Research on the application of artificial intelligence technology to promote the high-quality development path of manufacturing industry

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Abstract. At present, in the new round of scientific and technological development, artificial intelligence brings development opportunities for the upgrading of traditional industries and the cultivation of emerging industries, which is conducive to the upgrading of economic structure to achieve high-quality development. How to promote the application of AI technology in the manufacturing scene of manufacturing enterprises to promote the improvement of product quality of manufacturing enterprises? This paper analyzes the present situation of artificial intelligence application and put forward six major scenarios of the artificial intelligence in manufacturing industry, promote the digital transformation of manufacturing enterprises from sales C2S level to deepen the manufacturing C2M level, through artificial intelligence to promote the manufacturing industry chain upgrade, improve the quality of export products, improve the export competitiveness of China's manufacturing industry. By analyzing the problems existing in the application of artificial intelligence in China, targeted suggestions and countermeasures are put forward.

1 INTRODUCTION

Artificial intelligence (Artificial Intelligence), abbreviated as AI. It is a new technical science to research and develop the theories, methods, technologies and application systems for the simulation, extension and expansion of human intelligence. Nearly 30 years of artificial intelligence (AI) achieved rapid development, has been widely used in many fields, and has achieved fruitful results, with technology, industry, policy and other aspects of mature environment, Artificial intelligence began to truly empower the manufacturing industry to realize the implementation of AI and promote the development of digital industrialization and industrial digitalization.

At present, China's emerging technologies, such as artificial intelligence, industrial Internet and industrial robots, are developing rapidly, and constantly strengthen the penetration and integration with the manufacturing industry, which has brought opportunities to improve the development of China's manufacturing technology and export product quality, and promote the high-quality development of China's foreign trade. With AI technology playing an important role in manufacturing R&D innovation, production and manufacturing, quality control, supply management, after-sales service and other links, the application of industrial robots has greatly improved the productivity of enterprises, providing new possibilities for improving the quality of export products. According to statistics, at the present stage, more than 60% of manufacturing companies have adopted AI technology to improve operational efficiency, reduce downtime, and provide high-quality products that meet unique consumer needs. Taking the industrial robot, the representative of AI cutting-edge technology, as an example, according to the statistics of the International Federation of Robotics (hereinafter referred to as IFR), China's industrial robot installation has ranked first in the world for seven consecutive years. In 2020, the installed quantity will reach 168377, more than the sum of Europe and America 106436. The innovative development and deepening application of AI industry will expand the overall scale of China's high-end manufacturing industry and effectively improve the participation level of China's manufacturing industry in the global value chain. The latest research progress of AI application in manufacturing at this stage mainly focuses on three aspects: whether the big model has formed consciousness, the discussion of world model and general AI, and the core issues of the implementation of decision-making intelligence technology. This paper mainly focuses on the landing problem of intelligent technology, puts forward six application scenarios for the integration of artificial intelligence technology and manufacturing industry, analyzes the main problems existing in the deep integration of artificial intelligence technology and manufacturing industry and the solutions, and has certain practical significance for promoting the application and landing of artificial intelligence technology in the manufacturing industry.

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2 Research status

The academic research on AI and manufacturing mainly focuses on three aspects: first, analyze the integration mechanism and mode of AI and manufacturing theoretically. Deng Zhou (2018) believes that AI can achieve the deep integration of AI and manufacturing by improving the production efficiency of the manufacturing industry, improving the degree of production flexibility and promoting the service-oriented transformation of the manufacturing industry. Gao Yu (2019) believed that the deep integration of AI and manufacturing industry requires comprehensive intelligent development in production management, production operation, organization management and enterprise competition. Xu Wenwei et al. The second is the research on industrial robots and the upgrading of the manufacturing industry structure. Tang Xiaohua and Jing Wenzhi (2021) built a three sector model to describe the mechanism of flexible production on the intelligent upgrading of the manufacturing industry, and confirmed that the popularity of flexible production and the expansion of the level of flexibility have a lasting positive effect on the intelligent upgrading of the manufacturing industry, while the promotion of the level of technological flexibility on the intelligent upgrading of the manufacturing industry is only effective in the short term. Third, the impact of industrial robots on manufacturing employment. Yan Xueling (2020), based on the sub industry data of China's manufacturing industry, confirmed that every 1% increase in the number of industrial robots will reduce employment by 4.6%. Wen Huwei (2021) found that intelligent manufacturing has a significant positive impact on the labor income share of enterprise employees.

There are few empirical studies on AI application and manufacturing export product quality. Lv Yue (2020), based on the data of Chinese industrial enterprises from 2000 to 2013, confirmed that AI significantly promoted Chinese enterprises to participate in the division of labor in the global value chain; Liu Bin and Pan Tong (2020) used the data of 38 countries from 2000 to 2014 to confirm that AI technology has improved the participation and division of labor in the global value chain of a country's industry. Liu Hongying (2022) divided the manufacturing industry into low, medium and high-end manufacturing industries, and comprehensively examined the long-term and short-term impact of industrial robot application on the rise of China's manufacturing value chain. Zhang Keyun (2022) found that AI has significantly improved the quality of export products of Chinese manufacturing enterprises, and the domestic super large market has further strengthened the effect of AI on improving the quality of export products of enterprises. Cai Zhenkun (2021) applied China's customs data and industrial enterprise data from 2000 to 2015, proving that the application of industrial robots has significantly improved the quality of export products, and can improve the total factor productivity of enterprises and reduce marginal costs.

3 Application Status of Artificial Intelligence Technology in China

With the development of digital economy, it ushers in a new stage of intelligent economy with artificial intelligence as the core driving force. The global AI market size is expected to exceed US $6 trillion in 2025. As a major manufacturing country, China has provided a wealth of application scenarios for AI. The scale of AI application market in China's manufacturing industry will reach US $14.1 billion (Figure 1). At present, China's digital economy and artificial intelligence industry have entered a period of rapid development, and the development of artificial intelligence has become the next wind to drive the development of digital economy. However, it will take some time to move from the application of artificial intelligence to the development of the whole industrial chain, especially for the development of key technologies or equipment.

Fig. 1.2018-2025 AI application market scale in China's manufacturing industry

Data source: bit wit, Intelligent research consulting and sorting

At this stage, the digital transformation of most manufacturing enterprises has not reached the level of the production end (C2M), but is at the relatively primary level of customer direct sales (C2S). With the deepening of digitization and the continuous accumulation of digital quantity, digital transformation will gradually penetrate from the sales side to the channel side, the production side and even the R&D side. The "four in one" of data, computing power, algorithm and scenario jointly drives the "point to area" application of AI technology in the field of manufacturing export product research and development.
4 Main application scenarios of deep integration of AI and manufacturing

4.1 Intelligent design and R&D

In the process of product R&D, the probability of problems in demand and design environment accounts for 70% and 20% of the whole process. By integrating AI technology into the product research and development stage, we can greatly improve the accuracy of research and development. Through large data analysis, we can integrate a large number of user data, accurately grasp consumer preferences, demands, provide data support for enterprise research and development, not only greatly improve the manufacturing product design efficiency and accuracy, also accelerate the product design iteration process, research and development innovation to promote the quality of goods upgrade.

The product design enabling platform represented by digital prototype and virtual simulation completes the entire manufacturing process through 3D design, visualization, simulation tools, etc. through the characteristics of digital twins, such as simulation analysis, document production, industrial design, visual rendering, etc., which can improve the design efficiency of designers [Zhao Zhen2022]. Virtual models are used to conduct repeatable and variable parameter simulation experiments, tests verifying the performance and performance of products in different external environments can increase the accuracy and reliability of research and development, shorten the research and development process, significantly reduce the cost of product research and development and trial and error, and effectively meet the personalized needs of customers and the changing market environment. At this stage, Digital Twin has been applied to aircraft manufacturing, new drug research and development and other industries with long design cycle and great development difficulty.

The process of AI application development includes development process and operation process (Figure 2). The development process is the process of continuously processing (data annotation, model training, performance monitoring) data sources (big data systems, business systems of manufacturing enterprises) and obtaining AI applications; The process in the running state is relatively simple. It is mainly to arrange some models, knowledge or configurations together into an AI application. In this system, customers can monitor data and results. Once problems are found, they can conduct the next iterative development of data in the development state process and generate new AI applications. The development process of AI applications is a process of continuous generation selection and optimization.

![Fig 2. Flow chart for the development of artificial intelligence applications](https://example.com)

Data source: Huawei cloud

4.2 Intelligent manufacturing production line

Traditional large factories produce nearly 1TB of huge production data every day, but only 1% of the data has been analyzed and used as the basis for enterprise action. Efficient processing of these production data with cloud and AI technology can help predict business outages, minimize downtime and maximize throughput, and improve the efficiency of product manufacturing. With the full spread of manufacturing execution System (MES) production lines, the enterprise resource planning (ERP) system has taken root, and the product manufacturing process has achieved the integration of product data and manufacturing data. The advanced intelligent manufacturing technology represented by digital twins is playing an increasingly important role in the production line.

Industrial robots are typical representatives of the application of artificial intelligence in high-end manufacturing. The participation of intelligent robots in the production and manufacturing process will help to innovate processes, improve quality inspection efficiency and upgrade product functions, boost export enterprises from low-end processing and assembly to complex parts production and product design innovation, and help expand the scale of China's intelligent equipment manufacturing industry. So as to improve the overall scale and value level of China's high-end manufacturing industry. The application of industrial
robots has significantly improved the quality of export products of large enterprises.

4.3 Intelligent quality assessment

When manufacturing enterprises manufacture products or use equipment to simplify operations, it is difficult to detect the internal problems of products. Only by observing the appearance and function of the product, the quality inspector is often unable to identify internal defects, which will eventually lead to major process defects of the finished product.

The application of edge computing and AI technology reduces the process defects in manufacturing. AI and machine learning combine AI technology with processing and manufacturing technology, bringing revolutionary changes to the way manufacturing operations are conducted. For example, AI can identify minor faults in a machine or product, allowing designers to choose to solve the same problem before it becomes a major defect. The proximity of edge computing and AI technology can be used to process data at the location where data is generated, which helps to take quick action based on insights, reduce manufacturing defects, ensure worker safety and implement production monitoring, save a lot of costs for enterprises and greatly improve production efficiency.

AI helps to improve the overall product quality and performance of the end product. Many manufacturing companies use AI driven automation and powerful tools to detect defects in the process or the main causes of defects in product design. By using artificial intelligence to conduct in-depth quality testing, manufacturing enterprises can ensure that high-quality products and products produced in batches have a faster time to market.

4.4 Intelligent device maintenance

In traditional machinery and equipment, unless there is a major failure, daily maintenance of the machine is easy to be ignored by enterprises. A single failure in the equipment may seriously damage the entire production line, increasing downtime and overall cost. Therefore, correct and timely maintenance of machines is crucial for manufacturing enterprises to improve production efficiency.

Implementing AI driven manufacturing solutions can help automate processes and enable manufacturers to build intelligent operations, reducing cost overhead and downtime. Machine learning driven prediction tools and artificial intelligence solutions can predict when equipment needs regular maintenance through AI predictive maintenance technology. Predictive maintenance technology can predict and detect equipment failures through vibration analysis, infrared thermal imaging, ultrasonic analysis, acoustic monitoring and other methods. In some scenarios, the Internet of Things and cloud sensors are embedded in the equipment, helping to predict timely maintenance, At the same time, it can effectively prevent the occurrence of safety accidents in various industrial production.

4.5 Intelligent price forecasting

With the continuous development of artificial intelligence, based on massive data, combined with business logic, data mining methods and machine learning models can be used to predict prices more efficiently and accurately. For manufacturing enterprises, through omni channel and omni range data mining combined with machine learning algorithm, we can analyze the price fluctuation trend and more accurately predict the price and demand, which can effectively provide intelligent decision-making assistance for enterprises in optimizing product pricing strategies, channel management, intelligent marketing, etc.

Artificial intelligence prediction models can provide innovative big data tools for enterprises in the commodity industry chain to help them manage the risk of commodity price fluctuations and improve their profitability. For some industrial manufacturing enterprises that are greatly affected by commodity prices, the prediction of the trend of raw material prices by AI technology can provide information basis for enterprises to formulate hedging strategies. By improving the stability of hedging, some raw materials with large market price fluctuations can hedge the impact of price fluctuations on the company's profits through hedging and futures trading.

The big data tool will collect data from different market sources, adopt a more flexible modeling method and a closed-loop self-learning method, so that the prediction model can maintain accuracy, and conduct a comprehensive analysis of these data to make accurate price forecasts, providing a basis for enterprises to formulate product prices.

4.6 Intelligent inventory management

Inefficient inventory management may lead to a large amount of costs for manufacturers. Using AI tools, manufacturers can manage their order records and add/delete new inventory. Machine learning plays an indispensable role here, and it can manage inventory according to demand and supply. AI provides manufacturers with the best time and quantity of raw material procurement by using historical procurement data and relevant procurement analysis, as well as current consumption analysis, through model deduction, to ensure that the optimal inventory for production can be maintained.
5 Problems arising from the application of artificial intelligence in manufacturing

5.1 AI technology lacks coordinated development with manufacturing enterprises

Traditional manufacturing enterprises have insufficient understanding of AI technology. The design, manufacturing and other actual scenarios of manufacturing enterprises have the characteristics of demand variability and data diversity. To introduce AI technology into the manufacturing process, it is necessary to jointly develop and select multiple models according to the needs of enterprises through the professional knowledge of AI technology experts and enterprise manufacturing engineers [1]. Only by building the infrastructure for the implementation of AI technology and forming a special supporting scheme for enterprises can the threshold for the implementation of AI technology be lowered. Most manufacturing enterprises lack the supporting facilities and foundation for the implementation of AI technology, and the innovative development of AI industry has not developed technology to solve the actual problems of enterprises based on the needs of manufacturing enterprises.

5.2 Large investment in artificial intelligence technology R&D and introduction

China's AI industry is developing rapidly, with more than 4000 AI enterprises, which have great advantages in data and application layers. However, at this stage, the key technologies of AI - basic research and chips - still lag far behind those of the world's leading countries. The core technologies of AI are still mastered by foreign enterprises, which requires the introduction of a large number of foreign technologies, and the use of which requires the payment of high patent fees. The introduction of artificial intelligence into manufacturing enterprises requires a large amount of capital investment, and the cost pressure is high in the process of digital transformation of manufacturing enterprises.

5.3 Lack of enterprise AI talents

The application of AI technology in the manufacturing industry requires not only a large number of AI technology R&D talents, but also a large number of high-end composite application type technical talents who master AI technology, robot design, production process, manufacturing technology and other technologies at the same time, including operation talents, maintenance talents, integrated application talents, etc. At present, although a large number of colleges and universities in China have set up artificial intelligence, robot manufacturing and other specialties to cultivate high-level artificial intelligence professionals, there is still a large lack of high-end composite talents integrating artificial intelligence and manufacturing.

5.4 Hidden danger of enterprise information security

AI is applied in the digital transformation of manufacturing industry. The production, internal management and market data of enterprises must be collected and processed by AI systems, which leads to potential information security problems. On the one hand, the quality of AI technology itself, including the accuracy, completeness, consistency, real-time and other characteristics of the data collection, cleaning, labeling process, will also affect the model convergence efficiency and model performance. On the other hand, the premise of intelligence is security. In particular, the application of artificial intelligence in the manufacturing industry, which is still in the early stage of construction, has spawned various new data security risks. Artificial intelligence constructs and optimizes the algorithm model by training data sets. Because of the way it processes data, it will bring a series of new data security problems such as data pollution, data poisoning, and algorithm reality. At the same time, the application of artificial intelligence in automatic network attacks and data blackout makes network security and data security threats more replicated, which has a huge impact on the existing weak data security governance capabilities of countries and enterprises.

6 Suggestions on the Development of Artificial Intelligence in Manufacturing Industry

6.1 Accelerate the implementation of artificial intelligence in all fields of manufacturing

Improve the quality of export products through the application of advanced digital technology, and promote the high-end transformation of manufacturing industry. First of all, AI can help enterprises improve their intelligent operation level. Industrial enterprises can establish intelligent production lines and intelligent factories by using industrial robots, video recognition systems, etc., and develop intelligent R&D and design, intelligent production, intelligent warehousing, etc., so as to establish an AI industrial brain to improve the overall production efficiency and truly achieve cost reduction and efficiency increase; Secondly, the integration and application of artificial intelligence, 5G, industrial Internet and other technologies have promoted changes in manufacturing production and service models, decision-making models, and business models; Finally, AI drives the reconstruction of the manufacturing value chain, which is conducive to China's seizing the value highland of the global manufacturing industry chain.


6.2 Promote the innovation and research of AI technology based on the application of industrial artificial intelligence

Strengthen the coordinated development of AI and manufacturing industry, from scientific research innovation to industrial implementation, create a new mode of industrial agglomeration, and incubate manufacturing industry solutions. Based on the world's first intelligent remote sensing framework and data set, an intelligent remote sensing open source ecological alliance and a multi-modal artificial intelligence industry alliance were established. Huawei and more than 60 industry partners jointly established industrial alliances such as AI hydro-mechanics, AI bio-medicine, and Smart Rain to help large-scale innovation and industrial development in related fields. We should vigorously promote the joint research and development of AI technology industry experts and manufacturing industry related technical experts, promote the coordinated development of AI technology and manufacturing industry, promote the clustering and industrialization of AI research and development, accelerate the transformation of innovation input into output, so as to help Chinese enterprises participate in the global market competition with high quality.

6.3 Improve the policy guarantee mechanism for the development and application of artificial intelligence

First of all, China's digital economy governance system needs to be improved. The rule system to adapt to the development of the digital economy needs to be improved, the basic system of data elements is still under construction, the platform economic governance system that can stimulate vitality and ensure security needs to be improved, and various implementation rules supporting relevant laws and regulations need to be issued. By strengthening the intellectual property protection of AI related patent technology, a good innovation environment is provided for the development of digital technology. Establish a data security governance system, establish data security specifications from the regulatory, standard, technical and other levels, and escort the healthy and controllable development of AI technology by establishing a data security governance system.

Secondly, a series of financing services and preferential tax policies have been issued and implemented to vigorously support manufacturing enterprises to carry out digital transformation, machine replacement and artificial intelligence technology implementation. The investment of the capital market in the high-tech field can help AI enterprises to make full use of their innovation ability to obtain financing, boost enterprises to continue to increase R&D investment, and enhance China's core competitiveness in AI R&D.

Finally, universities, scientific research institutes and industrial enterprises are encouraged to cooperate with each other to establish scientific research bases, focus on hot industries, and jointly cultivate R&D talents and high-level skilled talents needed in the digital transformation of enterprises [3], so as to meet the needs of AI for various high-end composite technical talents during the implementation of the manufacturing industry.

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