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IMPACT OF TRADITIONAL ENTERPRISE TECHNOLOGY INNOVATION ON ECONOMIES OF SCALE DRIVEN BY INTELLIGENT MANUFACTURING

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Abstract

As the pillar industry of China's national economy, the manufacturing industry has injected a steady stream of power into China's economic growth. Sustained growth of economy is based on the powerful manufacturing system, affected by the international financial crisis the subsequent continued, however, from all walks of life within the scope of the manufacturing of various countries are facing the production decline, shrinking market, user demand increasingly personalized, high resource utilization, such as challenges, these problems reversed transmission with various countries began to re-examine its own manufacturing industry development prospects. Firstly, this study defined the definition of intelligent manufacturing on the basis of literature review, and investigated the driving factors of intelligent manufacturing in manufacturing enterprises by means of questionnaire and in-depth interview. After collating and analyzing, two dimensions of driving factor variables of intelligent manufacturing in manufacturing enterprises are identified, namely, intelligent technology innovation and cost control. Finally, combined with the above research analysis, the main conclusions and innovative points of the research are summarized, the management implications of the research conclusions are given, and the shortcomings and future research directions are pointed out. Based on the current status of the development of intelligent manufacturing industry, the relevant national policies on the development of intelligent manufacturing, and the previous research results on intelligent manufacturing, this study studied the influencing factors of the intelligent transformation and upgrading of manufacturing industry, and studied the overall research purpose.

Key words: Traditional enterprises; Intelligent technology innovation; Cost control; Market competition intensity; Economies of scale

INTRODUCTION

Manufacturing industry is an important index to measure the development degree of a country. It refers to the industries in which manufacturing resources (materials, energy, equipment, tools and other production factors) are transformed into large-scale tools, industrial products and consumer products in the manufacturing process according to the market demand in the era of mechanical industry (Zhu Xinxu, Qiao Can, Zhang Manli, 2015; Dong Wei, Zhang Mei, Wang Shibin, Tao Jinhu, 2018; Zhu Duoxian, Zhao Min, 2018; Xiong Jun, 2018; Wang Jianmin, Liu Jianxun, 2018; Wang Feiyue, 2018; Liu Xipeng, Wang Guohui, He Chuan, 2018; Zhang Yingfeng, Guo Zhengang, Qian Cheng, Li Rui, 2018; Ren Shan, Zhang Yingfeng, Huang Binbin, 2018; Bo Hongguang, Li Huanzhi, Zhang Huilin, 2018; Li Xiaoxue, 2019). Manufacturing industry is an important factor to measure a country's productivity level and international competitiveness. It occupies an important share in the national economy of the developed countries and is also an important indicator to distinguish between developing countries and developed countries. Although China is a manufacturing powerhouse, its regional technological development is unbalanced, the level of information development is uneven, and the degree of standardization is low. China is in the coexistence stage of industry 2.0 (electrification) and 3.0 (digitalization), and manufacturing enterprises in most industries are in the stage of development from 2.0 to 3.0. At the same time, the shortage of key core technologies in the manufacturing industry has not been fundamentally changed, and there are still some problems such as weak innovation ability, weak capability of key basic materials, core basic components, advanced basic technology and other industrial base, which restrict the development of intelligent manufacturing (Li Yongfeng, 2018; Li Qiuming, Song Xin, Liu Zhigang, Zhao Qiang, Qian Xiaolong, 2018; Guo Lianjin, 2018; Wang Yibin, 2018; Li Zhouli, Han Luping, 2018; Wei Yunfei, 2018; Wang Feiyue, Chen Jin, Yin Ximing, Zhao Chuang, 2018; Gao Yanchen, Shang Xiuqin, Zhang Jun, 2018; Sun Yanguang, 2018; Lou Xuming, Xu Congcong, 2020; Wang Baoli, Yang Xin, 2020).

Economic globalization has promoted the flow of capital and goods on the industrial chain, and industrial developed countries have transferred low-value-added processing and manufacturing to the third world countries with low labor costs. And they take the core technology such as product research and development, sales channel, brand service with high added value as the strategic focus of national development. For more than 40 years since the reform and opening up, China's labor-intensive manufacturing industry has continued to grow and develop in the coastal economic circle. China has introduced many preferential policies to attract international companies to invest and operate. With their technological and managerial advantages, China has gradually established manufacturing enterprises with Chinese characteristics (Yang Yixin, Yuan Zhaocai, Pi Zhibo, Xia Wei, Jiang Chao, Guo Konghui, 2018; Wei Guowang, 2018; Qian Yu, Zhang Dapeng, Sun Xinbo, Zhang Mingchao, Dong Lingyun, 2018; Chen Wanming, Bao Shizan, 2018; Sun Fei,

2019). They have not only created huge value and rich profits for enterprises, but also made domestic Enterprises have learned advanced technology and accumulated rich management experience. With the advantages of low cost and good facilities, Chinese manufacturing companies have participated in global value chains and industrial division of labor, and have achieved world-renowned achievements and become a true "manufacturing country". At the same time, such labor-intensive enterprises have created a lot of employment opportunities, greatly improved the people's living standards, and improved the people's happiness index.

At present, the global manufacturing industry is undergoing a period of profound transformation and has become a breakthrough in the manifestation of new international competitive advantages. Both the industry 4.0 plan proposed by Germany, the industrial Internet alliance of the United States and China Manufacturing 2025 all take intelligent manufacturing as an important development goal. Intelligent manufacturing is the general name of advanced manufacturing process, system and mode which is based on the new generation of information technology, through the design, production, management, service and other manufacturing activities of each link, with self-sensing of information depth, self-decision making of intelligent optimization and self-execution of precise control and other functions. Intelligent manufacturing is marked by the intellectualization of the whole life cycle of products, production, management and service. It has the characteristics of taking intelligent factory as the carrier, network interconnection as the support, and manufacturing intelligence as the core. "The road of transformation and upgrading with intelligent manufacturing as the important development direction is not enough to completely change the current status of the manufacturing industry through the renewal of equipment and parts." Just like in the final stage of enterprise competition, what enterprises compete for is the level of research and development. And it is the talent that leads the technology research and development. In some sense, the comprehensive quality of industrial workers determines the success or failure of manufacturing industry (Zhang Zhen, 2018; Yang Ruofan, Liu Jun, Li Xiaojun, 2018; Liu Yang, Xie Shengli, Cai Shuting, Du Yuxiao, Wang Yonghua, 2018; Li Bohu, 2019).

Problem Statement

As the core of the three major industries, industry is the foundation of a country and the cornerstone of the development of the national economy. Manufacturing, as a type of industry, is the use of methods to produce products for sale (Duan Xinyan, 2017; Jiang Li, Ma Chaoqun, 2018; Fu Hua, 2018; Gong Junbo, Sun Jie, Wang Jingkang, 2018; Cao Jiqing, Shen Hanfei, 2018; Zhang Yingfeng, Guo Zhengang, Qian Cheng, Li Rui, 2018; Lai Chaoan, 2019; Chen Jin, Li Ruohui, 2019). Manufacturing can generally refer to different levels of human input, from handicrafts to high-tech, and

industrial production, that is, the mass production of raw materials into finished products. All powerful nations are manufacturing powers, and the most important role of manufacturing industry as the foundation of a country is to have strong advantages in defense, military, aviation, transportation, production and other aspects, and these advantages are manifested in strong military deterrence, efficient transportation, manufacturing capacity with high productivity and so on. Manufacturing enterprises play a vital role in the development of China's economy. Compared with the development level of manufacturing enterprises in the world's advanced countries, China's long-term development law and development trajectory make the development of Chinese manufacturing enterprises appear core problems such as lack of core competitiveness, low-end industry, hollowing out industry, lack of independent innovation ability, continuously rising production costs and so on (Ding Feng, 2018; Liu Yang, Xie Shengli, Cai Shuting, Du Yuxiao, Wang Yonghua, 2018; Li Qiuming, Song Xin, Liu Zhigang, Zhao Qiang, Qian Xiaolong, 2018; Liu Yahong, 2019; Wang Hui, 2020; Zhao Lianlian, 2020).

Research Questions

Based on industrial transformation and upgrading, intelligent manufacturing and other relevant theories, the research on the influencing factors of intelligent manufacturing upgrading of manufacturing enterprises not only broadens the theory of industrial transformation and upgrading, but also broadens the relevant theoretical research on intelligent manufacturing. Industrial transformation and upgrading has always been the focus of academic and business circles. The industrial upgrading based on intelligent manufacturing is beneficial to the theoretical research of industrial upgrading. The research of intelligent manufacturing theory mainly focuses on the field of technology and engineering realization. The study on the influencing factors of intelligent manufacturing upgrading in manufacturing enterprises not only expands the theory of intelligent manufacturing, but also broadens its application value in economic management and industrial policy. Problems to be solved in this study:

(1) How to promote the upgrading and development of Chinese manufacturing enterprises? The strong development of the manufacturing industry is a barometer of China's favorable economic situation. In recent years, China's manufacturing industry has been affected by the global economic downturn, resulting in a sharp drop in OEM orders. At home, with the disappearance of China's demographic dividend, the annual increase in labor costs increases the operating pressure of enterprises, and the profit margins of OEM enterprises at the lower end of the value chain are greatly compressed. A growing number of big international companies are shifting orders and processing centers to southeast Asia and Africa, where labor costs are lower, and many manufacturing firms along the southeast coast are at risk of losses and closure. The fatigue of Chinese manufacturing that is large but not strong and lacking

momentum is beginning to emerge. Made in China is at the crossroads of transformation, especially, the transformation and upgrading of OEM enterprises with high consumption and low energy will be the top priority in the upgrading of intelligent manufacturing industry.

(2) Why does intelligent manufacturing promote the upgrading and development of Chinese manufacturing enterprises? The rapid development of Internet technology and information technology has brought about a new round of industrial revolution. With the continuous integration of cloud computing, big data, artificial intelligence, the Internet of things and other new generation of intelligent manufacturing technology with the manufacturing industry, the whole industrial chain of intelligent manufacturing from the design, production, management, service and other links has presented the characteristics of networking, digital, intelligent.

Research Objectives

The theoretical purpose of this research is to study the economies of scale of intelligent manufacturing in Chinese manufacturing enterprises. 1. Intelligent manufacturing is a major trend in the development of manufacturing in the future. Both developed countries such as the United States, Japan, Germany, and developing countries such as South Korea and India have taken the development of intelligent manufacturing as an important means to enhance the competitiveness of their manufacturing industries. “China Manufacturing 2025” also takes intelligent manufacturing as the main direction of the development and upgrading of the manufacturing industry. Based on such a background, this paper makes a detailed study on intelligent technology innovation, cost control and mechanism of manufacturing enterprises by referring to extensive literature, theory and empirical data analysis.

2. The status and problems of the upgrading and development of Chinese manufacturing enterprises are studied. According to the main problems and causes faced, and the useful inspirations from the international community, it is concluded that the development level of intelligent manufacturing in China's manufacturing industry should be further promoted from four aspects: enhancing innovation capacity, vigorously developing intelligent manufacturing service industry, strengthening capital and talent guarantee, and improving the level of international development.

LITERATURE REVIEW

Dependent variable: economies of scale

The economies of scale refer to the situation that the added value of output is greater than the added value of input when the enterprise increases the production factors in the same proportion (Zhang Zhen, 2018). Only when the scale of operation is expanded and the proportion of its output increase is greater than that of the increase of all factor inputs, can such a scale of operation have economies of scale. In order to produce, any enterprise must gather the factors of production together and combine them into a certain volume production capacity. Because of the inseparability of factors of production, when the production scale of an enterprise increases, various expenses will be saved, production costs will be reduced, and economic benefits will be improved. The substantial reason for the economies of scale is that the production cost of unit product is reduced because of the expansion of production scale (Zhang Zhen, 2018; Xiong Jun, 2018; Wang Feiyue, 2018).

Previous Research

The Economies of Scale Theory was first proposed by Adam Smith. In his “The Wealth of Nations”, he gave a classical explanation of economies of scale, that is, the division of labor improves the technical proficiency of each worker and saves time and cost. It is conducive to the invention and use of machinery, thereby increasing the amount of labor produced, and mass production at a certain scale is the basis of labor division. However, the theory of economies of scale in the true sense is explained by Marshall's neoclassical economic theory. Marshall divided the economies of scale into internal economies of scale and external economies of scale according to the forming way, and pointed out that the benefits of large-scale production are especially obvious in industrial production. In addition, Marx's book “Das Kapital” also clearly pointed out that large-scale production and cooperation are the prerequisites for the development of social labor productivity. Mass production can not only improve labor productivity, realize the division of labor and the combination of labor, but also further bring benefits through large-scale gathering of production materials. Marx believed that the expansion of production scale is aimed at reducing production costs, realizing the combination of production, supply, and sales, and capital expansion. It can be thought that economies of scale mean that as the absolute output increases, its unit production cost gradually decreases. With the continuous expansion of the scale of operation, the marginal cost decreases and the output benefits increase.

The meaning of scale in economics refers to the production batch, that is, the production volume of a certain product obtained by a certain production device or enterprise within a certain production period (usually one year) under a given production technology (Wang Yibin, 2018; Li Zhouli, Han Luping, 2018). The meaning of benefit in economics refers to the social labor economy obtained through

the exchange of goods and labor. That is, with as little labor cost as possible to achieve as much business results, or with the same labor cost to achieve more business results. Benefit is the comparison between capital occupation, cost expenditure and useful production result. The so-called good economic benefits is less capital occupation, low cost and more useful results. Economies of scale refer to the best economic benefits produced by a modest scale. In microeconomics theory, it refers to the phenomenon of long-term average cost reduction due to the expansion of production scale. Generally speaking, due to the role of economies of scale, the management costs are inversely proportional to the size of the company. The economies of scale of an enterprise refers to the change of output caused by the change of various production factors in the same proportion within the enterprise under the condition that other conditions remain unchanged. The change in returns to scale of an enterprise can be divided into three cases: increasing returns to scale, constant returns to scale, and decreasing returns to scale.

The concept of innovation was first proposed by Schumpeter in “Theory of Economic Development”. He believed that technological innovation is the reconstruction of various production functions for production due to the emergence of new production factors and production conditions, and thus the emergence of a new product form or production mode. The concept of innovation proposed at that time was mainly based on the technology and organization of the subject of innovation. It can be seen that Schumpeter's concept of innovation includes two levels of meaning: technological innovation and organizational innovation. Under the market conditions at that time, people did not realize the market value that innovation brought to enterprises. Therefore, no clear definition was given to innovation in academic circles, and no special subject was established. But with the continuous development of productivity, people's understanding of the progress of science and technology is deepening. Innovation is also getting more and more attention from the business community and academic circles, and it has been defined gradually. Therefore, in this paper, the definition of “technological innovation” is defined as: the business activity process of continuously reshaping products or improving existing products in order to achieve a certain business development purpose, such as economic purpose, social purpose, etc (Duan Xinyan, 2017; Fu Hua, 2018).

METHODOLOGY

Research Design and Instrumentation

Technological innovation refers to the original innovation or technological transformation of related technologies based on intelligent manufacturing, which can form new smart products or new process activities through intelligent technological innovation. The essence of intelligent technological innovation is technological

innovation. Yang Huafeng (2007) pointed out that the R & D expenditure is a measure of technological innovation in the process of researching the original innovation capability of the equipment manufacturing industry. Therefore, this article uses the investment in intelligent technology as one of the measures of intelligent technology innovation. Sheng Weizhong (2015) pointed out that high innovation is related to people with high educational achievements when researching innovation input and innovation effect. The quality and quantity of R & D personnel are the key factors that affect the effect of innovation. Higher level R & D personnel can improve innovation Efficiency and result, the proportion of senior R & D personnel and senior manufacturing personnel can reflect the quality of personnel in the R & D team. Intelligent technological innovation refers to the original innovation or technological transformation of related technologies based on intelligent manufacturing, which can form new intelligent products or new technological activities through intelligent technological innovation. The essence of intelligent technological innovation is technological innovation. This study believes that intelligent technology innovation of manufacturing enterprises can be measured from three dimensions: the proportion of investment in intelligent technology, the proportion of senior R & D personnel, and the proportion of senior manufacturing personnel.

Data Analysis Methods

First, based on a review of the literature, this study defines the definition of intelligent manufacturing and uses questionnaires and in-depth interviews to investigate the driving factors of economies of scale for traditional enterprises. After collating and analyzing, the paper identifies two dimensions of the driving factors of economies of scale of traditional enterprises, namely, intelligent technology innovation and cost control.

Analysis

Research Objective 1: Impact of technological innovation on economies of scale

From the perspective of the development of China's manufacturing industry, the extensive development mode of traditional small and medium-sized manufacturing enterprises has been unable to adapt to the current economic, social and environmental development as well as the growing market demand for quality, so it must be upgraded. From the original pursuit of quantity, to a more qualitative pursuit of quantity. It must be recognized that traditional manufacturing industry is not necessarily a sunset industry, and only by scientific upgrading and transformation can it regain its vigor and vitality. Based on the overall development trend of “ Made in China” and the actual market demand, we should strengthen scientific and

technological innovation and promote the transformation of old production capacity with new ones of small and medium-sized manufacturing enterprises. Let traditional manufacturing industries regain their vitality, release new vitality, let “quality and intelligent manufacturing” gradually become a reality, and consolidate the foundation for its sustainable and healthy development.

As the measurement models of other variables in the model have been tested previously, the descriptive statistical analysis of the survey items of market competition intensity is shown in Table 4-3. The statistical average of each item in the scale is between 3.13 and 4.03. The standard deviation ranges from 0.805 to 0.957. The absolute value of the skewness of the statistical values of each item is less than 3, and the absolute value of the kurtosis is less than 10, which indicates that the statistical values of the dynamic capability measurement items follow a normal distribution.

	N statistics	Minimum value	Maximum value	Mean	Standard deviation
QY1	360	1	5	3.52	1.203
QY 2	360	1	5	3.46	1.295
QY 3	360	1	5	3.04	1.138
QY 4	360	1	5	2.86	1.394

Table 0-5 Descriptive statistical analysis of market competition intensity items

Research Objective 2: Impact of cost control on economies of scale

Manufacturing enterprises are a type of enterprises engaged in industrial production and operation activities. With the continuous expansion of business scope, manufacturing enterprises gradually present an integrated development model, which integrates research and development, production, sales, and service. The main operating items of the enterprises described in this article are manufacture of glue dispensing robot. In the process of enterprise operation, it is found that the cost and expense account for a high proportion of the total revenue. On the one hand, enterprises should pay attention to research and development technology innovation, improve the level of robot manufacturing, on the other hand, they should pay attention to strengthen the internal cost control, thereby achieving the coordination and unification of benefits and costs of manufacturing enterprises. When it comes to cost control, people are always limited to control the costs related to production and ignore the cost control outside the production link. The front end of the production link

involves product design and development, material planning and procurement, storage and logistics costs, and the back end of the production link involves costs such as after-sales service and complaints. First of all, product development cannot be separated from a large amount of cost investment. One is to develop new products and the other is to expand new markets. All these require correct judgment and control of R & D direction and market demand. If the incomplete information leads to the wrong decision, the research and development costs will be wasted. Secondly, if the designer only considers the design when designing the product, and does not consider the cost and market competitiveness of the product, the product will not win the competition, resulting in a huge cost loss. If an enterprise does not have order, all is empty talk. Finally, the cost of material planning, procurement, warehousing and logistics is also very important. If the plan is not reasonable, there is no way to conduct competitive negotiations and warehousing and logistics arrangements, resulting in waste of costs. In a word, research and analysis and control should be carried out before cost solidification, and must not be limited to a certain link.

The important factors that determine the economic benefit of an enterprise are to increase revenue and reduce costs. With the increasingly fierce market competition, if an enterprise wants to increase market share and increase business income, it cannot do without competitive sales pricing, which is based on cost data. So the cost must be reasonable and accurate, and must also have an advantage over the competitors. Therefore, enterprises must strengthen the cost control and management of each link, and achieve effective cost control before, during and after the event, thus improving the competitiveness and economic benefits of enterprises.

The scope and objectives of manufacturing enterprise cost management should be expanded to the operation and management costs and refined to each link. At the same time, it is necessary to budget and control the costs in each stage: adopt various cost analysis methods to analyze the variable cost and fixed cost of the product, compare the cost and market competitiveness of competitors, analyze the contribution trade and gross profit of products, and adopt the corresponding cost control methods and measures through the cost control analysis, to achieve the target cost and profit margin of enterprises, thus contributing to the benign development of enterprises.

Cost control of manufacturing enterprise is an intricate and systematic project, which requires continuous improvement. Cost control in manufacturing has a long way to go. Under the environment with market information transparency, what enterprises compete is the management cost. If an enterprise does not make progress, it will fall back or even disappear in the market. The cost control of manufacturing enterprises is also the general trend of market reaction. Effectively using a variety of cost control methods and tools and striving forward on the road full of thorns, is the right way and a long-term strategy of the enterprises.

Conclusion

Intelligent manufacturing technology is essentially a deep integration of manufacturing technology with new technologies such as artificial intelligence and new sensor technology, which can realize self-analysis, self-organization, and self-processing in the whole process of business activities (Zhu Xinxu, Qiao Can, Zhang Manli, 2015; Li Xiaoxue, 2019; Lai Chaoan, 2019). Intelligent technology innovation refers to various technological innovation activities based on intelligent manufacturing, including the development of intelligent manufacturing technology and the application of intelligent manufacturing technology. The implementation of intelligent transformation by enterprises is inseparable from the driving role of intelligent manufacturing technology. New intelligent products or intelligent production activities are generated through intelligent technological innovation (Tao Fei, Qi Qinglin, 2018; Chen Jin, Li Ruohui, 2019; Zhang Jing, 2019; Lou Xuming, Xu Congcong, 2020).

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