

Global Value Chains in the Digital Age: The Impact of Smart Manufacturing and the Internet of Things

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Abstract: The rapid development of the digital era is changing the global economic pattern and production mode, and the application of digital technology is profoundly affecting the operation of the global value chain. Smart manufacturing and the Internet of Things, as core technologies in the digital age, are having a profound impact on global value chains. By exploring the application and impact of smart manufacturing and the Internet of Things in global value chains in the digital age, this paper aims to gain a deeper understanding of the driving and transformative impact of these technologies on the global economy.

Keywords: Digitalization; Global Value Chain; Intelligent Manufacturing; Internet of Things.

1. Introduction

With the rapid development of science and technology, the digital age has become the dominant trend of global economic and social development. In this digital age, the importance of global value chains has become increasingly prominent, becoming an important part of the global economic landscape and international cooperation. Optimization and integration of global value chains are essential to improve economic efficiency, optimize resource allocation, and achieve the Sustainable Development Goals.

Smart manufacturing and the Internet of Things, as the two core technologies of the digital age, are profoundly changing the pattern and operation of global value chains. Intelligent manufacturing relies on advanced information technology to upgrade the traditional manufacturing industry to an efficient and intelligent production mode to improve production efficiency and product quality. The Internet of Things makes the supply chain more intelligent and transparent by connecting various devices, sensors and objects to each other for real-time data collection, transmission and analysis.

In the context of increasingly fierce global economic competition and increasingly prominent supply chain risks, in-depth research on the impact of intelligent manufacturing and the Internet of Things on the global value chain has important theoretical and practical significance for guiding enterprises to make strategic decisions, optimize supply chain management, and achieve sustainable development goals

2. Literature Review

2.1. The Impact of Intelligent Manufacturing on Global Value Chain

Intelligent manufacturing is an important part of the digital era, which improves production efficiency and product quality through automation, digitalization and intelligent technology, while reducing production costs. Yuan and Xu (2019) pointed out in their research that the wide application of intelligent manufacturing technology in the global value chain has promoted the relay out of the global production network and improved the competitiveness of the global industrial chain. The application of smart manufacturing has also promoted the digitization and networking of global supply chains. The research of Kagermann et al. (2013) shows

that intelligent manufacturing technology can enable all links in the supply chain to realize real-time data sharing and information exchange, thus improving the transparency and collaboration of the supply chain. This digital supply chain network helps to improve production and logistics efficiency and reduce the operating costs of the supply chain.

2.2. The Impact of iot on Global Value Chains

As another major technological breakthrough in the digital era, the Internet of Things connects various devices, sensors and objects together to achieve intelligent interconnection. The application of Internet of Things technology has brought new changes to the global value chain. Through the Internet of Things technology, enterprises can achieve real-time monitoring and control of the production process, thereby improving the accuracy and stability of production. Erol et al. (2018) found that the application of the Internet of Things can help enterprises better grasp various links in the global supply chain, reduce waste and resource consumption in the production process, and improve the efficiency and flexibility of the global value chain. In addition, iot technology is bringing entirely new business models and services to global value chains. By combining with the Internet of Things, businesses can provide more personalized and customized products and services to meet the growing needs of consumers. These transformative innovations give new impetus to the upgrading and transformation of global value chains.

2.3. Synergy between Intelligent Manufacturing and Internet of Things

As the dual core technologies of the digital age, the synergy between smart manufacturing and the Internet of Things brings greater advantages to global value chains. The integrated application of intelligent manufacturing and the Internet of Things has accelerated the digitization and intelligence of the global production network. For example, automated devices and robots in smart manufacturing can be connected through the Internet of Things to enable information sharing and coordination between devices, enabling a more flexible and efficient production process. The study by Kim et al. (2020) points out that the synergistic application of smart manufacturing and iot brings new business opportunities and growth points to global value

chains. By integrating smart manufacturing and iot technologies, enterprises can build a more intelligent and efficient global supply chain, achieve optimal allocation of global resources and advanced upgrading of the industrial chain.

According to the literature review, global value chains in the digital age are being profoundly impacted by smart manufacturing and iot technologies. Intelligent manufacturing improves production efficiency and the intelligence of production networks, and the Internet of Things realizes the intelligent interconnection of devices and objects, accelerating the digitization and networking of global supply chains. The synergy of smart manufacturing and iot brings more opportunities and challenges to global value chains. In the future, enterprises and policy makers need to actively respond to the new situation and new changes in the global value chain in the digital era, give full play to the driving force of smart manufacturing and Internet of Things technology in the global economy, and achieve more intelligent, efficient and sustainable global industrial development.

3. Overview of Global Value Chains in the Digital Age

3.1. Characteristics of Global Value Chains in the Digital Era

Digital transformation: Digital technologies are widely used in all aspects of the global value chain, including production, supply chain management, marketing and sales. Digital transformation makes the acquisition and transfer of information more efficient and facilitates close collaboration among the various players in the global value chain.

Transnational networking: The digital age has accelerated the networked development of global supply chains. Closer partnerships have been established between multinational companies, while players in global supply chains have formed more complex and vast supply chain networks across geographical and national borders.

Customer orientation: The digital age has strengthened the ability of enterprises to understand and respond to customer needs. All segments of the global value chain are increasingly focused on customer experience and personalization to meet changing market requirements.

Flexibility and rapid response: The application of digital technology allows enterprises to adjust production and supply chain strategies more flexibly, quickly respond to market changes and demand fluctuations, and improve the resilience of global value chains.

3.2. Driving Factors for the Development of Global Value Chains in the Digital Era

Technological innovation: The continuous innovation of digital technologies has promoted the upgrading and transformation of global value chains. The application of smart manufacturing, Internet of Things, big data analysis and other technologies has brought new development opportunities for the global value chain.

Multinational competition: Multinational companies are increasingly competing in the global market, and in order to increase their market share and competitive advantage, they have to accelerate their digital transformation and optimize their global value chains to achieve more efficient operations and better products and services.

Changing consumer needs: Consumer needs in the digital age are constantly evolving, placing higher demands on product personalization, customization and rapid delivery. Global value chains must adapt to these changes to meet the diverse needs of consumers.

Policies and regulations: Policies and regulations in different countries and regions have an impact on the operation of global value chains. Global value chains in the digital age need to face a complex and changing policy environment to adapt strategies to ensure compliance and sustainability.

3.3. The Role and Position of Smart Manufacturing and iot in Global Value Chains in the Digital Age

Smart manufacturing and the Internet of Things, as core technologies in the digital age, play a crucial role in the global value chain. They work together to promote the upgrading and optimization of global value chains.

Intelligent manufacturing through automation, digitalization and intelligent technology, improve production efficiency and product quality, reduce production costs. In the global value chain, the wide application of intelligent manufacturing has promoted the relayout of production networks and strengthened the competitiveness of the global industrial chain. Through intelligent manufacturing, enterprises can better adapt to changes in market demand, achieve flexible adjustment and rapid response of production, thus improving the overall efficiency and flexibility of the global value chain.

The Internet of Things technology connects various devices, sensors and objects together to achieve intelligent interconnection. In the global value chain in the digital age, the application of the Internet of Things provides enterprises with more data sources and realizes real-time monitoring and control of the production process. Through the Internet of Things technology, enterprises can better grasp the various links in the global supply chain, reduce resource waste and energy consumption, and improve the transparency and collaboration of the supply chain. In addition, the Internet of Things also provides enterprises with more personalized and customized products and services to meet the growing needs of consumers.

The collaborative application of smart manufacturing and the Internet of Things has brought new business opportunities and growth points to the global value chain. By integrating smart manufacturing and iot technologies, enterprises can build a more intelligent and efficient global supply chain, optimize resource allocation and advanced upgrades of the industrial chain. In the global economic competition in the digital era, the role and status of intelligent manufacturing and the Internet of Things have become increasingly prominent, providing strong support for the sustainable development of enterprises and the optimization of the global value chain.

4. The Impact of Intelligent Manufacturing on the Global Value Chain

4.1. Application of Intelligent Manufacturing Technology in Supply Chain and Production Process

The application of intelligent manufacturing technology in

supply chain and production process covers many aspects, from the automation of production process to the digitization and networking of supply chain. The following are the applications of smart manufacturing technology in these aspects:

Production automation: Intelligent manufacturing technology automates the production process using automated equipment and robots. Automated production lines and robotic systems can perform repetitive, precision demanding tasks such as assembly, welding and packaging, improving production efficiency and stability.

Data analysis and prediction: Smart manufacturing monitors and analyzes production data in real time through big data analysis and artificial intelligence technology. Such data analysis can help enterprises identify potential problems in the production process, make predictions and adjustments in advance, thereby reducing production risks and optimizing production processes.

Customized production: Intelligent manufacturing technology supports personalized and customized production. Through digital production and flexible production systems, enterprises can customize production according to customer needs and provide products and services closer to the market.

Iot applications: The combination of smart manufacturing and iot technology enables production equipment, tools and products to be interconnected. The application of the Internet of Things can achieve real-time monitoring and remote control of equipment status, and improve the visualization and intelligence of the production process.

4.2. Intelligent Manufacturing Improves Production Efficiency, Reduces Costs and Improves Quality

Improve production efficiency: Intelligent manufacturing technology realizes the automation and digitization of the production process, reducing the intervention of human operations, thereby improving production efficiency. Automated production lines and robots can produce continuously and efficiently, reducing wait times and production cycles during production.

Reduce production costs: The application of intelligent manufacturing technology can reduce labor costs and energy consumption in the production process. The use of automation equipment and robots reduces the reliance on human resources, while data analysis and predictive technology can optimize production plans and reduce resource waste in the production process.

Improve product quality: Intelligent manufacturing technology improves the controllability and stability of the production process through digital production and data analysis, and reduces human errors and defects in production. This can greatly improve the consistency and quality of the product.

4.3. Impact of Intelligent Manufacturing on Global Value Chain Configuration and Organization

Supply chain digitization and networking: The application of smart manufacturing technologies has promoted the digitization and networking of global supply chains. Through intelligent manufacturing technology, all links in the supply chain can achieve real-time data sharing and information exchange, thereby improving the transparency and

collaboration of the supply chain.

Reorganization and cooperation of multinational enterprises: The application of intelligent manufacturing technology enables enterprises in global value chains to reallocate their production networks. Multinational enterprises rationally allocate production resources and optimize production processes on a global scale to achieve optimal allocation of global resources.

Personalized and customized production: The application of intelligent manufacturing technology supports personalized and customized production, meeting the global consumer demand for personalized products and services. In this way, companies can better adapt to the needs of different markets and increase their global market share.

Improve the transparency and responsiveness of the global supply chain: The application of smart manufacturing technology makes the global supply chain more transparent, and enterprises can monitor and track all aspects of the global supply chain in real time. This allows for faster identification of problems and adjustments, increasing the speed and resilience of the global supply chain.

In summary, the application of smart manufacturing technology has a positive impact on the optimization of supply chains and production processes, and has a profound impact on the configuration and organization of global value chains. Through smart manufacturing technology, global value chains can operate more efficiently, intelligently and flexibly, providing strong support for the development and sustainable development of the global economy.

5. The Impact of iot on Global Value Chains

5.1. Application of iot Technology in Logistics, Warehousing and Delivery

Logistics: iot technology can achieve real-time tracking and monitoring of goods, improving the visualization and transparency of logistics. The application of sensors and labels enables logistics companies to track key information such as the location, transportation status and temperature and humidity of goods, so as to better plan transportation routes, reduce latency, and improve logistics efficiency.

Warehousing: The application of Internet of Things technology in warehousing makes the management of goods more intelligent. Automated storage systems can monitor the storage and removal of goods through sensors, improving the utilization of storage capacity while reducing loss and waste caused by human error.

Delivery: iot technology can optimize the efficiency and accuracy of delivery. Iot devices on delivery vehicles can update traffic information and route planning in real time, as well as adjust delivery schedules to get products to their destinations faster and improve customer satisfaction.

5.2. iot Enhances Visibility and Traceability of Global Value Chains

The application of iot technology enhances the visibility and traceability of global value chains, giving businesses and consumers a clearer picture of the products and services in the global supply chain:

Visibility: iot technology enables real-time monitoring and data sharing at all points in the global supply chain. By collecting and transmitting data through iot devices, businesses can gain more comprehensive supply chain

information, understanding real-time status and progress during production, transportation and delivery.

Traceability: iot technology provides unique identification and traceability codes for products and raw materials through the application of sensors and labels. This can trace the origin, manufacturing process and transportation path of the product, ensuring the quality and safety of the product, while improving the traceability of the supply chain.

Risk management: The real-time monitoring and early warning function of iot technology enables enterprises to find potential risks and problems more quickly, take corresponding measures to reduce risks in the supply chain, and ensure the sustainability and stability of the supply chain.

5.3. Impact of iot on Supply Chain Collaboration and Decision Optimization

Real-time collaboration: The application of iot technology enables real-time data sharing and communication across all links in the supply chain. Through the iot platform, information can be exchanged in real time between different participants to make collaborative decisions, improving the synergy and flexibility of the supply chain.

Data-driven decision making: iot technology collects and analyzes large amounts of real-time data to provide a more comprehensive and accurate basis for supply chain decisions. Through data analysis, companies can identify bottlenecks and optimization opportunities in the supply chain and make more scientific and effective decisions.

Prediction and Optimization: iot technologies combine data analytics and predictive algorithms to provide more powerful tools for supply chain optimization. By predicting market demand, the state of goods transportation and the operation of equipment, companies can make more accurate production and distribution plans and optimize the operational efficiency of the supply chain.

In summary, the application of iot technologies in logistics, warehousing and delivery has enhanced the visibility and traceability of global value chains, creating new opportunities and challenges for supply chain collaboration and decision optimization. In the digital era, the wide application of the Internet of Things will continue to promote the upgrading and transformation of the global value chain, providing stronger support for the development and sustainable development of the global economy.

6. Future Development Direction and Prospect

6.1. Future Development Trends of Global Value Chains in the Digital Age

In the digital era, global value chains will continue to be deeply influenced by digital technologies such as smart manufacturing and the Internet of Things, and future trends will show the following characteristics:

Integration of smart Manufacturing and the Internet of Things: Smart manufacturing and the Internet of Things will be more closely integrated to form a more intelligent, efficient and flexible production and supply chain network. Automated devices and robots in smart manufacturing will be connected through the Internet of Things to enable real-time data sharing and coordination between devices, further improving the overall efficiency and intelligence of the global value chain.

Data-driven and AI applications: Data will continue to play a crucial role in global value chains. The application of data

analytics and artificial intelligence technologies will be further deepened to provide more accurate, real-time and predictive support for supply chain decision-making and production optimization, helping enterprises to better respond to market changes and demand fluctuations.

Sustainability and Green Supply chains: The digital age will emphasize the importance of sustainability and green supply chains. The application of smart manufacturing and iot technologies will help optimize resource utilization and reduce environmental impact, driving global value chains towards a more environmentally friendly and sustainable direction.

Cross-border integration and innovation model: The digital era will promote the integration and innovation between different industries, forming a new industrial ecology and business model. The application of smart manufacturing and the Internet of Things will promote the diversification and highly interconnected global value chains, facilitating the rise of multinational and innovative enterprises.

6.2. Future Development Prospects of Intelligent Manufacturing and Internet of Things

Smart manufacturing and the Internet of Things have broad development prospects in the future and will continue to lead the innovation and upgrading of the global value chain.

Intelligent manufacturing: With the continuous development of artificial intelligence, big data and automation technology, intelligent manufacturing will achieve more advanced autonomy and intelligence. Intelligent manufacturing will become a key driver for improving production efficiency, improving product quality and achieving sustainable development.

Internet of Things: The Internet of Things technology will continue to expand its application field to cover more devices and objects. From industry to cities, from homes to transportation, the Internet of Things will realize a full range of connectivity, providing stronger support for the digital and networked development of global value chains.

6.3. Proposals and Strategies for Adapting to the Changes in Global Value Chains in the Digital Age

Invest in digital technologies: Businesses should actively invest in and adopt digital technologies such as smart manufacturing and the Internet of Things. These technologies will be a key element in improving business competitiveness and adapting to changes in global value chains.

Strengthening data security and privacy protection: As the importance of data in global value chains continues to increase, ensuring data security and privacy will become a critical task. Enterprises should strengthen data management and network security measures to ensure the security of data during transmission and storage.

Optimize Supply chain collaboration: Global value chains in the digital age require closer supply chain collaboration. Enterprises should strengthen cooperation with supply chain partners, share information and resources, and improve the coordination and flexibility of supply chain.

Strengthen talent training: The demand for talents in the digital era has changed, requiring talents with digital technology and data analysis ability. Enterprises and educational institutions should strengthen talent training to

train professionals who can adapt to global value chains in the digital age.

Focus on sustainability: When developing global value chains in the digital age, companies should focus on sustainability and green supply chains. Through the application of smart manufacturing and the Internet of Things, optimize resource utilization and environmental impact, and promote the development of enterprises in a more sustainable and environmentally friendly direction.

Overall, the future of global value chains in the digital age will be full of opportunities and challenges. By actively applying smart manufacturing and iot technologies, strengthening supply chain collaboration and talent training, enterprises can better adapt to change, upgrade and transform the global value chain, and achieve more intelligent, efficient and sustainable global industrial development.

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