Domestic and Foreign Smart Factory Development Status and Trend Analysis

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Abstract: As an important development direction of modern industry and manufacturing, smart factories realize the automation, digitization and intelligence of production processes through the integration of advanced technologies such as the Internet of Things, big data and artificial intelligence. The construction of smart factories not only helps to improve production efficiency and quality, but also can meet the increasingly diversified and personalized needs of consumers, and promote the development of manufacturing in a more efficient, smarter and greener direction. This paper will analyze the development status and trend of smart factories at home and abroad in detail, in order to provide reference for relevant enterprises and policy makers.

Keywords: Intelligence; Algorithm; Estate.

1.Introduction

In recent years, the scale of China's smart factory market has continued to expand. According to the "2024-2029 Global and China's smart factory and manufacturing industry development status research and investment prospects Analysis Report" released by the China Business Industry Research Institute, the size of China's smart factory market will be 856 billion yuan in 2020, and will grow to 1.2 trillion yuan in 2023. China's smart factory market is expected to reach 1.3 trillion yuan in 2024, with an average annual growth rate of more than 10% [1]. In addition, the data of Puhua Industrial Research Institute also shows that the size of China's smart factory market has reached 1,056.6 billion yuan in 2022, and increased to 1,168.6 billion yuan in 2023, and it is expected that the market size will further grow to 1,285.4 billion yuan to 1,600 billion yuan in 2024.

The Chinese government attaches great importance to the development of smart manufacturing, and the Ministry of Industry and Information Technology, the National Development and Reform Commission, the Ministry of Finance and other departments have jointly issued a number of policy documents to promote the gradient cultivation and construction of smart factories. For example, the introduction of policies such as "Made in China 2025", "National Intelligent Manufacturing Standard System Construction Guide" and "14th Five-Year Plan" intelligent Manufacturing Development Plan "has provided strong support for the development of smart factories; The continuous maturity and application of new generation information technologies such as the Internet of Things, big data and artificial intelligence have provided strong technical support for the development of smart factories. These technologies enable smart factories to achieve equipment interconnection, data interoperability, intelligent decision-making and other functions to improve production efficiency and quality. The continuous

development of automated production lines and robot technology has further enhanced the automation and intelligence level of smart factories.

The diversification and personalization of consumer needs has driven the development of smart factories. The traditional mass production model has been unable to meet the market demand, smart factory through digital and intelligent means, can achieve rapid response to market demand, provide customized and personalized products and services. At the same time, the demand for green development has also become an important factor in promoting the development of smart factories. In the context of increasing global environmental awareness, the manufacturing industry needs to pay more attention to green and sustainable development. Smart factories achieve green production by optimizing production processes, improving equipment energy efficiency, reducing energy consumption and material waste and other measures, which is in line with the development trend of the future manufacturing industry.

2.The Development Trend of Smart Factories at Home and Abroad

The application fields of foreign smart factories are also broad, covering many industries such as automobile manufacturing, electronic equipment manufacturing, and pharmaceutical manufacturing. For example, Ximenzi Amberg Electronics Factory has realized the mixed-line production of multi-variety industrial computer; FANUC has achieved a high degree of automation and intelligence in the production process of robots and servo motors, and has used automated three-dimensional warehouses to transfer materials between intelligent manufacturing units in the workshop, achieving up to 720 hours of unattended; Schneider Electric fully automates the manufacturing and packaging of electrical switches; Mitsubishi Electric Nagoya Manufacturing Plant adopts a new robot assembly line that combines human and machine to realize the transformation from automation to intelligence, significantly increasing the output per unit of production area; Market players in the smart factory construction industry include international giants, leading domestic enterprises, and numerous small and medium-sized enterprises. These companies occupy different positions in the industry with their respective technological strength, market share and brand influence. For example, international giants such as Siemens and ABB have advanced technology and rich experience and occupy a leading position; On the other hand, domestic enterprises such as Haier and Midea gradually rise through technological innovation and differentiated competitive strategies [2].

2.1 Digital and Intelligent Application

Nearly 10,000 digital workshops and smart factories have been built across the country, and artificial intelligence is deeply integrated with manufacturing. These digital workshops and smart factories automate, digitize and intelligentize production processes by integrating advanced technologies such as the Internet of Things, big data and artificial intelligence. For example, Haier Foshan drum washing machine factory can realize the order configuration, production and assembly, the use of highly flexible automatic unmanned production lines, the wide application of precision assembly robots, and through the MES system full order execution management system, to achieve machine-machine interconnection, machine-thing interconnection and man-machine interconnection.

With the continuous integration and application of new generation information technologies such as the Internet of Things, big data and artificial intelligence, smart factories will achieve a higher level of automation, digitalization and intelligence. The integration of these technologies will further enhance the production efficiency and intelligence level of smart factories, and promote the comprehensive optimization and upgrading of the production process. For example, cloud computing technology provides powerful data storage and computing power for smart factories, while digital twin technology simulates and optimizes production processes by building virtual factory models. The combination of the two will further improve the decision-making efficiency and accuracy of smart factories [3].

Through algorithms such as machine learning and deep learning, artificial intelligence realizes self-adaptation and self-optimization of equipment to improve production efficiency and product quality. With the continuous progress of AI technology, its application in smart factories will be more extensive and in-depth; Big data technology helps enterprises extract valuable information from massive data to optimize production processes and decisions. The combination of big data analytics and smart factories will further improve production efficiency and product quality; Iot technology closely connects devices, systems and people together to achieve real-time data collection and analysis. The application of Internet

of Things technology in smart factories will further enhance the automation and intelligent water of production processes; The introduction of 5G communication technology will further improve the communication speed and reliability of smart factories, providing strong support for real-time data acquisition and remote monitoring.

2.2 Coordinated Development of Industrial Chains

The construction of smart factories involves close cooperation between enterprises and institutions in multiple fields. In the future, the cooperation between upstream and downstream enterprises in the industrial chain will be closer, forming a good trend of coordinated development, and promoting technological innovation and industrial upgrading.

Upstream companies focus on the manufacturing of smart hardware and sensors, providing key equipment and technical support for smart factories. With the continuous progress of technology, the performance and functions of smart devices are also constantly improving, providing strong support for the construction of smart factories; Midstream companies focus on system integration and software development to provide customized intelligent solutions for factories. System integration is the integration of various smart devices, systems and software to form a complete smart factory solution. System integrators need to have deep technical strength and rich project experience to ensure the stability and reliability of the system; Downstream enterprises are involved in the operation, maintenance and optimization services of smart factories. The quality of operation and maintenance services directly affects the stability and operation efficiency of smart factories. Therefore, operation and maintenance service providers need to have professional technical teams and rich operation and maintenance experience [4].

2.3 Diversification and Individuation of Market Demand

With the increasingly diversified and personalized needs of consumers, smart factories will face more diversified market demands. Enterprises need to provide customized smart factory solutions according to the needs of different industries and different customers. This will help enterprises to expand market space and increase market share.

For example, in the automobile manufacturing industry, consumers' demands for the performance, configuration, appearance and other aspects of vehicles are increasingly diversified, and smart factories can realize more flexible production modes by introducing advanced production lines and manufacturing technologies to meet the individual needs of customers. In the electronic equipment manufacturing industry, with the acceleration of the replacement of electronic products, consumers have increasingly higher requirements for the function, appearance, quality and other aspects of electronic products. Through digital and intelligent means, smart factories can quickly respond to market demands and provide customized and personalized products and services [5].

2.4 Greening and Sustainable Development

In the context of increasing global environmental awareness, green development has become an important trend in manufacturing. Smart factories achieve green production by optimizing production processes, improving equipment energy efficiency, reducing energy consumption and material waste and other measures, which is in line with the development trend of the future manufacturing industry.

By introducing advanced environmental protection technologies and equipment, smart factories reduce energy consumption and emissions in the production process and improve resource utilization. At the same time, smart factories also achieve green production by optimizing the production process and reducing waste and pollution in the production process. This will help enhance the company's environmental image and social responsibility, and enhance market competitiveness.

2.5 Supply Chain Collaboration and Networking

The construction of smart factory will promote the development of supply chain collaboration and network. Through the construction of a digital and networked supply chain system, the close connection and efficient collaboration of all links of the supply chain are realized. This will help improve the transparency and responsiveness of the supply chain, reduce inventory costs and operating costs, and improve the competitiveness of the overall supply chain.

For example, through the introduction of Internet of Things technology and big data analysis technology, smart factories can monitor all aspects of the supply chain in real time, achieving transparency and visualization of the supply chain. At the same time, smart factories can also achieve collaborative optimization and dynamic adjustment of the supply chain through

predictive analysis and optimization algorithms, and improve the response speed and flexibility of the supply chain.

2.6 International Cooperation and Competition

With the continuous development of the global economy and the increasingly fierce global competition, the international cooperation and competition of the smart factory industry has become an important trend. Domestic enterprises will actively expand the international market and improve their competitiveness in the global market. At the same time, international enterprises will also increase their investment and layout in the Chinese market.

International cooperation and competition will promote technological innovation and industrial upgrading in the smart factory industry. Through the introduction of international advanced technology and management experience, domestic enterprises can improve their technical level and international competitiveness. At the same time, domestic enterprises can expand international market share and brand influence through cooperation and exchanges with international enterprises [6].

3.Challenges Facing Domestic Smart Factories

3.1 Lack of Strategic Planning and Thought Leadership

Many manufacturing companies have not yet mapped out the blueprint for smart manufacturing development from a strategic level, resulting in a lack of thought leadership and strategic planning for digital transformation. Lack of overall business value goal planning and status assessment analysis, it is difficult to deeply integrate new technologies with intelligent manufacturing application scenarios. At the same time, intelligent manufacturing requires high-quality technical and skilled personnel, and domestic and foreign manufacturing enterprises may face the problem of talent shortage, so they need to invest resources in training and recruitment [7].

3.2 Misunderstanding of Technology and Hardware Investment

Some companies equate smart manufacturing construction with technology and hardware investments, such as deploying automated production lines to connect separate processes together or replacing labor with automated equipment. This practice may result in a lack of flexibility in the production line, which can only accommodate the production of a single variety, or the equipment management system does not follow up, resulting in frequent equipment failures.

Foreign manufacturing enterprises are also facing problems such as rising labor costs and overcapacity, and need to invest a lot of money in the construction of smart factories. This is particularly difficult for small and medium-sized enterprises (smes), which may find it difficult to advance the transformation due to insufficient funding.

3.3 Data Management and Integration Issues

Data is the cornerstone of smart manufacturing, but industrial data silos are ubiquitous. The larger the enterprise, the more processes, and the more complex the legacy system, it is very difficult to break the data silos and realize the data connectivity between information technology and operation technology. As more and more devices in smart factories are connected to the Internet, cybersecurity and privacy protection become important issues. Manufacturing companies need to have effective security measures in place to protect devices and data from hackers and malware. Policies and regulations in different countries and regions may have different impacts on the construction and operation of smart factories. Manufacturing companies need to understand and adapt to relevant policies and regulations to ensure compliant operations [8].

3.4 Insufficient Performance of Information Systems and Equipment

The factory operation layer lacks the support of information system, the workshop is still a black box, and the production process is difficult to achieve full traceability. Production equipment is not fully utilized, equipment health status is not effectively managed, and unplanned downtime is often caused by equipment failure.

With the rapid development of intelligent manufacturing technology, small and medium-sized enterprises may face the problem of inadequate technical mastery. This may cause enterprises to encounter technical bottlenecks in the process of transformation, and it is difficult to achieve the expected results. Smart factory construction involves suppliers in multiple fields, and integration is difficult. There are not only information islands, but also automation islands in enterprises, and the automated production line is not uniformly planned [9].

4.Conclusion

The development of smart factories at home and abroad is in a stage of rapid advancement, and through the integration of advanced technologies such as the Internet of Things, big data and artificial intelligence, the automation, digitalization and intelligent upgrading of production processes are constantly promoted. However, in the process of development, smart factories at home and abroad are facing many challenges. On the one hand, the lack of strategic planning, the misunderstanding of technology and hardware investment, the problems of data management and integration, and the insufficient performance of information systems and equipment restrict the further development of smart factories. On the other hand, high transformation costs, inadequate technical mastery, talent shortage and training needs, security and privacy issues, and the adaptability of policies and regulations are also challenges that cannot be ignored.

In order to overcome these challenges, manufacturing enterprises need to strengthen strategic planning, optimize technology and hardware investment, improve data management and integration capabilities, improve information system and equipment performance management, strengthen informatization and automation integration, reduce transformation costs, improve technology mastery, strengthen personnel training and training, strengthen network security and privacy protection, and adapt to relevant policies and regulations. Therefore, in order to promote the healthy development of smart factories, relevant enterprises and policy makers need to pay close attention to these challenges and take effective measures to deal with them, so as to achieve the efficient, intelligent and green development of manufacturing.

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