

"BOTTLENECK" AND COUNTERMEASURE OF HIGH-TECHNOLOGIZATION OF MARINE INDUSTRY IN CHINA

LUAN Wei-xin

(Sustainable Developmental Research Center of Marine Economy, Liaoning Normal University, Dalian 116029, P. R. China)

ABSTRACT: This article deeply researched into the existent five problems and four main "bottlenecks" in the high-technologization of marine industry in China on the basis of analyzing the new trends in international marine problems and the necessity of implementing the strategy of developing China based on marine. This article brought up specific measures to the five "bottlenecks" according to the situations, and pointed out that new marine industry should be high-technologization and the traditional marine industry should be reformed by high-technique. The research results may provide the scientific basis for realizing the high-technologization of marine industry in China.

KEY WORDS: marine industry; high-technologization; bottleneck

CLC number: P74; F061.3

Document code: A

Article ID: 1002-0063(2004)01-0015-06

Marine industry development specially depends on high technique. Maintaining marine rights and national defense safe, marine investigation, and marine monitoring require high-tech support. And marine industry has some characteristics such as high risk, high input, internationalization, and complicated technique. Marine developmental practice in China has already proved that high-technique is the main motive of marine economic development. This article analyzed the background and the main "bottlenecks" on high-technologization of the marine industry in China and specifically discussed the countermeasures.

1 URGENCY OF HIGH-TECHNOLOGIZATION OF MARINE INDUSTRY IN CHINA

1.1 Violent International Ocean Competition

After land partition in the World War II, the strategic position of marine has been gradually outstanding in the world, and some new trends have appeared in international marine business.

1.1.1 Marine rights competition

Along with *Communal Arrangement of Marine Law in United Nations* coming into effects formally, the new order of the international ocean has been gradually established, and the coastal waters of $130 \times 10^6 \text{ km}^2$, which amounts for 35.8% of the whole ocean, will be

divided into the jurisdiction sea area by the maritime countries. So the countries in the world will compete for marine rights violently. The 380 pieces of marine boundaries among the countries in the world require to be delimited, but now only 1/3 were resolved, so the marine boundaries would be the core problem of the international marine political businesses in the coming 20 years. The competitive problem of marine rights still exists in the Yellow Sea, the East China Sea and the South China Sea (RICHARD, 2000; LIU, 1997).

1.1.2 Marine Resources Competition

The international marine resources competition includes the dispute of oil and gas resources at the bottom of sea and the dispute of fish resources in marine economic realm, the competition in the prospective and developmental realm of deep-sea mineral resources and the use of deep-sea biological resources and so on.

From the 1970s, Philippines, Malaysia, Brunei, Vietnam, Indonesia began to explore and develop the prospective oil and gas resources in the Nansha Islands of China, even took it as the their national policies. According to the preliminary statistics, the current peripheral nations have drilled more than 1000 wells in the Nansha Islands, and found oil and gas of $26 \times 10^9 \text{ t}$, and 97 oil fields and oil structures, 75 gas fields and gas structures. The dispute of fish resources occurred

Received date: 2003-06-17

Foundation item: Under the auspices of the National Natural Science Foundation of China (No. 40271029)

Biography: LUAN Wei-xin (1959–), male, a native of Shenyang City, Liaoning Province, professor, specialized in regional marine economic geography. E-mail: weixinl@vip.163.com

occasionally in the Yellow Sea, the East China Sea and the South China Sea.

1.1.3 Special interest in forelands

Forelands become the hot point that gains a special interest at present. Marine industry has already become the important pillar of the world economy, and the total production value increased from US\$250×10⁹ in 1980 to US\$1.3×10¹² in 2001 at a speed of 8.2% annually (higher than the average speed). Coastal zones become the centers of politics, economy, culture and technology in the most littoral countries. About 75% of big cities in the world, 70% of industry funds and more than 50% of population are concentrated on the regions that are less than 100km away from the bank.

Entering the 1980s, the developed countries such as the United States, England and Japan have made the development of marine technology become the focus of competing for the ocean.

1.2 Developing China by Ocean Strategy

1.2.1 Rich in marine resources

China is to the west of the Pacific Ocean and owns both land and ocean, with mainland shorelines of more than 18×10³km and island shorelines of 14×10³km. It rules over roughly an area of 3×10⁶km², which is equal to 1/3 of Chinese land areas. Chinese islands are numerous and distributed in the east and south waters of China, which is close to mainland very much and forms natural national defense. The islands are part of national territory and have important value of politics and national defense. The islands and their surrounding waters have abundant nature resources including the port's position, creature, tourism, mineral and marine energy and so on, which is the base of marine development.

1.2.2 Great land pressure

Land pressure in China urgently needs alleviating through marine development. The natural resources have being exhausted in China, and per capita resources is lower than the average level of the world. The per capita land area, water resources and mineral resources in China is only 1/4, 1/4 and 1/2 of the average of world respectively, and 22% of the world population are fed by the cultivated lands which are 7% of that of the world. At the same time, the population migration to the sea and the progress of civilization make about half of population in China concentrate on the coastal zones. The pressure of food, resources and environment and so on in the coastal lands is more and more. Therefore we must alleviate the contradiction of supply and demand in land resources through making

use of the marine resources, in order to guarantee the sustainable, rapid, healthy development of Chinese economy and to implement the strategy of "extend the reigned areas and expand the resources". Then more resources could be stored for 1.3×10⁹ persons' sustainable development through Blue Ocean instead of Brown Land.

1.2.3 Great economic growth point

The marine economy is the great economic growth point in China, which has been increased by 20% annually since 1980, and the direct productive value of marine industry in China had been increased from 6.4×10⁹ yuan (RMB) in 1979 to 723.4×10⁹ yuan in 2001 (increased by 113 times); the value proportion of marine industry to national industry had been increased from 0.7% to 7.4% in the same period. An industrial structure system has been gradually formed, which takes aquatic products industry as its main industries, and makes such new marine industries as oil and gas resources exploitation, biological pharmacy, synthetic seawater use and solid mineral resources exploitation develop rapidly.

Economic rapid development along the coast in China urgently requires developing and making full use of marine resources, and we must invest the more funds in ocean industry in order to guarantee national political safe, coastal defense safe and marine rights.

1.3 Marine Development by High Technique

The science and technique is the primary productive force. Marine development has a special dependence on the high technique because of the change of marine environment and developmental difficulty. Cosmic development enters the marine developmental realm by such techniques as acoustics technology, space technology, electronics technology, laser technology, remote sensing technology, and imitation technology in the ground. A series of problems exists in the marine developmental process, but the most important problem is the gap of marine high technique between China and the developed countries.

The strong marine countries such as the United States, Japan, England and France pay much attention to the development of marine high-tech clusters. They have input plenty of funds and manpowers to do the researches of technique and equipment in marine monitoring, marine deep-dive, marine creature and marine exploration since the 1960s. The contribution rate of marine technical progress to marine economic development has exceeded 50% (LIU and NI, 2000). The high-technologization of marine industry is the way to

the sustainable and rapid development of marine economy in China, and it (not simply the industrialization of marine high technique) has three implications: 1) To study and develop the high technique, to implement the promotion of high technique and transformation to the industries of marine aquatic industry, sea conveyance, sea salt industry and so on, and to increase the intensive degree of knowledge and technical developmental level and self-created ability in the traditional marine industry. 2) To do the techno-economic activities of professionalization, scalization, integralization, and marketing to industrialize those industries, such as marine medicine, sea desalting, which have great effects on economy, and more social effects and economic returns, and can form the industries through the industrialization progress. The scale of the new marine high-technical industries can be expanded, such as marine medicine, marine environmental protection, synthetic seawater use, marine energy and so on through these activities. 3) To increase the level of marine monitoring, marine forecast, marine information management and marine environment management, to take an active part in the important marine research plan in the world, exploratory development and management at the bottom of international ocean, scientific investigation and business in polar regions, the management and use of marine creature resources in the world, marine eco-environmental protection in the world and so on, and to equip marine service system by new high technique in order to protect marine rights.

2 KEY PROBLEM AND "BOTTLENECK"

2.1 Key Problems

The gap of marine high-tech level between China and developed countries is closing, but the former is still 10–15 years behind the latter as a whole. The lower level of high-technologization of marine industry is the key problem to limit marine economic development in China in the future (LEROY, 2000; LU, 1996).

(1) The present research course is not good for the industrialization. The researchers engaged in basic research are much more than those in application technology in Chinese marine research. Marine technical personnel are concentrated on the research institutes (65%), universities and colleges (31%), but the researchers engaged in the productive activities are little (about 4%).

(2) The conversion rate of research result is low. Scientific research is lack of ties and smooth channels

with the industrialization because of the lack of the contact between scientists and entrepreneurs. The enterprise would not like to invest the funds for the early research and the result conversion, which does not form the good circle of converting from the scientific results to the industries.

(3) The basic and applicable technique stores are shortage. The main problem is to neglect research law of science and technique, but to be eager for immediate interests and quick success. The proportion of research items for result store to total research items is 20% in developed countries, but only 5% to 10% in China.

(4) The technical equipments fall behind. Main technical equipments in China fall behind the developed countries. Lots of technical equipments abroad should be introduced to the fields of marine oil and gas resources development, marine forecast, the exploration of mineral resources in the deep-sea, marine fish resources and marine agriculture.

(5) Marine industry structure is not reasonable. Marine industrial development in China is in the elementary stage, which belongs to the extensive management or plunderage to resources. The proportion of marine aquiculture to marine industry is over 70%, and high-technologization level of marine industry is low and marine industrial structure falls 10–15 years behind the developed countries.

(6) The contribution rate of science and technology is low to marine economy. The contribution rate to marine economy has got to 50% to 60% in some marine countries such as the United States, Japan and so on, while that is only 30% in China. The gap is also great between China and other modern advanced countries in the world.

(7) The service level of marine science and technology is low. Many techniques, such as marine management, marine monitoring and forecast, marine environmental protection, marine information management and so on, falls behind the developed countries.

2.2 Bottlenecks

The reason for the above problems is the existence of these four bottlenecks:

(1) The whole competition ability of science and technology in China is weak. Marine industry is in the advanced position to reveal the unknown realm through the sophisticated technique in the whole high technical industry clusters. But Chinese competition ability of science and technology (ranks 28th), technical creative ability (the patentable index ranks 21st)

and the level of high-tech industry are low, which restrict the high-technologization of marine industries.

(2) The investment in marine research is absent. The funds input in marine research in China is 1×10^9 yuan annually, which is only 5% of that in the United States. Marine industry is regarded as the higher technical part, but the intensive degree of R&D (the proportion of the funds of R&D to industrial growth value) is only 0.4% or so, which is much lower than the average in China and becomes the biggest restricted factor of the high-technologization of marine industry (WANG, 2000).

(3) Marine educational ability increases slowly. The proportion of recruit students, undergraduate students, graduate students in the professional field of ocean is only 0.2% to 0.3% of total in China. The demand of marine development for high-tech personnel is above the average in China. But the current marine educational ability in China does not suit for the marine economic development that is 3.4% of GDP.

(4) Marine scientific and technical power is weak. The proportion of marine scientific and technical personnel to the whole country is 0.05%. The professional personnel in China increase at a speed of 7.6%, while marine professional personnel decrease at a speed of 1%. The average number of professional personnel per 10^4 personnel in China is 1044.7 in 1990, 1890.5 in 1999; while the average number of marine professional personnel per 10^4 personnel is 122 in 1990, 81 in 1999. This fact is worth worrying.

3 COUNTERMEASURES

3.1 Main Measures of Breaking "Bottlenecks"

(1) "Three spiral" Model—combination of industry, university and research institute. The "three spiral" model is the combinational power model that imitates the interaction mechanism among science, market, government in the view point of the theory of evolution. The government is the basic guarantee in the combination of industry, university and research institute, and enterprise is the main body of scientific research, development and investment, and university and research institute are the cores in the model, which should do research and study following the market economic law, educational regulation, scientific and technical development rule, and become gradually the cooperative relations of benign cycle.

(2) Implementing system innovation. The innovation environment should be established gradually, taking

the enterprise as main creative body, in order to increase gradually the proportion of self-innovation; also, the important task of enterprise leaders is to form "Study" instead of "Control" in the complicated and changeable competitive environment. At the same time, it is important to set up the support system of diversified investment network and efficient risk investment.

(3) Setting up new Marine High-tech Industry Park (MHIP). It is a good way to promote the combination of marine research, education, production, and form new marine high-tech industry clusters and demonstrative areas depending on the university and research institute, whose aim is to develop marine high technique, to expand the new marine industry and develop new products.

The new MHIP has the mechanism of self-expansion, self-breeding, self-adaptation, self-stabilization, which is the source of development, also has the functions of hatcher and demonstrative areas, and the possibility and practicality of promoting the competition ability of the traditional marine industry according to the analysis at macroscopic and microscopic level.

In Chinese marine science and technology field, a lot of research results have been got. But most of them have been shelved and forgotten, only a few of them can be turned into realistic productivity and industrialization results, therefore the development of marine science and technology industrialization is slow. It shows that the latent advantages of marine science and technology in China cannot be turned into real economic advantages. The MHIP is a kind of high-tech zones, whose task is to study, develop and produce the high-tech products, and promote the commercialization and industrialization of marine science and technology results. At the same time, it can develop the function of new high-tech zones brooder, push the traditional marine industrial development and expand marine economic scale. The basic activities of the business enterprise in MHIP are researches and product's developments that are done by senior scientists and engineers, instead of making and selling. Depending on the talent advantage and intelligent advantage in marine research enterprises and colleges, the whole field will possess strong research and competition strength in China, which will push the formation and development of marine high-tech industry.

According to the analysis on the formative conditions of new high-tech zones, MHIP should be set up in the places which have more intensive intelligence, stronger marine science and technology power, and

better open setting, certain ability to absorb high technology, such as Qingdao, Shanghai, Tianjin, Dalian and so on. The first MHIP in China—Marine Science and Technology Industry Park in Tanggu of Tianjin has already begun to be built, and Qingdao has prepared for setting up its own marine science and technology park, which will promote the high technologization of marine industry in China. Dalian may consider developing marine science and technology park on the foundation of "Double D Harbor" (Double D is the abbreviation of "DIGITAL and DNA"). Marine science and technology park must be planned as the important part of cities along the coast. And it should be given the legal power of special economic management, with the mode of "Science and Technology Special Zone".

(4) Implementing the personnel engineering. Along with the improvement of automation, information and intellectualization in marine business, a lot of heavy, repeated physical labors are replaced by various automatic machines, and the requirement of technical marine workers is greater. It is important for Chinese marine business to increase the proportion of science and technology talents in marine workers and improve the whole quality of marine workers. The engineering can be divided into three levels:

The first level: professional talents. Now there are 30×10^3 marine professional talents and 4×10^6 marine workers in China. The proportion of professional talents to industrial workers is less than 1%, which is lower than the level of medium developed marine countries in the world. That proportion should amount to 15% in 2015, 30% in 2030 so as to implement the 21st century marine strategy better.

The second level: management talents. It is feasible to educate the compound talents of old men, middle-aged men and young men, with higher level of knowledge and stronger practice abilities. The proportion of personnel with the educational backgrounds of postgraduate student to all marine management personnel will reach 30% in 2015, and 50% in 2030.

The third level: industry workers. The proportion of illiteracies to all marine workers in China is 20%, and the average educational degree is only equal to primary school degree. The aim is to exterminate the illiteracies and raise the average educational degree of marine workers to the senior middle school degree in 2015, and above university degree in 2030.

3.2 Reforming Traditional Marine Industry

The traditional marine industry is the main part of ma-

rine industry (the proportion of whose value to marine industry in China is over 75%). It is the main battlefield that the high technique is turned into the productivity. It is the main way to promote the high-technologization of the traditional marine industry by a series of high technology, for developing marine economy and meeting the international challenge.

(1) To reform marine industry by modern biological technique. The biological techniques include breeding fine varieties of marine aquatic products, setting up all kinds of fine varieties bases, improving the diagnosis and prevention technique in cultivation diseases as soon as possible, perfecting diagnosis and research on epidemic diseases of scallop, abalone, big clam and laver.

(2) To reform traditional ship industry by high technology. It should be done to accelerate the obsolescence of ships equipments, to conduct important ship's reformation including design, structure, type, pushing system, communication system, automation and management, to strengthen production abilities of the large-sized oil ship, finished product oil ship, container ship, LNG, LPG.

(3) To improve soft environment in marine transportation by EDI system. Along with the development of the world trade, accurate, rapid and extensive marine transportation becomes more important. EDI (Electronic Data Inter-change) system can handle the business documents such as trade, production, conveyance, insurance, finance, customs through international grammar rules, which will tally with the international standard format. This is the key technique to improve the soft environment of marine transportation in China.

(4) To improve the technique in salt production. It is necessary to develop large-sized vacuum production equipment, and increase the labor production rate as well as salt productive ability in the enterprises through the technical reform, at the same time, to increase quantity and quality of sea salt production by the saltpan biology technology, such as breeding, inoculating and gathering of pot-stewed insects, processing of pot-stewed insect eggs, and breeding of brine alga and spiral alga. The techniques of extracting β -carotene from the salt alga and getting alga protein from spiral alga have been already industrialized.

(5) To develop tourism industry along coast. Lots of inventions are the important foundation of marine tourism, such as portable submarine breath machine, mixture diving machine, yacht, surfing and sailboat, and navigation system.

3.3 Industrialization of Marine High Technique

It is possible that the five technical systems become marine high-tech industries in the future, including marine biological medicine and marine health production, the industrialization of marine energy, the technique of exploiting marine oil and gas deposits, and tapping regional resources and so on. Of those, the two industries, marine biological medicine and marine health production, and regional resources tapping technique in the world, are on the key roles.

The regional resources at the bottom of international ocean is the biggest political geography unit that has the special position in law, the extensive rights and latent economic benefits, and is the main selected object of Blue Enclosure Movement in the developed countries. The resources at the bottom of international ocean should play its strategic function of sustainable development in China in order to break the monopoly of strong countries in "regional" resources. Then it is more important to enhance the research on equipments and techniques concerning exploration, exploitation, carry, use of regional resources at the bottom of international ocean, and to set up gradually the industrial chains which is representative of gene resources development of marine creature and the manufacture of deep-sea exploratory equipments, so as to obtain synthetic rights of developing the "regional" resources in China.

In 2000, US\$330×10⁹ was produced in the international medicinal market, by which it is estimated that the medicinal market has great potential (WANG, 2000). Marine creatures contain the active materials of medicine and health value, because ocean is stereoscopic water environment, and marine creatures are under the special ecologic environment with high salt content, high pressure and low temperature, depending on the special structures and functions to live. It is the first duty to make use of varieties of marine resources and the existent foundation of marine medicinal development, of which the foci are : 1) anti-cancer, anti-tumor medicine; 2) anti-blood vessel disease medicine; 3) anti-bacteria, anti-viruses medicine; 4) marine biological toxin.

3.4 High-technologization of Marine Service System

To realize the high-technologization, marine service should be considered in four aspects on the basis of analyzing the promotive functions of science and technique to marine service and the relations between marine service and marine scientific and technical development. The first one is to promote the intellectualization of marine management by strengthening marine synthetic management system and organizing the special soft scientific research. The second one is to accelerate the connection with GOOS (Global Ocean Observation System) by setting up stereoscopic monitoring system of marine environment, real-time monitoring and information service system of marine environment in the bay and harbor, ecologic monitoring and service system of marine fishery and so on, to increase marine monitoring and forecast ability. The third one is to raise modernization level of marine information service, with emphasis on developing the technique of "Digital Ocean". The fourth one is to raise protection level of marine environment through trying to get the support from other technical fields, enhancing international exchanges, paying attention to basic research and so on.

REFERENCES

- LEROY Creswell, 2000. The emergence of aquaculture: bridging the gap [J]. *MTS Journal*, 34(1): 3-5.
- LIU Rong-zi, 1997. Developing marine resources to set up marine economic strong country [J]. *International Technical and Economic Research*, (4): 16-25. (in Chinese)
- LIU Yan-hua, NI Yue-feng, 2000. *The Developmental Prospect of Marine Science and Technology in China in the Early 21st Century*[M]. Beijing: Marine Publishing House. (in Chinese)
- LU Da-dao, 1996. *The Sustainable Development in Chinese Forelands in the 21st Century*[M]. Wuhan: Hubei Science and Technology Publishing House. (in Chinese)
- RICHARD DeVoe, 2000. Marine aquaculture in the United States: a review of current and future policy and management challenges [J]. *MTS Journal*, 34(1): 5-17.
- WANG Jia-rui, 2000. *The Developmental Strategy in the Technologization of Marine Science and Technology* [M]. Beijing: China Ocean Press. (in Chinese)