

Research on the Path of Digital Economy Enabling High-Quality Development of Equipment Manufacturing Industry in Liaoning Province

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ABSTRACT

As the global digital economy rapidly advances, it has become a key driver for global economic restructuring and industrial upgrading. In the face of a new wave of technological revolution and industrial transformation, Liaoning's equipment manufacturing industry is facing significant challenges. This paper analyzes the current challenges confronting Liaoning's equipment manufacturing sector and proposes targeted strategies to explore the enabling pathways of the digital economy for its high-quality development. These strategies not only provide systematic guidance for the industry's transformation but also enhance its competitiveness in the global digital economy. Additionally, the paper emphasizes the critical role of policy and institutional environments in promoting digital transformation, offering valuable insights for policymakers to support the sustainable development and economic transition of Liaoning's equipment manufacturing industry.

KEYWORDS

Digital economy; Equipment Manufacturing Industry; High-Quality Development; enabling pathways

1 Introduction (Heading 1)

In recent years, the digital economy has experienced rapid growth and has become one of the main drivers of global economic expansion. The widespread adoption and application of digital technologies are reshaping the production, operation, and management models of traditional industries. Emerging technologies such as big data, artificial intelligence, the Internet of Things, and cloud computing are providing industries with profound transformation opportunities. The digital economy not only drives the rapid growth of the information technology sector but also transforms traditional manufacturing, promoting its development towards intelligence, sustainability, and connectivity. Major global economies regard the digital economy as a key force in driving national industrial restructuring and high-quality economic development ^[1].

China, as the world's second largest economy, has also made the digital economy a strategic priority for future development. According to the White Paper on the Development of China's Digital Economy, the scale of China's digital economy has exceeded 50 trillion yuan in 2023, accounting for more than 40% of GDP. At the same time, the National 14th Five-Year Plan also clearly puts forward the need to vigorously develop the digital economy, promote the digital transformation of traditional industries, and enhance the intelligent level of the manufacturing industry. As a large industrial province, Liaoning Province in promoting the transformation and

upgrading of the equipment manufacturing industry, the empowering role of the digital economy is becoming more and more important ^[2].

Liaoning Province, as one of China's traditional industrial bases, regards the equipment manufacturing sector as one of its pillar industries, which has long played a key role in areas such as national defense, aerospace, and energy. However, faced with a new wave of global technological revolution and industrial transformation, Liaoning's equipment manufacturing industry is encountering significant challenges. The critical issue now is how to harness the digital economy to enhance the intelligence of its equipment manufacturing sector and drive its high-quality development. This has become a pivotal task in the province's efforts toward industrial transformation and upgrading. Therefore, exploring how the digital economy can empower Liaoning's equipment manufacturing industry, identifying specific pathways and mechanisms, holds not only significant theoretical value but also practical implications for the region's economic development ^[3].

2 Challenges in the Digital Transformation of Liaoning's Equipment Manufacturing Industry

2.1 Insufficient Depth in Technology Application

Although the rapid development of the digital economy and technology has provided new opportunities for the equipment manufacturing industry, Liaoning Province still faces numerous bottlenecks in technology application and innovation. On one hand, the depth and breadth of technology adoption by enterprises remain limited. Many companies are only implementing surface-level digital applications, such as introducing ERP systems or building basic digital workshops, but they lack sufficient investment in core areas like intelligent manufacturing and the development of industrial Internet platforms. On the other hand, some equipment manufacturing companies have a limited understanding of digital technologies, and their planning and implementation of digital transformation are neither systematic nor comprehensive, leading to suboptimal transformation outcomes ^[4].

Moreover, the equipment manufacturing industry in Liaoning is also confronted with barriers in technological innovation. While some leading enterprises are at the forefront of digital technology application, the overall industry's capacity for technological innovation remains weak, particularly in the independent research and development of key core technologies, where there is a heavy reliance on imported equipment and technologies. These technological bottlenecks restrict the depth of digital transformation in the equipment manufacturing sector and hinder the improvement of the industry's overall competitiveness.

2.2 Lagging Business Models and Management

In the platform economy model, many enterprises lack advanced digital platforms, limiting their ability to deliver potential value-added services. A significant number of equipment manufacturing companies still operate under traditional business models and have not fully integrated digital tools, resulting in limited capacity to improve operational efficiency and respond to market changes. Additionally, insufficient trust between companies reduces their willingness to share resources, while a lack of systematic resource allocation makes coordination challenging. Technical barriers, such as inconsistent data standards and poor information flow, further constrain the advantages of shared manufacturing ^[5].

Moreover, the inadequate digitalization of customer relationship management weakens

companies' ability to establish long-term, close cooperation with clients. Without effective customer management systems, enterprises struggle to obtain timely customer feedback, leading to reduced customer loyalty and satisfaction, which ultimately impacts the sustainability of profits. The failure to build core competencies in data analysis and customer insights diminishes companies' ability to provide personalized services, limiting the expansion and retention of long-term customer resources.

2.3 Insufficient Industrial Chain Collaboration

Liaoning's equipment manufacturing enterprises have made slow progress in developing digital supply chain platforms and advancing intelligent manufacturing, leading to inefficient collaboration across the industrial chain. This inefficiency has significantly undermined the overall competitiveness of the industry. The lack of a unified digital platform results in poor communication between companies, with prominent information silos hindering the effective sharing of resources and the coordinated management of production planning across upstream and downstream enterprises. Consequently, this lack of efficient information exchange within the supply chain prolongs production cycles, increases inventory backlogs, and causes delivery delays, ultimately affecting customer satisfaction and slowing market responsiveness. Furthermore, the application of intelligent manufacturing technologies is still insufficient. Many enterprises have not fully leveraged digital tools to implement automated production and intelligent collaboration, which hinders improvements in production efficiency and cost reduction. Some companies continue to rely on traditional manual operations and have yet to adopt advanced automation equipment and intelligent systems.

2.4 Lack of Strategic Guidance and Information Sharing

The absence of systematic policy guidance has led to unclear strategic goals and undefined pathways for enterprises undergoing digital upgrading. While governments at various levels and industry associations recognize the importance of digital transformation, they often fall short in providing detailed, targeted strategic guidance at the operational level. For example, the digitalization implementation paths vary significantly for companies of different types, sizes, and industries. However, existing policies are often too generalized and fail to offer tailored guidance based on the specific needs of individual enterprises. This lack of policy direction leaves many companies uncertain about which areas to prioritize in their digital upgrades, causing inefficiencies in resource allocation and delays in transformation efforts^[6]. In addition, inconsistent technological standards among enterprises and the lack of effective communication mechanisms have made seamless information and data integration difficult, leading to the creation of "information silos." This silo effect not only hampers the integration of internal systems within companies but also limits inter-company collaboration, particularly in key areas such as supply chain management, product development, and market responsiveness.

3 Pathways for the Digital Economy to Empower Liaoning's Equipment Manufacturing Industry

3.1 Technology-Driven Pathways

3.1.1 Application of Artificial Intelligence (AI) in the Equipment Manufacturing Industry

As a key technological pillar of the digital economy, artificial intelligence (AI) has been widely

adopted in the equipment manufacturing sector, particularly in areas such as intelligent manufacturing, predictive maintenance, and production optimization. In Liaoning Province, many equipment manufacturing companies are leveraging AI technology to improve production efficiency and product quality. For instance, AI can assist enterprises in real-time data analysis during the production process, automatically adjusting the operation of manufacturing equipment, optimizing workflows, and reducing production errors ^[7].

In specific use cases, AI-driven intelligent manufacturing systems can apply machine learning and deep learning algorithms for fault prediction and equipment maintenance. For example, Shenyang Machine Tool Group has implemented AI technology for predictive maintenance management of its production equipment, significantly reducing unplanned downtime and enhancing production efficiency. Through AI-powered algorithms, companies can achieve real-time monitoring of equipment conditions and predictive maintenance, minimizing production interruptions due to equipment failures and lowering operational costs.

3.1.2 Internet of Things (IoT) Driving Equipment Connectivity and Production Coordination

The application of Internet of Things (IoT) technology in the equipment manufacturing industry provides robust support for equipment connectivity and production coordination. Through IoT, production equipment can achieve real-time data interconnection and sharing, enabling highly automated production systems that reduce human intervention and enhance the level of production intelligence. For example, some equipment manufacturing companies in Liaoning Province have used IoT technology to enable remote monitoring and automated operations of production equipment. This not only improves the flexibility and adaptability of production lines but also significantly reduces labor costs ^[8].

IoT technology also allows companies to exchange real-time data with upstream and downstream enterprises in the supply chain, increasing responsiveness and coordination efficiency. For instance, through sensors and networks, companies can monitor raw material inventory and production needs in real-time, facilitating seamless collaboration with suppliers. This IoT-based supply chain management system helps enterprises achieve precise production, reduce inventory backlogs, and enhance overall operational efficiency.

3.2 Pathways for Business Model Innovation

3.2.1 Value Chain Extension and Diversification

Through the platform economy and shared manufacturing, equipment manufacturing enterprises can extend and diversify their value chains. Under the platform economy model, companies can generate profit not only from product sales but also by offering value-added services such as equipment leasing, maintenance, and data analytics, thus expanding revenue streams. For instance, a Liaoning-based equipment manufacturing company leveraged a digital platform to offer data-driven production optimization services to its clients, combining products with services and opening new revenue sources. The shared manufacturing model also creates new profit opportunities, as companies can generate additional income by renting out idle equipment or offering shared production capacity services. This diversification of revenue models enables companies to be more resilient in the face of market fluctuations.

3.2.2 Transformation of Customer Relationship Management

The implementation of new business models allows equipment manufacturing enterprises to

better manage customer relationships. Through the platform economy, companies can establish direct digital connections with customers, enabling them to promptly understand customer needs and offer personalized services. This customer-centric business model helps companies enhance customer loyalty and satisfaction, ultimately increasing customer value. In the shared manufacturing model, collaboration with customers during the production process fosters closer relationships. For example, a Liaoning manufacturing company collaborated with its customers to co-develop customized products, resulting in long-term strategic partnerships, which helped secure stable customer resources and ensure sustainable profitability.

3.3 Pathways for Industrial Chain Collaboration

3.3.1 Establishing a Digital Supply Chain Platform

Creating a unified digital supply chain platform is fundamental to achieving industrial chain collaboration. This platform can integrate information on production, logistics, inventory, and procurement from upstream and downstream enterprises, enabling resource sharing and collaboration. With such a platform, companies can access real-time production and demand information from upstream and downstream partners, allowing for timely adjustments. Liaoning Province can draw from the experiences of advanced companies both domestically and internationally to establish a regional digital platform centered around the industrial chain, facilitating efficient collaboration between various stakeholders. For instance, blockchain technology can be introduced to ensure data security and transparency, establishing a trusted digital platform for seamless information flow between enterprises^[9].

3.3.2 Promoting Smart Manufacturing and Collaborative Production

Smart manufacturing is a key pathway to achieving industrial chain collaboration in the equipment manufacturing industry. By adopting smart manufacturing technologies, companies can automate and optimize their production processes, thereby improving production efficiency and enhancing collaboration across the industrial chain. Through a digital platform, enterprises can share production plans and order information, enabling collaborative production, optimizing resource allocation, and reducing waste in the production process. For example, a Liaoning-based equipment manufacturing company implemented a smart production system that enabled intelligent collaborative production with its supply chain partners. The system can automatically adjust production schedules and coordinate with suppliers in real-time, ensuring continuity and efficiency in the production process.

3.3.3 Strengthening Policy Support and Standardization

Government policy support is crucial to driving industrial chain collaboration. Liaoning Province should introduce a series of policy measures to encourage enterprises to undertake digital transformation and industrial chain collaboration, including tax incentives, financial support, and technology innovation rewards. In addition, efforts should be made to establish unified digital standards to ensure that the systems and platforms of upstream and downstream enterprises are interoperable. Through policy guidance and standardization, the government can create a favorable environment for collaboration within the equipment manufacturing industry, driving the efficient development of the industrial chain. For example, Liaoning could follow the successful experiences of other regions by issuing special policies to support the intelligent upgrading of the equipment manufacturing sector, accelerating digital transformation and collaborative innovation across the

industrial chain.

3.4 Enabling Paths in the Policy and Institutional Environment

3.4.1 Issuing special policy documents

The government should actively formulate and release special policy documents to clarify the strategic goals and directions of digital transformation. These policy documents should cover key areas of digital technology application, such as smart manufacturing, cloud computing, big data and IoT, to help enterprises identify the key direction of their own transformation. Policies can include industry analysis, sharing of successful cases and guidance on technology application, thus providing enterprises with a clear framework for action. In addition, the government can help enterprises assess their own digitization level and development needs by setting up digital transformation consulting services, incentivizing the industry to accelerate its transformation, and promoting the tilting of social resources towards the digital field^[10].

3.4.2 Develop and promote technical standards

The government should take the lead in formulating and promoting a series of technical standards adapted to digital transformation to ensure that systems, data and information can be seamlessly connected among equipment manufacturing enterprises. By establishing a unified standards framework, enterprises can exchange information and share resources more efficiently and reduce losses caused by information silos. In addition, drawing on international standards, especially in the areas of data security, interoperability and smart manufacturing, can effectively enhance the position and competitiveness of Liaoning enterprises in the global industrial chain and help them integrate into the global market.

4 Conclusion

The empowerment of the digital economy on the equipment manufacturing industry in Liaoning Province is a multi-dimensional and multi-level process that requires the joint efforts of the government, enterprises and all sectors of society. This study discusses in depth how the digital economy empowers the high-quality development of equipment manufacturing industry in Liaoning Province, and puts forward a series of targeted path choices. Through the implementation of the path choices put forward in this paper, the equipment manufacturing industry in Liaoning Province is expected to realize the transformation from traditional manufacturing to intelligent manufacturing, improve the overall competitiveness of the industry, and promote the continuous innovation and development of the equipment manufacturing industry in Liaoning Province in the context of the global digital economy.

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