Research on the Impact of Digital Transformation on The Production Efficiency of My Country's Manufacturing Enterprises

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Abstract

With the continuous development of the global economy, digital transformation has become a key means for manufacturing enterprises to improve production efficiency and competitiveness. This paper systematically combs through relevant literature to explore the impact of digital transformation on the production efficiency of China's manufacturing enterprises. First, this paper explains the connotation and main technologies of digital transformation, including intelligent manufacturing, the Internet of Things, big data analysis, artificial intelligence and robotics. These technologies have played an important role in production process optimization, cost control, product quality improvement and supply chain management. Secondly, this paper analyzes the specific application of digital transformation in the manufacturing industry and demonstrates the significant impact of digital transformation on enterprise production efficiency through case studies. Case studies show that the application of digital technology not only improves the real-time monitoring and feedback capabilities of the production process, but also optimizes production scheduling, reduces operating costs and improves resource utilization. At the same time, digital transformation has also significantly improved product quality. Through quality control and improvement and customized production, enterprises can better meet market demand. In addition, the implementation of digital supply chain management has improved the collaborative efficiency of the supply chain and enhanced the overall competitiveness of enterprises. Finally, this paper summarizes the comprehensive impact of digital transformation on the production efficiency of China's manufacturing enterprises and puts forward corresponding policy recommendations. It is recommended that the government strengthen its support for digital transformation and formulate relevant policies to guide enterprises to carry out digital upgrades. At the same time, enterprises should actively embrace digital technology, formulate practical transformation strategies, and continuously improve their production efficiency and market competitiveness. This paper provides theoretical support and practical reference for future research, and points out potential directions for further research.

Keywords

Digital transformation, manufacturing, enterprise production efficiency, transformation strategy.

1. Introduction

1.1. Research background

Globally, digital transformation has become an important strategy for countries to promote economic growth and industrial upgrading. With the rapid development and widespread application of information technology, enterprises have adopted digital technology to optimize production processes, improve management efficiency and innovate business models, which

has become a key means to enhance global competitiveness. Especially in the manufacturing industry, digital transformation has greatly changed the traditional manufacturing model and production efficiency through the application of technologies such as intelligent manufacturing, the Internet of Things, big data analysis, and artificial intelligence. Countries have introduced relevant policies and plans to promote the digital transformation of their own companies in order to cope with the fierce competition and rapid changes in the global market.

China's manufacturing industry occupies an important position in the national economy and is an important pillar of economic growth and employment. However, despite the large scale of China's manufacturing industry, it is still at the middle and low end of the global value chain, facing many challenges such as low production efficiency, low resource utilization, and insufficient innovation capabilities. At the same time, with the intensification of international market competition and the rise in domestic labor costs, the growth model of traditional manufacturing is unsustainable. In order to achieve the transformation and upgrading of the manufacturing industry, the Chinese government has proposed the "Made in China 2025" strategy, which aims to improve the production efficiency and international competitiveness of enterprises by promoting the digital transformation of the manufacturing industry.

1.2. Research significance

Theoretically, digital transformation provides manufacturing companies with a new research perspective and analytical framework. By systematically exploring the application of digital technology in manufacturing, we can enrich and deepen the theory of production efficiency and reveal the profound impact of digital transformation on production processes, management models and corporate performance. This will help the academic community further understand the internal mechanism and action path of digital transformation and provide a theoretical basis and reference for subsequent research.

From a practical point of view, digital transformation has brought actual opportunities for manufacturing companies to improve production efficiency and enhance competitiveness. By adopting technologies such as smart manufacturing, the Internet of Things, big data analysis, and artificial intelligence, companies can automate and intelligentize the production process, reduce production costs, and improve product quality and market response speed. This study will provide companies with practical digital transformation strategies and practical suggestions to help them gain an invincible position in the fierce market competition. At the same time, the government can draw on the research results, formulate and improve relevant policies, promote the comprehensive digital transformation of the manufacturing industry, and promote high-quality economic development.

1.3. Research objectives

This paper aims to explore the specific impact of digital transformation on the production efficiency of my country's manufacturing enterprises. By systematically combing and analyzing relevant research results at home and abroad, this paper reveals the specific mechanism and effect of digital technology in improving production efficiency. It focuses on the application of technologies such as intelligent manufacturing, the Internet of Things, big data analysis, and artificial intelligence in production process optimization, cost control, product quality improvement, and supply chain management, and analyzes their effect on improving production efficiency.

In addition, this paper also aims to provide theoretical support and practical suggestions for manufacturing enterprises. By analyzing the successful cases of digital transformation in detail, summarizing their experiences and lessons, and proposing targeted transformation strategies and implementation paths, it is hoped that it can provide valuable references for enterprises in the process of digital transformation, helping them to better cope with challenges, seize

opportunities, and achieve efficient production and continuous innovation. At the same time, the research results of this paper will also provide a theoretical basis for government departments to formulate relevant policies and promote the overall digital upgrade and high-quality development of my country's manufacturing industry.

2. Literature Review

2.1. Research on Enterprise Digital Transformation

At the level of the internal logic evolution of enterprise digital transformation, Lyytinen et al. (2018) pointed out that digital transformation is a technological change in enterprise management and operation. This means that digital transformation is not only the application of digital technology to the operation of enterprises, but also involves major changes in management and operation. Hu Qing (2020) pointed out that digital technology can fully penetrate into the enterprise and effectively alleviate the information asymmetry between supply and demand. Qi Yudong et al. (2021) believe that enterprise digital transformation is a kind of "intelligent connection" that will lead to changes in the business processes and production models of enterprises. Sturgeon (2021) regards digital technology as the latest extension of information and communication technology. Bertani et al. (2021) believe that the manifestation of digital transformation is a digital business model, that is, the process of enterprises using advanced digital technologies (such as big data, artificial intelligence, and the Internet of Things) to transform and upgrade manufacturing and production. With the intensification of market competition, enterprises are ready to implement business model innovation strategies to seize more market share.

2.2. Research on the impact of digital transformation on enterprise production efficiency

In terms of the research on factors affecting production efficiency, Jiang Changliu and Jiang Chengtao (2020) pointed out that by supervising the legality of the R&D investment of enterprises, it is possible to ensure that R&D funds are converted into real productivity, thereby ensuring the innovation ability of enterprises and promoting the improvement of the total factor productivity level of enterprises. Secondly, from the perspective of external factors affecting the total factor productivity of enterprises. An open market environment is more conducive to technological innovation, thereby improving production efficiency. Jhorland (2022) believes that high-quality human resources can increase the R&D investment of enterprises, increase the breadth and depth of enterprises' adoption of new technologies, and help improve the production efficiency of enterprises. Dold and Speck (2021) explained that the complexity of value creation and value delivery in digital production will cause the generation of "paradoxes", and provide solutions through qualitative models and related "toolboxes". Qiu Zixun and Zhou Yahong (2021) constructed digital transformation variables through quasi-natural experiments, and used DID to empirically verify that the establishment of big data pilot areas effectively promoted the development of regional technological innovation, thereby greatly improving regional production efficiency.

3. Application of Digital Transformation in Manufacturing

3.1. Intelligent Manufacturing

The rise of Industry 4.0 marks a new stage in the manufacturing industry's move towards intelligence and digitalization. Intelligent manufacturing is the core of Industry 4.0. By integrating emerging technologies such as the Internet of Things, cloud computing, big data, and artificial intelligence, it realizes the comprehensive intelligence of the production process. Intelligent manufacturing not only improves production efficiency, but also improves product

quality and flexibility, enabling enterprises to better respond to market changes and customer needs. Specifically, the main technologies of intelligent manufacturing include intelligent control technology, digital twin technology, cloud computing and edge computing , and additive manufacturing (3D printing). These technologies optimize production scheduling and resource allocation through real-time monitoring and feedback to ensure the efficiency and stability of the production process. For example, intelligent control technology can realize the automated control of production equipment, digital twin technology optimizes production decisions through the interaction of virtual and real, and cloud computing and edge computing improve the speed and flexibility of data processing. Additive manufacturing technology makes customized production of complex structures possible, further improving production efficiency and product market competitiveness.

3.2. Internet of Things (IoT)

IoT technology is an important part of the digital transformation of the manufacturing industry by interconnecting production equipment, sensors and information systems to achieve information sharing and collaborative work between equipment. IoT is widely used in the manufacturing industry, including equipment monitoring and maintenance, production process optimization and supply chain management. Through sensors installed on the equipment, IoT can monitor the operating status and performance parameters of the equipment in real time, detect faults and abnormalities in a timely manner, perform preventive maintenance and predictive maintenance, and reduce equipment downtime and maintenance costs. In addition, IoT technology can also optimize the production process. By real-time monitoring of various parameters in the production process, it can optimize production scheduling and resource allocation, improve production efficiency and product quality. In terms of supply chain management, IoT realizes information sharing and collaborative management of upstream and downstream enterprises, improves the visualization and transparency of the supply chain, improves the response speed and management efficiency of the supply chain, and ensures the smoothness and efficiency of the production process.

3.3. Big Data Analysis

Big data analysis technology provides valuable insights and decision support by collecting, storing, processing and analyzing the massive data generated in the manufacturing process. In the manufacturing process, the application of big data includes production data analysis, quality management and supply chain optimization. Through real-time analysis of production data, bottlenecks and problems in the production process can be discovered, production processes and process parameters can be optimized, and production efficiency and product quality can be improved. In terms of quality management, big data analysis can identify key factors affecting product quality, optimize quality control strategies, reduce the probability of quality problems, and increase product qualification rates. Supply chain optimization optimizes each link of the supply chain through the analysis of supply chain data , improves the efficiency and flexibility of the supply chain, and reduces inventory and logistics costs. Data-driven decision support not only improves the scientificity and accuracy of corporate decision-making, but also helps companies gain an advantage in competition.

3.4. Artificial Intelligence (AI) and Robotics

Artificial intelligence technology has been widely used in the manufacturing industry by simulating human intelligence to achieve automated processing and decision-making of complex problems. The application of AI technology in the manufacturing industry includes predictive maintenance, production optimization and robotic automation. Predictive maintenance uses AI algorithms to analyze equipment operation data, predict the possibility of equipment failure, perform preventive maintenance, and reduce equipment failure rate and

maintenance costs. In terms of production optimization, AI technology automatically adjusts production processes and procedures by real-time monitoring and analysis of various parameters in the production process to ensure the efficiency and stability of the production process. Robotic automation improves production efficiency and safety by introducing industrial robots to replace manual work for highly repetitive and dangerous tasks.

4. The Specific Impact of Digital Transformation on Production Efficiency

4.1. Production process optimization

The primary impact of digital transformation in the manufacturing industry is the optimization of the production process. Through real-time monitoring and feedback, companies can obtain detailed data such as equipment operating status, production line efficiency, and product quality during the production process. These data are collected in real time through IoT devices and sensors, and transmitted to the central system for analysis to promptly discover and solve abnormal problems in production. For example, sensors can monitor key parameters such as temperature and pressure of equipment. Once they exceed the preset range, the system will automatically issue an alarm to prevent the expansion of faults, reduce downtime and maintenance costs. At the same time, production scheduling optimization optimizes the allocation and use of production resources and improves the work efficiency of the production line through advanced algorithms and big data analysis. The production plan can be dynamically adjusted according to real-time order demand, inventory status, and production capacity to ensure the efficient operation of the production process, reduce waiting time and production bottlenecks, and thus improve overall production efficiency.

4.2. Cost Control

Digital transformation has brought significant cost control effects to the manufacturing industry. First, by implementing intelligent manufacturing and automation technologies, enterprises can reduce operating costs. Automated equipment and robots can replace manual labor to complete a large number of highly repetitive and dangerous tasks, reducing labor costs and the risk of work-related injuries. In addition, intelligent monitoring systems can monitor energy usage in real time, optimize energy distribution and usage strategies, reduce unnecessary energy consumption, and reduce energy costs. Secondly, improving resource utilization is an important goal of digital transformation. Through accurate data analysis and prediction, enterprises can optimize the procurement and use of raw materials, reduce waste and inventory backlogs. For example, big data analysis can predict market demand and production trends, help enterprises formulate reasonable procurement plans, ensure the timely supply and efficient use of raw materials, thereby reducing production costs and inventory pressure.

4.3. Product quality improvement

Digital transformation plays a key role in improving product quality. Through advanced quality control and improvement technologies, companies can achieve all-round quality monitoring and management in the production process. Sensors and testing equipment can collect key quality indicators of products in real time. The system automatically detects and feedbacks according to preset standards, promptly discovers and corrects quality problems, and ensures product consistency and reliability. For example, automated testing equipment can perform high-precision testing on product size, weight, color, etc. to ensure that each product meets quality standards. In addition, digital technology has also promoted the development of customized production. Through flexible production systems and accurate data analysis, companies can carry out customized production according to the personalized needs of

customers, provide diversified and high-quality products, and improve customer satisfaction and market competitiveness.

4.4. Supply Chain Management

The application of digital transformation in supply chain management has greatly improved the efficiency and coordination capabilities of the supply chain. Through the digital management of the supply chain, enterprises can achieve information sharing and collaborative operations in all links of the supply chain , and improve the transparency and visual management of the supply chain. For example, through the Internet of Things technology, enterprises can monitor the inventory status, logistics process and supplier production in the supply chain in real time, adjust the supply strategy in time, and avoid inventory backlogs and out-of-stock risks. The improvement of supply chain coordination efficiency is also an important achievement of digital transformation. Through advanced information systems and data analysis, enterprises can achieve close cooperation between upstream and downstream of the supply chain and optimize the overall efficiency of the supply chain. For example, big data analysis can predict changes in market demand, help enterprises formulate scientific production and procurement plans, ensure the efficient operation of the supply chain, reduce operating costs, and improve market response speed. Through digital transformation, manufacturing enterprises have made significant progress in supply chain management, providing strong support for improving overall production efficiency.

5. Case Analysis

5.1. Case selection and introduction

In order to better understand the specific impact of digital transformation on the production efficiency of manufacturing enterprises, this paper selects a representative digital transformation enterprise - Haier Group. Haier Group is one of the world's leading home appliance manufacturers, and its exploration and practice in digital transformation are at the forefront of the industry. Haier has comprehensively promoted intelligent manufacturing by introducing advanced technologies such as the Internet of Things, big data, and artificial intelligence, and established a smart factory based on the industrial Internet platform. Specifically, Haier has achieved digital management of the entire process from product design, production and manufacturing to after-sales service through its self-developed COSMOPlat industrial Internet platform. The platform can quickly adjust production plans and process flows according to market demand and customer feedback, and improve production flexibility and response speed. In addition, Haier also uses the Internet of Things technology to monitor and maintain equipment in real time, optimize production scheduling and resource allocation through big data analysis, and ensure the efficiency and stability of the production process. Haier's digital transformation practice provides valuable reference and reference for manufacturing enterprises.

5.2. The specific impact of digital transformation on enterprise production efficiency

Haier Group's digital transformation practice has significantly improved its production efficiency. Before the digital transformation, Haier's production process relied on traditional manual work and mechanized equipment, with low production efficiency, unstable product quality and high operating costs. By introducing digital technology, Haier has achieved comprehensive optimization and automation of the production process. First, Haier uses the Internet of Things technology to monitor and feedback production equipment in real time, timely discover and solve equipment failures, reduce equipment downtime and maintenance costs, and improve the utilization rate of production lines. Secondly, through big data analysis

and intelligent scheduling systems, Haier optimizes production plans and resource allocation, reduces waiting time and bottlenecks in the production process, and improves production efficiency and product quality. In addition, Haier's industrial Internet platform makes information sharing and collaborative operations in all links of the supply chain more efficient, and improves the overall operational efficiency of the supply chain. Haier's successful experience shows that digital transformation can not only improve production efficiency, but also improve product quality and customer satisfaction. However, Haier also encountered some challenges in the process of digital transformation, such as large technology investment and high demand for employee skill improvement. By summarizing Haier's successful experience and lessons, other manufacturing companies can better plan and implement digital transformation to improve their own production efficiency and market competitiveness.

6. Conclusion and Outlook

6.1. Research conclusions

This paper systematically analyzes the application of digital transformation in manufacturing and reveals the comprehensive impact of digital transformation on production efficiency. The study shows that digital transformation has a significant positive effect in production process optimization, cost control, product quality improvement and supply chain management. Intelligent manufacturing improves the automation and intelligence level of the production process through real-time monitoring and feedback, optimized production scheduling and other methods. Internet of Things technology realizes the interconnection of equipment and production lines, optimizes production processes, and reduces equipment failure rates and downtime. Big data analysis provides accurate decision support, optimizes resource allocation and production planning, and improves production efficiency and product quality. Artificial intelligence and robotics technology improve production efficiency and product consistency through automated operations. Overall, digital transformation not only improves the production efficiency of manufacturing enterprises, but also enhances their market competitiveness and innovation capabilities.

6.2. Policy recommendations

In order to better promote the digital transformation of manufacturing enterprises, the government and enterprises need to work together. First, the government should increase its support for digital transformation, formulate relevant policies and incentives, and encourage enterprises to increase investment in the research and development and application of digital technologies. For example, provide tax incentives, set up special funds to support digital projects, and promote the popularization and application of digital technologies. In addition, the government should strengthen the construction of digital infrastructure, promote the widespread application of technologies such as the Internet of Things and 5G networks, and enhance the infrastructure guarantee for the digital transformation of enterprises. Secondly, enterprises should actively formulate digital transformation strategies, clarify transformation goals and paths, increase investment in digital technologies, and improve employees' digital skills and literacy. Enterprises should make full use of advanced technologies such as big data and artificial intelligence to optimize production processes and management models, and improve production efficiency and product quality. At the same time, enterprises should strengthen cooperation with technology suppliers and scientific research institutions, use external forces to promote digital transformation, and achieve resource sharing and collaborative innovation.

6.3.   Future research directions

Although this paper has conducted a detailed analysis of the impact of digital transformation on production efficiency, there are still many areas that deserve further research. Future research can focus on the following aspects: First, explore the differences and commonalities in digital transformation among manufacturing enterprises of different sizes and industries, and find out the digital transformation paths and strategies that are most suitable for various types of enterprises. Second, study the impact of digital transformation on the long-term performance and sustainable development of enterprises, and evaluate the role of digital technology in environmental protection and social responsibility. Third, deeply analyze the challenges and obstacles in digital transformation, such as technical risks, data security and privacy protection, and propose effective countermeasures and solutions. Future research can adopt a variety of research methods and tools, such as case studies, questionnaires and data analysis, and further reveal the deep-seated impact of digital transformation on the production efficiency of manufacturing enterprises through a combination of quantitative and qualitative methods, and provide more practical guidance and suggestions for enterprises and governments.

Acknowledgements

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