and its decline

After World War II, the world market was rapidly changing. In 1960, the world shipbuilding production had grown by more than 2.4 times, with 8.4 million GT compared with 3.5 million GT in 1950. Britain production was 1.3 million GT in 1960, exactly the same as in 1950. The marker share in 1960 was decreased by half, from 38% in 1950 to 16%. In 1956, it handed over industrial leadership to Japan, which had increased production rapidly (see (Fig. 3)).

The four primary causes of Britain's failure were immobilization, lack of product innovation for large tankers, organizational inertia, and endless struggles with labor unions and pressure for full employment.



Source: KOSHIPA Statistics (Originally, Lloyd's Register of Shipping, Annual Shipping Returns)

(Fig. 3) British and Japanese shipbuilding production

(1) Diminished profits owing to the world long-term recession and British immobilization

From 1920 to 1935, due to the long-term world recession, Britain's shipbuilding industry had hovered between life and death. During the Great Depression of 1930 to 35, its shipbuilding production decreased rapidly to 130,000 GT, from 2.000,000 GT in 1920. Clydebank (which had 36% of the market share in Britain) made 3% gross profit from 1919 to 1938, and the portion of merchant ships was only 0.4% of the total output (Slaven, 1977). In 1922, Britain laid off 32% of its workers and cut 22% of its wages.

After the World War II, in order to meet the demands for super-tankers (which were 250 to 300 m in length) and to react to the fast-growing world market, the British needed greater shipyards with wider spaces (Burton, 1994). The shipyards in Britain had been located in narrow regions along river fronts. Although this issue was reviewed (Warren, 1973), its profitability was so poor that Britain could no longer afford to invest (Steed, 1968; Slaven, 1977; Connors, 2007).

Britain instead focused on the replacement orders for 1,000 ships sunken during the World War II (Parker, 1996) and the lucrative repairing of vessels (Parkinson, 1960). It also concentrated on productivity improvement and cost reduction rather than the expansion of building capabilities so as to respond to periodic recessions. Britain gave weight to the immobilization that insisted on maintaining existing production capacity for securing profitability.

(2) Lack of product innovation for the rush on larger tankers

In those days, Britain's competence in product development and technological prowess was the world's highest. There was no need to develop new products, as it focused on obtaining orders for its existing products (Parker, 1996). Although it delivered 32,000 DWT in 1957, 54,000 DWT in 1963, and 100,000 DWT in 1965, it was 4 to 6 years later than Japan. This meant that British product innovation regarding timeliness had failed.

(3) Organizational inertia that resisted changes

The welding technology had showed its effectiveness in the United States, Sweden, and Japan, from the 1940s to the early 1950s. In the 1950s, there were some suggestions that called for Britain to adopt new shipbuilding technology, which were ignored (Parkinson, 1960). Britain did not apply the American technology until the early 1960s (Connors, 2007).

A Shipbuilding Inquiry Committee was set up by the British government for the enhancement of international competitiveness in 1964, and reported in 1966 the outcome of a review that the issue of competitiveness could be overcome by cost reduction, and that there was no urgent need to invest in new shipyards and building docks because the existing shipbuilding facilities were satisfactory, and that the demands for 200,000 DWT supertankers would slow down in the very near future (Geddes, 1966). There clearly was organizational inertia in Britain marked by the preference to maintain successful strategies, and production methods, and existing organizations from the past that had presented the British with their long-term success (McGoldrick, 1983; Connors, 2007).

(4) Labor union pressure for full employment and endless struggles

It is often pointed out that a crucial cause of the British decline was the conflict between the work force and management (Lorenz, 1991; McGoldrick, 1983). Until 1945, the British Labour Government had pushed ahead with a full employment policy (Cliff and Gluckstein, 1988). Generally, a shipyard had 17 unions, and they provided skilled field-workers (Lorenz, 1991).

In the early 1950s, the partial welding work had been widely applied, and thus, the welders were shorthanded. When management suggested employing one apprentice for every two skilled workers, the boilermakers' union insisted on placing one apprentice for every five skilled workers. Upon the application of the automatic welding machine, management wanted to replace skilled workers with apprentices, but the union insisted on placing four laborers with two skilled workers and two part-time workers (McGoldrick, 1983). The unions achieved their goals in these cases. Furthermore, they hindered management attempts to change the existing work processes by applying new technology and machines for productivity improvement (McGoldrick, 1983). Britain had not increased its shipbuilding production even in the 1970s; it had built 1.3 million GT in 1970, the same as in 1950 or 1960, which was only 7% of that year's market share.

3. Case 2: Japanese Shipbuilding Industry (1956 to 2002)

1) Great Success

After taking leadership in 1956, Japan did not lose the lead for the next 44 years. Its market share was 41% in 1965, 47% in 1980, 43% in 1990, and 40% in 1999 (KOSHIPA, 2005). As shown in 〈Table 4〉, Japan had led the market through product innovation in the form of super tankers, great bulkers, and great container ships since the late 1950s, and product architecture innovation such as the completion of moss-type[6] LNG[7] ships in 1981.

〈Table 4〉 Japanese production innovation (1956 to 2000)

Innovation	Content
Product architecture	• Large LNG ship (moss type : 129,000 m^3, length (L) 289m) 1981
Product	• Super tanker and Double hull tanker 100,000 DWT (L 285 m) 1959, VLCC[8] (209,000 DWT (L 342 m) 1965, ULCC[9] (327,000 DWT) 1968, ULCC (565,000, L 458 m) 1980, Double-hull tanker[10] : world's first 100,000 DWT 1991, VLCC 1993 • Large Bulker: 164,000 DWT 1982, 233,000 DWT 1989 • Large container ship with high speed 752TEU[11] (L 187 m, 26 knots) 1968, 2326TEU 1976, 3818TEU 1976, 4960TEU 1995, 6690TEU (L 284 m) 1998

Source: Ikehata (1997), Yoshiki (2005), based on completion

Japan not only applied its own developed process innovation, but also invested in constructing great building-docks, the construction of block factories, and the transportation equipment such as large tower cranes (Okita, 1995). A high-efficiency production system was also constructed through process innovation in design, production, and information methods (see 〈Table 5〉).

In 1996, Japan had higher productivity than Korea for double-hulled VLCCs (ex: Japan: 550,000 to 650,000 MH per ship, Korea: 850,000 to 950,000 MH per ship), and was far superior in non-price competitiveness factors, such as technology, delivery, quality, and after-services. Therefore, Japan received 1.05 to 1.2 times more price than Korea (Nagatsuka, 1998).

6) Moss type means an LNG ship design with independent spherical tanks.

7) LNG is an abbreviation for liquefied natural gas.

8) VLCC (Very Large Crude oil Carrier) means a 175,000-300,000 DWT tanker.

9) ULCC (Ultra Large Crude oil Carrier) means a tanker larger than 300,000 DWT.

10) Double-hull tanker means a tanker in which the bottom and sides of the hull have two complete watertight layers.

11) 1 TEU means one 20-foot container (length 20 feet, breadth 8 feet, height 8 feet), 752 TEU means a container ship able to load 752 TEU.

〈Table 5〉 Japanese process innovation (1956 to 2000)

Innovation		Content
Great building-dock construction		• MHI[12] 300,000 DWT[13] 1965, MES[14] 500,000 DWT 1968, SHI[15] 800,000 DWT 1972, MHI 1million DWT 1972 etc.
Production Facilities and method	• Block shop • Erection • Outfitting • welding machine	• Fabrication shop, Block assembly shop and paint shop etc. • Large erection block, large crane (200 to 600 tons). • On block and on board outfitting. • CO^2 welding machine(1979~) and welding robot (1997~)
Design	• CAD/CAM	• CAD(1970~), CAM(1980~)
Information system	• CIM[16]	• Computer integration system of Design, material and production information (1987-1992).

Source: Yoshiki (2004)

2) Changes in the competitive environment

(1) Technological and market changes (container ship, LNG ship and drillship)

The demand for container ships also increased by 12% annually during the 1990s (Lloyd's Register, 2007). Ships were consistently becoming larger (ex: 1984 - 4,458TEU, 1996 - 6,000TEU, 2003 - 8,000TEU) (Ham, 2004).

After the mid-1990s, the demand for LNG ships increased due to rising oil prices and the preference for green energy. For the safety of LNG ships, which carry the high-risk LNG, there were two types of LNG ships (Moss or Membrane-type). Japan chose the moss-type, which proved its safety on land, in 1981 (Morita, 2006).

The progress of the three-dimensional seabed exploration technique and drilling equipment resulted in vigorous deep-sea exploitation (more than 330 meters deep) (BP, 2011). The deeper the depth of water became, the longer the exploration period was. The adequate alternative was the drill ship. In the late 1990s, a large high-tech drill ship became available (L 222m), which could drill to 3.3 km below sea level in a storm (drilling depth: 8.3 km) (Park and Ahn, 2009).

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12) MHI is an abbreviation for Mitsubishi Heavy Industries.

13) 300,000 DWT dock means a dock capacity for ship's hull as large as 300,000 DWT.

14) MES is an abbreviation for Mitusi Engineering & Shipbuilding.

15) SHI is an abbreviation for Sumitomo Heavy Industries.

16) CIM is an abbreviation for Computer Integrated manufacturing.

(2) The Entrance of Korean companies and their successful technological innovations

Hyundai entered the market in 1973, followed by Daewoo (DSME) in 1978, and Samsung (SHI) in 1979, with their medium-large docks supported by the Korean government (Lee and Ryu, 1984). Based on strong government control and financial support for exports on a deferred-payment basis, the Korean shipbuilding industry jumped to the second position in the world in 1982, and finally, took first position in 2000 (shipbuilding production: 12.2 million GT, market share: 40%) (KOSHIPA, 2005). The three factors of its success are as follows.

First of all, Korea made timely investments in the construction of large docks to meet the expanded market demands, as did the semiconductor industries of Korea (Kim, 2011). Hyundai, Daewoo, Samsung, Hanjin, and others had constructed medium and large docks, continuously benchmarking the Japanese shipbuilding companies. As shown in ⟨Table 6⟩, the increase to 13.0 million GT (with 27 docks) was as equivalent the expansion in Japan in 2000.

⟨Table 6⟩ Korean Shipbuilding's Dock Facilities (~2000)

	~1983	1984~2000
Dock facilities (above 10,000 DWT)	Hyundai 3, Daewoo 1, Samsung 2, Hanjin 2 Total 8	Hyundai 9, Samsung 4, Daewoo 4, Mippo 3, Samho 2, Hanjin 3, STX 1, Daesun 1 Total 27
Goliath crane	450 ton (Hyundai), 900 ton (Daewoo)	600 ton (Samho), 900 ton (Hyundai)

Source: Lee and Ryu (1984), KOSHIPA (2005)

Secondly, the Korea push fully applied Japanese process innovation. Through the benchmarking about Japan's success, specialty factories were established, which included fabrication, block assembly, painting, and outfitting shops, and an attempt was made to improve productive efficiency through process innovations. Nevertheless, Korea was one step behind Japan in productive efficiency. To construct a double-hull VLCCs, Korea needed 1.16 to 1.25 times more MH than Japan in 2000 (ex: Korea: 500,000 to 700,000 MH, vs. Japan: 400,000 to 600,000 MH) (Hong, 2003).

Thirdly, Korea was successful in product innovations. It built large bulkers as big as Japan's in the late 1980s, and tankers in the early 1990s. For 6,000 TEU class container ships were built in 2001, three years later than Japan (see ⟨Table 7⟩). In the case of LNG ships, Korea built the moss-type 13 years later than Japan, but the membrane-type was built 9 years faster. In the late 1990s, Korea began to overtake Japan in some aspects of product innovation. For example, Korea delivered highly innovative drill ships in 1998, but Japan could not.

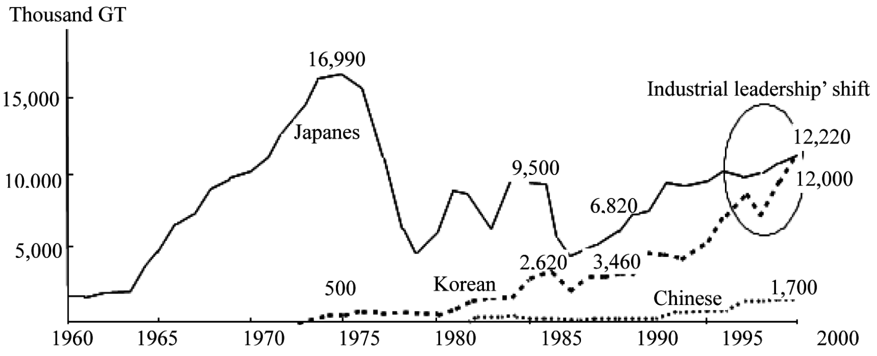
⟨Table 7⟩ Korean Product innovation (~2001)

Division	Korean	Japanese
Tanker	• VLCC 1974, ULCC 1993 • Double-hull VLCC (282,000 DWT) 1992	• VLCC 1965, ULCC 1968 • Double-hull VLCC (291,000 DWT) 1993
Bulker carrier	• 222,000 DWT 1986 • 320,000 DWT 1996	• 209,000DWT 1982
Container ship	• 2,219TEU 1984, • 4,409TEU 1991 • 6,447TEU 2001	• 2,326TEU 1976 • 4,000TEU 1985 • 6,690TEU 1998
LNG ship	• Moss-type (129,000 m^3) 1994 • Membrane-type[17] (131,000 m^3) 1995	• Moss-type (129,000 m^3) 1981 • Membrane-type (131,000 m^3) 2004
Drill ship	• 103,000 DWT 1998	-

Source: Kim (2006), Ikehata (1997), Yoshiki (2005), based on completion

3) Japan's lack of response and its decline

In the mid-1990s, Korea expanded while Japan stood still, as shown in (Fig. 4).



Source: KOSHIPA Statistics (Originally, Lloyd's Register of Shipping, Annual Shipping Returns)

(Fig. 4) Japanese and Korean shipbuilding Production

17) Membrane-type means an LNG ship design that installs the tanks consisting of a primary and secondary membrane on the ship's hull.

Japan lost its leadership in 2000. In practical terms, Japan had been displaced by Korea during from the mid-1990s to 2000. The three core causes of Japanese failure were immobilization, lack of product innovation, and organizational inertia.

(1) Diminished profits and Japanese's immobilization

Due to the long-term global recession from 1976 to the 1980s, the shipbuilding production of Japan decreased by 28%, from 16.9 million GT in 1975 to 4.7 million GT in 1979. The ratio of ordinary profits of the ten largest companies was rapidly reduced from an 8.8% surplus in 1973 to a deficit from 1978 to 1979 (Yamashita, 1993). From 1991 to 1995, the ordinary profit ratio also barely maintained at a low level of 1.9% to 3.4% (Han, 1998). As a result of the large-scale downsizing of facilities and personnel led by the Japanese government, its shipbuilding capacity was reduced by 48%, from 9.6 million CGT[18] (about 13.4 million GT, 1CGT = about 1.4GT) in 1979 to 4.6 million CGT (about 6.4 million GT), (Fukushima, 2012).

After the mid-1990s, a rise was expected due to the replacement demands for 300 worn tankers, and the orders for large container ships and LNG ships also increased. In the early 1990s, Japanese shipping companies asked for the restoration of the shipbuilding capacity that had been reduced before (Aso, 1997). However, large Japanese companies kept their conservative strategy of pursuing high profits from higher prices without expanding their shipbuilding capacities. The government approved this suggestion and decided to preserve the status quo, and the decision was not changed until 1996 (Aso, 1996; 1997).

Ku and Kato (2013) revealed that Japan took a very dark view of the market whilst experiencing a long-term recession during the 1990s, and because Japan recognized the shipbuilding business as a smokestack industry, it could not seize the opportunity in a period of industrial expansion when a mature industry shifts to a growth industry.

(2) Lack of product innovation for container ships and LNG ships

Japan had focused on building standard bulkers that have a size limit due to canal routes such as the Suez or Panama canals. As for the standard bulkers, they were

18) CGT (Compensated Gross Tonnage) means the amount of work that charged for the ship's production. It is calculated by multiplying GT by the coefficients according to the ship's type.

optimal to build using existing facilities without keen competition with Korea, and the orders were good enough (Ku, Kato and Mukai, 2010). In the case of large container ships, Japan had led the market with continual success in building 6,000 TEU class ships (Yoshiki, 2005). However, from the mid-1990s, Japan was faced with unexpected difficulties with flooded orders for 7 to 11 container ships with quick delivery of 1 to 2 years, which was almost impossible to fulfill with its existing capacity. They could not obtain orders for large container ships, which had increased rapidly.

For the LNG ships, the moss-type ships developed by Japan had been a dominant product for a decade since 1981 (Morita, 2006). In the mid-1990s, Korea decided to build membrane-type LNG ships, which reduced production cost by 10%, improved fuel-economy, and increased size capacity (SHI, 2004). Ships were delivered successfully from 1995 to 1999 (Kim, 2006). By verifying its safety and feasibility, the membrane-type LNG ship had become a dominant product. Korea has dominated the market of the LNG ships in 2000s.

(3) Organizational inertia that resists changes

In the early 2000s, cost-reduction-oriented Japan insisted on using its standard production system, and did not accept customer's requests for specification changes on the product on the grounds of the delivery schedule or the cost of production (JMC, 2003). Furthermore, Japan selectively obtained orders only from its highly profitable customers, even showing a tendency to dump the orders for low-price ships to Korea (Aso, 1996). The order-selection policy that was adopted to avoid business risk using its forward position became a stumbling block of rapid decision making (Ku, Kato and Mukai, 2010).

In 2003, the Japanese government forecasted that the world shipbuilding production in 2010 would be 30.0 million GT, and set its goal of production as 10.0 million GT. Japan took a very conservative market outlook and could not set a proper target, and thus lost the timing to invest in spite of its sufficient resources (Ku and Kato, 2013). The organizational inertia that resisted changes precluded Japan from making a rational decision.

Japan competed on equal terms with Korea for the market share in 2000 (38.4%: 39.1%) and in 2001 (38.6%: 37.2%). In 2002, China took a 6.7% share, Japan's share decreased to 36.2%, and Korea's share somewhat increased to 38.7%. Since then, Japan has lost its share, with China having expanded its capacity for bulk carriers.

V. The Innovation Strategy of the Korean Shipbuilding Industry

1. Learning from the Cases of Britain and Japan

The leading industrial companies have declined due to immobilization, a lack of product innovation, and organizational inertia. A shifting in industrial leadership occurs in a period of rapid growth, and innovative companies that launch innovative products rather than cost advantages, and establish optimal facilities, take the lead. While leading companies depended too much on out-of-date products and processes declined, companies that developed products rising from rapid-growth markets rather than cost advantages took the lead.

Additionally, for the leading companies, low profitability in a period of long-term recession devoured their capability to invest, and became a target of restructuring, so they had lost their power for re-growth. The leading companies had failed to properly handle the challenges from their rivals, who were armed with new strategies for market expansion along with product and process innovation.

Fifthly, the root causes for the failure of the leading companies was that they could not control the organizational inertia formed by their past successes. In order to escape this practice, the reconstruction of innovative management systems that are suitable for future environment changes is required. The multiple union struggles caught up with the companies in Britain. Korea's leading companies need to be innovative in their management and organizations to cope with organizational inertia and the multiple unions.

2. Innovation Strategy of the Korean Shipbuilding Industry

A customer-oriented and innovation-centered management system should be constructed for Korea. Based on the past success strategies, the existing organization tends to put its own policies first rather than to accept core demands from its major customers, and as such, the system needs to be fully transformed qualitatively so as to meet the needs of new major customers. To achieve this, leading companies should form a customer-oriented and innovation-centered task force, and find out information about the major customers and products which lead future markets and technologies, and preferentially create innovation strategies and an operational system.

The leading companies should also establish a management system to form and execute strategies for recession and periods of re-growth. In order to avoid any possible immobilization, let the revival challenge the task force in the planning or managerial department to predict market changes, to establish reactive strategies beforehand, and to create a consensus with management, shareholders, and employees. By securing enough reserve funds in boom periods, preparations should be made for proper investment in the next re-growth period of the market.

Product and process innovations should be consistently pursued. Since it is not easy to predict which dominant products will emerge in the future market, the self-selected products, as shown in the cases of Britain and Japan, are more likely to end in failure. It is most important to interact with major customers periodically on new products and technology trends. Furthermore, sales and R&D should carry out close interdepartmental cooperation, and R&D could interact with major customers directly in order to develop new products and technology.

Furthermore, the reactive strategies should be established in response to China, which is targeting Korea by developing high-value products. A Chinese response task force should be established to periodically check into the innovation strategies and the speed of Chinese companies, and to work out strategic implications. Moreover, the task force should set up target costs and implement an action plan established by functional organizations against Chinese cost advantage

A new organizational culture should be created in which everyone in the company cooperates with each other to cope with slumps without labor-management disputes. Each company's organizational culture has to be changed to achieve internal consensus. Employee training highlighting the cases of failure in Britain and Japan will also be helpful, as would examples of customer secession and missing market opportunities due to disputes.

VI. Conclusion

This study shows that the decline of leading companies occurs in three stages: great success, a change in the competitive environment, and lack of response. The three core factors of decline are immobilization, lack of innovation for major products, and organizational inertia. Although leading companies made reasonable choices in their own ways, the outcome of their insufficient strategies ended in failure, while entrants, seizing the chance, took over leadership in the market with their successful product and process innovation. The leader of the market was not decided by strong competitiveness, but by quick reaction to major customers' needs. The out-of-date strategies that had promised great success in the past did not contribute to maintaining leadership. The root cause of the decline of leading companies is organizational inertia marked by persistence with existing strategies in spite of the change in the competitive environment, which is a failure in innovation.

The leading industrial companies of Korea should not settle for the success of the present, and should construct a customer-oriented and innovation-centered management system in order to prepare for an uncertain future, and to overcome fierce global competition. A practical and innovational system is needed, including re-organization, so that the whole company can effectively respond to major customers' demands on time. It is also important to form a consensus about long-term visions and strategies for overcoming recessions with decision-makers, shareholders, and investors, so as engineer cutbacks, and so that investor confidence does not waver. The leading companies of Korea should check into the innovation strategies of China so as not to lose their position. Consensus should be formed between labor and management, and employee training should be strengthened so that labor-management disputes do not happen.

Though this study has suggested an analytical framework that can extract innovation strategies for leading companies through the analysis of industrial leadership shifts, this case study is limited in that it deals with only one industrial field. However, this study may also help researchers who work with other industrial fields, including the automobile, steel, machinery, and chemical industries.

Follow-up studies would include the effects of change in the technologies of the shipping business and offshore plants, the markets of the shipbuilding industry, analysis of the competitiveness between Korea and China, the strategic choices for cost leadership. product positioning strategies, and new business strategies. Such research may help the leading companies in Korea establish visions and core strategies for the twenty-first century.

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김병수

삼성중공업에서 27년간 근무하였고 현재 자문역이며 성균관대학교에서 기술 경영 박사과정을 수료하였다. 주요 관심분야는 기술경영, 혁신전략, 신제품개발, 6시그마 등 이다.

조근태

현재 성균관대학교 시스템경영공학과/기술경영학과 교수로 재직 중이다. 성균관대학교 산업공학과에서 박사학위(1995)를 취득하고, University of Pittsburgh에서 Visiting Scholar(1997~1998)로 활동하였다. 주요 관심분야는 Management of Technology, R&D Management 등이다.