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Industrial Engineering and Lean Management for Intelligent Manufacturing

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Abstract

The era of industry 4.0 is coming to us slowly, intelligent manufacturing mode has been the general trend. The birth of industrial engineering has been more than 100 years of history, during the hundred years of development, industrial engineering has experienced several transformation and upgrading. The innovation and development of intelligent manufacturing cannot be separated from the development of industrial engineering and the improvement of lean management. Industrial engineering is the material basis of intelligent manufacturing era. Industrial engineering is to improve and optimize the integrated system composed of human, logistics and information elements. The development of intelligent manufacturing era must rely on highly integrated logistics information system, the development of industrial engineering for the advent of intelligent manufacturing era. Lean management is the guarantee of intelligent manufacturing. Lean management, also known as good management, aims to reduce consumables, continuously improve production efficiency and improve product quality. In the era of intelligent manufacturing, although the degree of automation is high, if the employees are not lean management, the development process of intelligent manufacturing will be slow. It can be seen that the development of industry 4.0 era needs to be based on intelligent industrial engineering and lean management. At present, there are still many problems in intelligent manufacturing transformation and lean management in domestic enterprises, and researchers in related fields are focusing on solving these problems. Based on the study of the development line of developed countries, this paper defines the problems in the process of transformation and development, explores the management technology and mode of transformation and upgrading.

Keywords

Intelligent manufacturing, Industrial engineering, Lean Management

1. Introduction

Facing the great changes unseen in a century, the Industry 4.0 era of intelligent manufacturing is beckoning to us. In our country, intelligent manufacturing has been regarded as the mainstream direction of the future development of the real manufacturing industry. Under the guidance of national policy, many domestic enterprises have used digital technology to try enterprise transformation. However, the actual effect has not reached the expected goal. Although the concept of lean management appears in the management work of many enterprises, the management personnel do not understand the connotation of lean management, so the management quality is not high [1].

The powerful resource utilization and integration ability of industrial engineering make intelligent manufacturing no longer a dream. The intelligent wave is rolling in, and industrial engineering is of great significance to the development of intelligent manufacturing. From the perspective of the long-term development of manufacturing industry, industrial engineering and lean management are the keys to the transformation of manufacturing industry.

2. The development path of developed countries

Take Britain, the birthplace of the first Industrial Revolution, for example, steam engine completely changed people's way of production and life and provided technical support for the development of manufacturing industry. Subsequently, Western countries started the industrial revolution with Britain as the center, changed the manufacturing production mode, and established Europe's dominant position in manufacturing.

As a country with a large number of immigrants, the United States has fully inherited a variety of advanced technologies and achieved rapid development of manufacturing industry through improvements in quality, cost and technology, surpassing the status of Europe in one move. Take automobile production as an example. Although it was born in Germany, the workshop production mode makes the production efficiency low and the development is severely restricted. By means of resource integration, the United States has realized assembly line production of automobiles, greatly improving the production efficiency of automobiles, and enabling the automobile manufacturing industry to withstand strong market competition [2].

Japan's manufacturing revitalization is mainly achieved through the mode of "technology innovation + management innovation". During World War II, the development of manufacturing industry in Japan as a defeated country suffered a serious blow. After Japan's defeat in the war, it became clear that the development of manufacturing industry was of vital importance to its military security. Therefore, after the war, Japan analyzed the reasons for the limited development of manufacturing industry, and brought the development of manufacturing industry into the right track by means of research and development technology and innovative management mode.

3. Difficulties in intelligent manufacturing transformation and lean management of Chinese enterprises

3.1 Unconsciousness at the top

In recent years, the Internet has dominated the market, and many small manufacturing industries have closed down due to the pressure of market competition. Many manufacturing executives do not see the future of the real economy, so they do not put much thought into industrial transformation. The decision of the top level of the enterprise directly affects the development direction of the enterprise, so there are many problems in the intelligent transformation road of most domestic enterprises. In addition, the top management of the enterprise does not reflect on the management, which leads to the technological innovation cannot reach the expected goals of the enterprise development. The development and progress of enterprises cannot be separated from lean management. Lean management can deeply stimulate the vitality of enterprises, so that enterprises have greater competitiveness among peers [3].

3.2 Enterprise information system is not perfect

The intelligent manufacturing transformation of enterprises needs to rely on the perfect information system. Intelligent manufacturing needs to combine all the information systems involved in the work into a collation, speed up production efficiency, reduce production consumables. However, although many enterprises have applied many systems to improve work efficiency at present, there is no connection between different systems like islands. In addition, enterprises cannot guarantee the accuracy of basic information data, so it is difficult to promote intelligent manufacturing.

3.3 Heavy automation, light intelligence

With the continuous updating of machinery and equipment, the manufacturing industry gradually develops towards the direction of automation. Enterprise managers choose to introduce a large number of automation equipment in order to improve operating profits and production efficiency. Nowadays, domestic manufacturing automation has been popularized, but intelligent production has not been implemented. The intelligent transformation of enterprises needs to invest a certain amount of capital, and at the same time, there is no complete experience for reference, so most domestic enterprises choose the development direction of "emphasizing automation, light intelligence", focusing on the liberation of labor [4].

3.4 Digital transformation is not effective

As the digital transformation technology is not perfect enough, some enterprises have no significant effect after investing in the digital transformation, which leads to the obstacles in the promotion of enterprise intelligence. Digital transformation is limited by capital, equipment, technology and other factors, many enterprises do not have the basic requirements for digital transformation, so the intelligent transformation of enterprises is out of the question. In addition, there are great uncertainties in digital transformation, so enterprises will not rush into digital transformation without adequate preparation.

3.5 Not enough money

There are great differences in each subsector of manufacturing industry, and enterprises in different industrial chains have strong personalization, so the intelligent breakthrough is also different, and enterprises cannot learn from each other. Since the operating profit of the manufacturing industry is not high, many enterprises will face the problem of insufficient funds in the process of intelligent transformation. Senior leaders will not take risks to force through smart transformation.

3.6 Introduce theory but not management

The phased achievements of industrial transformation and upgrading in developed countries have brought a lot of enlightenment to the development of domestic enterprises. In order to improve the market competitiveness, domestic enterprises have introduced the theory of lean production management in order to achieve industrial transformation by changing the existing internal management mode of enterprises. However, the introduction of the theory has not brought significant changes to the enterprise, so there is a serious lack of motivation in the late stage of transformation. The reason why the introduction of lean management model did not promote the industrial transformation is that the enterprise did not implement the relevant regulations of the management model, but only introduced the theory into the enterprise [5].

3.7 Lack of basic management

Basic management is the prerequisite of lean management. At present, the internal management of some domestic manufacturing industries is relatively chaotic and they do not have the basic conditions for lean management, so they cannot introduce lean management mode. The lack of basic management is mainly reflected in the imperfect management system and the low level of management implementation.

3.8 Staff quality mismatch

Although most domestic manufacturing industries have basically realized automation and the number of workshop employees has been greatly reduced, employees are still the key to the operation of enterprises. The workshop has a high degree of automation, so the enterprise does not have high requirements for employees' personal literacy, which leads to some personnel's personal literacy and enterprise development vision conflict, employees do not have a strong sense of belonging. Lean management does not work in this context.

3.9 There is no standardized management system

Standardized management is the institutional basis of enterprise transformation. The standardized management system reflects the degree of an enterprise. At present, many domestic enterprises lack standardized operating conditions. Some enterprises with standardized management system are not strictly implemented in accordance with the management system, so it is difficult for domestic enterprises to achieve rapid transformation.

4. Key technologies of intelligent manufacturing management for the transformation and upgrading of Chinese enterprises

4.1 Lean field management and process optimization

Intelligent manufacturing is based on the establishment of a standardized and lean management system, through the optimization of the production process to achieve significant improvement in the production efficiency of enterprises, promote the transformation and upgrading of enterprises. Lean field management and process optimization can be based on digitalization, using new technology and new system to effectively promote the transformation and development of enterprises.

4.2 Lean logistics management under the multi-variety and small-batch production mode

With the development of new information technology, logistics and supply chain industry is also quietly changing. Under the condition of highly centralized information, the whole industrial chain can be interconnected, and the manufacturing can be sensed, visible and controllable. Intelligent logistics is the externalization of lean management. It helps enterprises to purchase materials in all aspects, improve production efficiency and improve industrial chain. Lean logistics management under the multi-variety and small-batch production mode will be one of the main trends in the future development.

4.3 Lean intelligent manufacturing production organization, planning, scheduling management and process innovation

Under the background of intelligent manufacturing, enterprises need to innovate production process, update scheduling management and change production plan according to their own conditions in the face of customers' personalized needs. With the combination of big data, artificial intelligence and manufacturing production, intelligent manufacturing will no longer be far away. In order to accurately predict customer demand, manufacturing industry needs to use information technology to understand customer preferences and capture the hearts of customers.

4.4 Human-machine collaboration and human factor engineering for intelligent manufacturing

Man-machine collaboration is one of the important measures to improve production efficiency, and human factor engineering is the only supporting technology for the high-quality development of enterprises. Human factor engineering is the deep combination of informatization and industrialization, and is also an important design methodology. The operation of intelligent manufacturing equipment requires man-machine coordination between employees and machinery. The development of human-machine collaboration and human factor engineering is very important for the improvement of core competitiveness of domestic manufacturing enterprises.

4.5 Innovative technologies, methods and applications of industrial engineering in manufacturing services

Massive data and ubiquitous network provide the material foundation for the innovation of management mode. The field is one of the key links that domestic enterprises need to improve most. Supply chain competition between enterprises will be transformed into ecological competition. In the field of manufacturing services, industrial engineering forms a knowledge-driven model based on the whole life cycle of products, relying on the Internet, big data, Internet of Things and artificial intelligence.

5. IE/LM management mode triggered by the "chariot and horse model"

5.1 Carriage and horse model

The two wheels in the horse and cart model represent technological innovation and management innovation. The failure of technological innovation to keep up with management innovation will lead to the serious lack of power for enterprise production, and the failure of management innovation to keep up with technological innovation will lead to the waste of technical resources. Both technology and management are important links in the process of enterprise transformation and upgrading.

5.2 Basic characteristics of IE/LM

Technological innovation and management mode are innovative. Although technology openness is advocated to promote development, there are still technical barriers between different enterprises. Due to the great differences between enterprises in culture, staff quality and other aspects, so the management model does not have the replication type. Each enterprise must explore the management mode suitable for its own development according to its own needs.

Technological innovation and management mode are cumulative. Technological innovation does not happen overnight and requires a long period of accumulation to make a qualitative leap. The update of management mode also requires enterprises to adjust in the process of continuous development. It can be seen that the technology and management needed for enterprise transformation need to be accumulated for a long time.

5.3 IE/LM first builds the foundation of intelligent manufacturing

Intelligent manufacturing is a manufacturing mode facing the whole life cycle of products, which needs to be established on the basis of efficient production mode. IE/LM is the foundation of constructing digital and standardized management mode. The production mode constructed by IE/LM provides the material basis for intelligent manufacturing.

5.4 IE/LM accompanied support intelligent manufacturing implementation

The mode of combining technology and management can make the production work of enterprises in a standardized system, and the pressure of intelligent manufacturing implementation will be greatly reduced. The advanced management mode avoids many problems in the manufacturing process and promotes the standardization of intelligent manufacturing.

5.5 IE/LM integration enables intelligent manufacturing transformation

Technology is the key driving force to promote the transformation, and management is the indispensable key to assist technology to achieve industrial transformation. The integration of the two approaches solves the technical problems encountered in the enterprise transformation and improves the loopholes in the management system of the enterprise. Therefore, IE/LM integration can enable the transformation and upgrading of intelligent manufacturing.

6. Summary

The requirements of industrial engineering and lean management for intelligent manufacturing are more stringent. Enterprises need to measure whether they have the necessary conditions for transformation according to the standards before the transformation. With the continuous innovation of technology and management mode, more and more domestic enterprises are actively promoting the transformation work. Intelligent manufacturing is the inevitable trend of the development of The Times, and the positive transformation of enterprises is an important force to promote the advent of intelligent manufacturing era.

References

[1] PANG Xiaobing, WANG Yaquan, ZHANG Yuwen. Experience and Lessons from the "Production Hell" of Tesla Model 3 [J]. Equipment Management and Maintenance. 2021(22).

[2] Cong Dong, Zhong Mingli et al. Research on China's Industrial Engineering Innovation in the New Development Stage [J]. Mechanical and Electrical Engineering Technology. 2021(03).

[3] Huo Yanfang, Wang Han, Qi Ershi. Building Smart Logistics and Supply Chain, Helping Smart Manufacturing -- Introduction to Smart Logistics and Smart Supply Chain [J]. China Mechanical Engineering. 2020(23).

[4] Qi Ershi, Lin Yu, Li Jianguo, et al. Analysis on Lean Management Strategy of Chinese Manufacturing Industry and Thinking on Construction of Guangdong-Hong Kong-Macao Greater Bay Area [J]. Mechanical and Electrical Engineering Technology. 2020(02).

[5] Ouyang Sheng, Kong Deyang. New Outlet of Chinese Manufacturing Industry in the Era of Industry 4.0 -- Lean Intelligent Manufacturing Recommended Reading [J]. China Mechanical Engineering. 2018(16).