Evaluation of Scientific and Technological Innovation Ability of China's Ship and Ocean Engineering Manufacturing Industry Research review and outlook

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Abstract: It is a groundbreaking work to study the technological innovation capability of listed companies in China's shipbuilding and offshore engineering manufacturing industry. Based on the research results of relevant literatures at home and abroad in recent years, the research progress of the evaluation of scientific and technological innovation ability is analyzed in detail: the connotation of scientific and technological innovation ability, the content of scientific and technological innovation ability evaluation, the evaluation index of scientific and technological innovation ability and the evaluation method of scientific and technological innovation ability. At the same time, combining the characteristics of this industry and the research status of its scientific and technological innovation ability, it finally draws further research prospects.

Introduction

The marine engineering equipment and shipbuilding industry, also known as the “big ship industry”, is a modern comprehensive and strategic industry that provides technical equipment for water transportation, marine resource development and national defense construction. Since the beginning of this century, China has become the world's most important shipbuilding country. In addition, as a strategic emerging industry in the ocean, China's offshore engineering industry has grown rapidly and has entered the world's first phalanx since 2005.

However, after the US financial crisis, the shipbuilding industry has entered the fourth decline cycle in history. At the same time, the orders for various types of marine engineering vessels have also fallen sharply, and the orders for offshore engineering are in a downturn. It can be seen that the status quo of China's shipbuilding industry is still very strong. Especially in terms of technological innovation, China's shipbuilding industry has been extensive in industrial growth for a long period of time, and its technological innovation capability is weak. Among the elements of industrial development, the contribution rate of technological innovation is low.

Solving the problem of low-end products as soon as possible, enhancing the core scientific and technological innovation strength, seizing the international market, and extending to the service field with higher added value is the only way for the development of China's shipbuilding and marine engineering manufacturing industry.

Summary of research at home and abroad

Summary of Research on the Connotation of Scientific and Technological Innovation Ability. The theory of innovation was first produced in 1912 by the American Austrian economist Schumpeter's book Economic Development Theory, in which he defined innovation as "a change in the production function, and this function cannot be broken down into infinitesimal steps" [1].Scientific and technological innovation is a three-dimensional structural system including scientific innovation, technological invention, and technological innovation. Its essence is mainly knowledge innovation and technological innovation [2]. At the beginning of the 21st century, Utterpark defined technological innovation to another level, combining it with the market and defining the application of technological innovations in the market [3].The ability of scientific and technological innovation refers to the comprehensive strength of inventions and innovations in the technical fields of a certain discipline, such as enterprises, schools and scientific research

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institutions [4].

The three concepts of innovation, technological innovation and technological innovation capability are the basis for the evaluation of technological innovation capability. Through literature review, the research on the evaluation of scientific and technological innovation capability mainly includes the following parts: (1) the content of scientific and technological innovation capability evaluation (2) the evaluation index and system construction of scientific and technological innovation capability (3) the evaluation method of scientific and technological innovation capability.

Summary of Research on the Content of Scientific and Technological Innovation Ability Evaluation. The evaluation of scientific and technological innovation ability is to test whether it meets the standards and capabilities in the resource allocation, system implementation and innovation management work by examining the operation of the innovation system technology innovation of an object.

Mao Lianghu and Jiang Ying (2016) constructed the indicator system of regional science and technology innovation capability of the Yangtze River Economic Belt Province [5]. Y Zhou (2018) established a comprehensive index system for regional science and education innovation ability, and sought key factors for the innovation ability of science and education [6]. Li Caixia and Guan Hongbo (2018) used DEA to analyze the effective degree of technological innovation capability of 18 marine science and technology small and medium enterprises in Shanghai [7]. Yao Ping (2017) took the 2010-2015 China coal industry as a sample, using typical correlation analysis, entropy weight TOPSIS and linear regression analysis to empirically conclude that the investment in science and technology innovation has a positive effect on the economic competitiveness of the coal industry [8].

Through the above analysis, from the current research level, the evaluation of scientific and technological innovation ability is mainly focused on the evaluation of innovation ability at the regional, industry, and enterprise levels.

The connotation of the evaluation index of scientific and technological innovation ability.

Table 1 The evaluation index of scientific and technological innovation ability

Scholar	Year	Research content
Pattakos、Dunton	2000	Proposing innovative system architecture models that include shared innovation aspirations and strategies, innovative environmental support, and innovative environmental networks that continue to innovate in eight pillars [9].
V Yachmeneva、GVol'S'Ka	2014	The factors affecting the technological innovation capability of enterprises were divided into internal environment and external environment [10].。
Du Danli and Zeng Xiaochun	2017	They have established the evaluation index system of enterprise science and technology innovation ability from three dimensions [11].。
G Chi，Z Zhao	2018	From the four standards, the innovation environment, innovation investment, innovation output and the impact of innovation on the economy and society, the enterprise is proposed as the indicator system of the main body of technological innovation [12].。

Through the combing of the above documents, scholars have comprehensively analyzed the indicators of scientific and technological innovation ability evaluation from different angles. After in-depth analysis and summary, the indicators for evaluating technological innovation capabilities can be broadly divided into three categories: technological innovation environment, technological innovation investment, and technological innovation output.

Summary of the evaluation methods of scientific and technological innovation ability. Steele first evaluated technological innovations in the form of checklists in 1980.Most domestic scholars

have established an evaluation index system based on actual conditions, and then selected specific methods for research and analysis. Chai Wei (2015) used DEA data envelopment analysis to measure the input and output technical efficiency of resource-based enterprises' scientific and technological innovation ability [13]. In 2015, Shi Yinghui applied the factor analysis method to analyze the total amount of scientific and technological innovation input and output. [14]. L Peng (2017) uses the interval allocation method to evaluate the ability of scientific and technological innovation from two aspects: innovation input and output. [15].

It can be seen from the research of these scholars at home and abroad that the main methods for evaluating the ability of scientific and technological innovation include: DEA, factor analysis and so on. Foreign scholars tend to explore a unified and widely applicable evaluation method and measurement standard.

Characteristics of shipbuilding and marine engineering manufacturing. According to the statistics of the Ministry of Industry and Information Technology, there are many similarities between the shipbuilding industry and the marine engineering equipment manufacturing industry, and the key common technologies for ship and offshore engineering equipment are proposed [16]. Therefore, China's shipbuilding industry should rely on offshore engineering equipment to further consolidate the status of a shipbuilding power.

In summary, the offshore engineering equipment and shipbuilding industry is a modern comprehensive and strategic industry that provides technical equipment for water transportation, marine resource development and national defense construction. It is labor intensive, technology intensive, capital intensive, industrial chain long, and the regional economy has a large contribution.

Summary of research on scientific and technological innovation in shipbuilding and marine engineering manufacturing. Li Guoqiang (2006) analyzed the development status of China's shipbuilding science and technology independent innovation capability, and proposed that it is necessary to adhere to the combination of introducing innovation and independent innovation to improve the overall technological innovation capability [17]. Zhang Shengkun (2016) pointed out that the important reason for China's ship and ocean engineering is not strong, that is, China's scientific and technological level in related fields is not enough to support a ship-powered country [18]. Liu Hongchang (2018) pointed out that the cultivation of strategic marine emerging industries cannot be separated from the close integration of major marine technology breakthroughs and major development needs. Marine technology innovation and market demand are the two driving forces for promoting the development of strategic marine emerging industries [19].

From the above analysis, it can be seen that domestic scholars' research is mostly qualitative analysis. It only points out the necessity of scientific and technological innovation capability, the reason for the lack of scientific and technological innovation capability. And the method does not quantitatively study the overall technological creativity of China's shipbuilding and offshore engineering manufacturing industry.

Summary of Theoretical Research on Entropy Weight Method and TOPSIS Method. There are many methods of weighting, subjective empowerment, objective empowerment and subjective and objective combined empowerment. According to the characteristics of the listed companies in the manufacturing industry, this paper selects the entropy method combined with the TOPSIS method [20] to evaluate the listed companies in the shipbuilding and offshore engineering manufacturing industry, in order to conduct objective and effective evaluation research on the sample companies.

The basic principle of entropy weighting is to assign corresponding weights to each index according to the coefficient of variation of each index value. The entropy weight method is an objective weighting method. Its advantage is that it can avoid the subjectivity of weights.

The TOPSIS method is also called the sorting method that approximates the ideal solution. It is mainly used for comprehensive analysis and evaluation of objects with multiple indicators.

Research Review

The early research mainly analyzes the scientific and technological innovation ability of

shipbuilding and marine engineering manufacturing from qualitative aspects, and lacks systematic induction and theoretical refinement for the quantitative research on the scientific and technological creativity of China's shipbuilding and marine engineering manufacturing.

At present, there are many researches on the evaluation of scientific and technological innovation ability in various fields, but the evaluation index system for the specific scientific and technological innovation capability of shipbuilding and marine engineering manufacturing has not yet been formed.

Most of the selection of evaluation indicators for technological innovation capability of enterprises does not take into account the availability of the database, and it is difficult to guarantee the objectivity of the evaluation results. This paper intends to use the entropy weight method to calculate the weight of each index, which can avoid the error caused by human factors to some extent. At the same time, combined with the objective data of listed companies, the TOPSIS model is used to objectively and comprehensively evaluate the effect of indicators, which can better describe each indicator, and finally draw the conclusion of the study.

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