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Study on the Mechanism, Innovative Pathways, and Countermeasures for Driving Green Upgrading of Energy Industry by Digital Economy in Liaoning Province

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Abstract: This paper studies the empowerment mechanisms, innovative pathways, and countermeasures of digital economy in driving the green upgrading of the energy industry in Liaoning Province. First, the paper analyzes the innovative mechanisms, talent mechanisms, and structural mechanisms of digital economy in driving the green upgrading of the energy industry in Liaoning Province. Then, based on the theory of digital empowerment, the paper explores the development model of energy industry intelligent green upgrading in Dalian, and takes IBM's digital transformation as an example to provide insights into how digital economy drives industrial transformation and upgrading. The paper also constructs a measurement model to empirically verify the impact and pathways of digital economy on the green upgrading of the energy industry. Finally, it proposes countermeasures such as relying on digital economy to drive the intelligent upgrading of industries, promoting the construction of intelligent industrial management systems, and building a complete digital empowerment capital support system to promote the digitalization, intelligentization, and high-end development of the energy industry in Liaoning Province.

Keywords: Digital Economy, Green Transformation of the Energy Industry, Intelligent Development, Innovation Pathways, Industrial Policy

1. Introduction

Under the new industrial revolution led by digital technology, the digital and intelligent development of industrial systems, along with green and service-oriented trends, is reshaping global industries and competition[1]. Achieving intelligent and digital upgrades for industrial systems has become the "main theme" of China's economic transformation and high-quality development. Digitalization and intelligence are key directions for upgrading the energy industry[2,3]. Improvements in product design, information resource management, planning control, and automation all rely on advancements in digital information technology.

According to the 《National Informatization Development Evaluation Report (2020)》, developed countries have higher digitalization levels, ranking at the global forefront[4]. In 2020, the informatization development indices for the U.S., U.K., and Japan were 84.1, 82.7, and 81.5, respectively, while China's was only 72.8. This shows that lagging IT development has become a major obstacle to upgrading China's traditional energy industries. China introduced the 《Made in China 2025》 plan in 2015 and the 《14th Five-Year Plan for Smart Manufacturing Development》

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in 2021, both encouraging green innovation in the energy sector. For Liaoning Province, green upgrades in energy industries are essential for high-quality economic growth, but challenges remain: insufficient R&D funding and weak digital economy mechanisms reduce motivation for green upgrades, and most energy companies lack long-term plans for green transformation.

2. Research on the empowering mechanism of the digital economy driving the green upgrading of the energy industry in Liaoning province

2.1. The innovation mechanism of the digital economy driving the green upgrading of the energy industry in Liaoning province

With the development and application of digital technologies, the global energy industry has gradually been connected through networks, forming a closer "digital economy - energy industry" community[5,6]. In the era of the digital economy, informatization and digitization have been presented to countries around the world[7]. People have gradually discovered that the close connection between digital technologies and the energy industry can change the existing energy consumption patterns, providing a more efficient and energy-saving development model for the green economic development of various countries[8]. Since entering the new century and joining the World Trade Organization, China has been more closely linked with the economies of other countries in the world. The diffusion of advanced technologies brought about by the opening-up policy has benefited China a great deal. The economic prosperity has also made the Chinese government value the significance of science and technology for China's development even more[9]. With the intensifying global competition situation, China has increasingly realized the practical significance of mastering core technologies for the green upgrading and development of its own energy industry[10,11].

During the process of China's transformation from Industry 2.0 to Industry 3.0, Liaoning Province has increased its policy support for green technology innovation and focused on supporting the transformation and upgrading of traditional energy enterprises by the digital economy. On the one hand, the digital economy is conducive to the efficient dissemination of emerging energy technologies, helping to improve the production efficiency of industries and the technological content of products, and realizing the two-way structural "empowerment" of regional industrial digitization and digital industrialization[12]. On the other hand, in the development practice of China's "digital technology + new business forms", the digital economy has strengthened the formation of new business forms such as blockchain, cloud manufacturing, and Internet +[13,14]. To a large extent, it has broken the time and space constraints of information exchange, and also improved the innovation integration efficiency of upstream and downstream enterprises in the energy industry, helping the energy industry to transform and upgrade from "conventional" innovation to "structural" innovation[15,16].

2.2. The talent mechanism of the digital economy driving the green upgrading of the energy industry in Liaoning province

It can not only promote the comprehensive upgrading of the energy industry structure but also help the industry achieve green and high-end development[17]. At present, the government's talent incentive policies for research institutions such as schools are more than the subsidy policies for innovative talents within enterprises[18,19]. And the transformation of the technical achievements of schools into the technical main body of enterprises requires many authorizations and restrictions, which to a certain extent hinders the spread and diffusion of green technologies applicable to energy enterprises and slows down the process of energy enterprises using low-carbon technologies for production[20].

At present, the traditional energy industry in Liaoning Province is facing four major problems: poor professional qualities of workers, insufficient supply of specialized and compound talents, lack

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of capabilities of marketing and management professionals, and low employee loyalty with high mobility. As a major national development strategy, the digital economy can empower the cultivation of technical, compound, and new professional talents required for the green upgrading of the energy industry. Firstly, the digital economy can promote the energy industry to build a multi-level R&D talent cultivation system and establish a continuous professional development path for R&D talents[21]. Secondly, digital energy can achieve efficient project cooperation and academic exchanges between research institutes of energy enterprises. By giving full play to the professional research strength of universities and scientific research institutes and establishing in-depth cooperation between schools and enterprises in professional talent cultivation, it is of great benefit to promoting the continuous professional development of enterprise R&D talents[22]. Finally, the energy industry in Liaoning Province is in a critical period of green, intelligent, and high-end development transformation and upgrading. The talent elements induced by the digital economy have gradually undergone profound changes, promoting low-carbon technology professionals to be more oriented towards market demands, carrying out scientific research activities based on the actual problems faced by the green upgrading of the energy industry, and maximizing the support for the transformation and upgrading of the energy industry.

2.3. The structural mechanism of the digital economy driving the green upgrading of the energy industry in Liaoning province

At the present stage, there are certain deficiencies in both the internal organizational structure and the operation and management mode of the traditional energy industry in Liaoning Province. It is mainly manifested that the organizational structure of the traditional energy industry lacks a certain degree of flexibility, and it is difficult to have good cooperation and communication with other strategic emerging industries, resulting in poor coordination among enterprise departments. The digital economy can help the energy industry achieve clean production and green manufacturing, and promote the green development of the industry with high-quality, high-tech, and high-value-added new energy output, which is also one of the important policy focuses for Liaoning Province to build a "green" energy industry system[23]. According to the current development situation of the traditional energy industry in our province, the structural mechanism generated by the digital economy can drive the green upgrading of the energy industry from four aspects: first, it promotes the upgrading of the industrial structure. Due to the "low-end" characteristics of the traditional energy industry structure, the cost-output efficiency of enterprises is low. And the digital economy, due to its high-value-added attribute, can optimize the industrial structure, promote the transformation of the energy industry towards high-end and intelligent directions, and gradually eliminate backward production capacity; second, the flexibility of the organizational structure of energy enterprises[24]. The organizational structure of the traditional energy industry lacks a certain degree of flexibility, while the digital economy can make the organizational structure flexible, which is conducive to improving the adaptability of enterprises to the external environment and also conducive to improving the efficiency of green production; third, the networking of the internal industrial structure. Through digital technologies, the internal networking of the organizational structure can be realized, which is conducive to the communication among enterprise employees and the collaborative effect within the enterprise; fourth, the rationalization of the internal industrial structure. As the most important strategic deployment during China's 14th Five-Year Plan period in the information age, the digital economy can maximize the frictionless flow of innovation elements among upstream and downstream enterprises in the energy industry, adjust and optimize the proportion of innovation elements among departments, and promote the flow of high-quality talents and R&D capital from low-efficiency industrial departments to high-efficiency departments, thereby promoting the optimization of

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resource allocation and coordinated development of the energy industry departments and empowering the overall high-quality development of the energy industry in Liaoning Province.

3. Research on the development model of intelligent green upgrading in Dalian's energy industry based on digital empowerment theory

3.1. Theoretical analysis of development models driven by digital economy for intelligent green upgrading of energy industry

Dalian's energy industry currently exhibits a development model characterized by extensive operations, high energy consumption, and high emissions. The coordinated relationship between the development of the digital economy and the intelligent green upgrading of the energy industry represents a critical challenge for achieving high-quality economic development. Based on the theories of digital empowerment and development economics, the interactive development of the digital economy and the energy industry can be categorized into four models: the "Government-Led" model, the "Industry-Dependent" model, and the "Industry-Complementary" model.

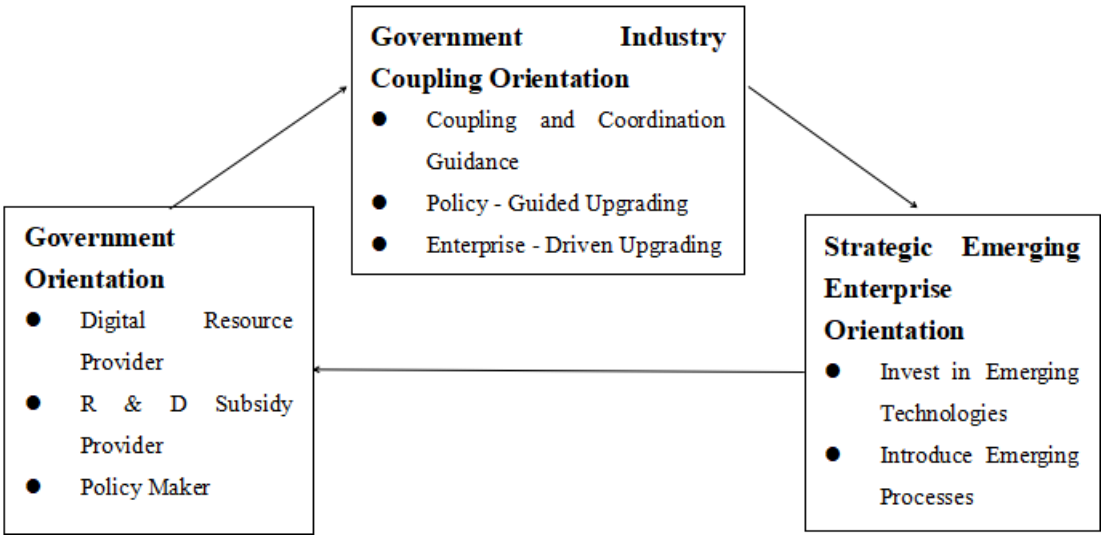

Figure 1: Development model of intelligent and green upgrading in the energy industry driven by the digital economy

Government-Driven Intelligent Green Upgrading Model for the Energy Industry. The government promotes the construction of digital and intelligent emerging energy industry technology parks to provide a better incubation environment for high-tech green energy enterprises[25]. Simultaneously, preferential policies are selectively implemented for enterprises within these parks, guiding the establishment of industrial clusters and enhancing regional competitiveness, which aids in the green upgrading of the energy industry. Furthermore, the diffusion of green energy technologies under this model is guided by the preferential policies within the parks, with small and medium-high-tech new energy enterprises as the main body, facilitating technological diffusion within the energy industry. Strategically Emerging Enterprise-Oriented Intelligent Green Upgrading Model for the Energy Industry. Under the mechanism of digital economy empowerment, strategically emerging industries collaborate with energy enterprises in research and development to drive innovation, thereby achieving improvements in the production processes and technological innovation of traditional energy industries. Specifically, through technical and product cooperation, high-tech "new" energy enterprises can reduce the constraints on traditional energy enterprises' utilization of emerging technologies and alleviate difficulties in introducing new technologies. Traditional energy enterprises

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may even benefit from "free riding," gaining additional advantages that significantly enhance their equipment renewal and low-carbon technological innovation capabilities.

Government-enterprise coupling leads to the intelligent green upgrade model of the energy industry. Essentially, the government-enterprise coupling-oriented model is a comprehensive superposition of the above patterns. At this stage, there are still imperfections in the energy technology market in Dalian, which is mainly manifested in poor information circulation, non-standard market order, poor sense of competition and other problems, so it is necessary for the government and emerging energy enterprises to coordinate and cooperate, actively mobilize the enthusiasm of traditional energy enterprises to adopt low-carbon technology and green production technology, bear the cost risks such as the diffusion and transfer of green technology technology, and provide professional services for traditional energy enterprises by the government, and reduce the emergence of "trust crisis" and "lemon market" situation of energy enterprises.

3.2. Successful cases of digital economy driving industrial transformation and upgrading

IBM(International Business Machines Corporation)Founded by Thomas Watson in 1911 in the United States, with a history of more than 100 years, IBM's development history has mainly achieved four major transformations, from the initial punch card data processing equipment as the main business to the world's largest computer manufacturer, and then transformed into the world's largest information technology and business solutions service provider, and later transformed into a cognitive solutions and cloud platform company in early 2016, realizing the first time to position itself as a platform company. IBM in the mid-90s of the 20th century to develop a transformation strategy from the traditional manufacturing industry to the software service industry, during this period, IBM acquired Lotus Software, PricewaterhouseCoopers Consulting, acquired Tivoli, and from 2004 to carry out the gradual separation of the original hardware business, has the personal computer business, printer business, X86 server hardware and other businesses from the value chain separation, and gradually to provide customers with high-quality consulting services and software business transformation. Among them, the specific transformation process of IBM can be represented in Figure 3.2.

As can be seen from Figure 3.2, in the 90s of the 20th century, IBM was forced to look for a way out of the transformation due to a serious financial crisis. After the company's internal analysis and market research, it was found that there is a large demand market for dealing with complex hardware and software integration problems through digital and systematic overall solutions, so IBM took this as the entry point to find high-quality service providers. In the process, IBM first acquired Lotus Software to provide customers with high-quality intelligent collaboration solutions, then acquired Tivoli and provided intelligent infrastructure management solutions to other companies using IBM products, and later IBM acquired PricewaterhouseCoopers Consulting to further improve its digital and intelligent operation capabilities. Therefore, in the early stage, IBM expanded its service business scope through continuous acquisitions and mergers and acquisitions, and realized the process of gradual transformation to "intelligent manufacturing" services. In the later period, IBM began to strip and integrate its own development business, first in 2004, IBM sold the loss-making computer business to Lenovo Group, in 2006, the printer business that began to develop was sold to Ricoh, and in 2014, IBM once again sold X86 server hardware to Lenovo, making IBM the world's largest digital technology and business solution service provider. Until 2016, IBM announced the transformation into a cognitive solutions and cloud platform company, realizing the continuous integration of the original business, integrating the global business consulting department and sales department into the global industry department, and integrating other departments into the IBM cognitive solutions and cloud business (big data, cloud computing, blockchain) department, successfully realizing IBM's fourth transformation.

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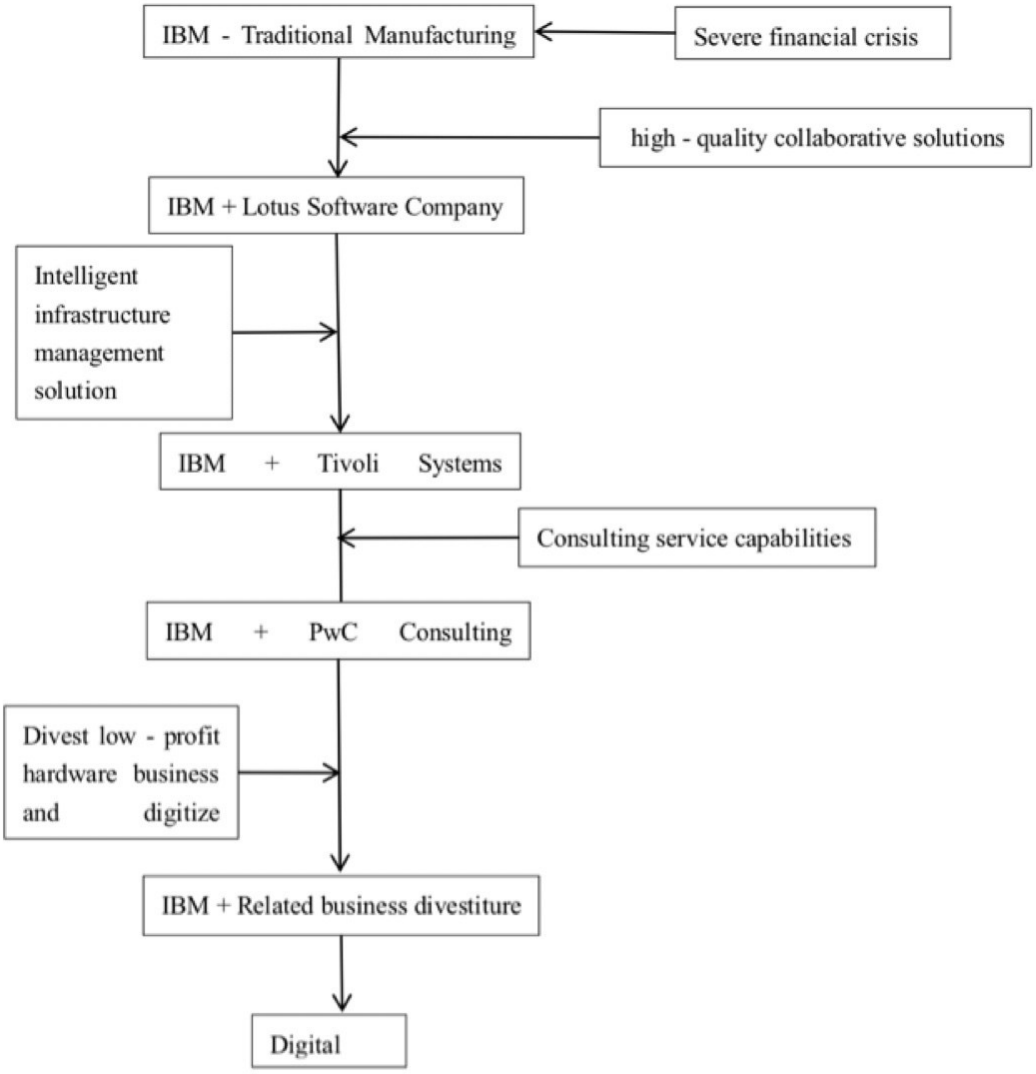

Figure 2: Development pathway of IBM's digitalization and intelligentization

3.3. Insights from case studies on the role of digital economy in driving industrial transformation and upgrading

Taking IBM as a case study, this paper analyzes how traditional industries can transform and upgrade to digital and intelligent emerging industries with the help of the digital economy, and the enlightenment for promoting the intelligent and green upgrading of the energy industry can be summarized as the following three experiences:

First, the new development pattern of the digital economy and the "dual carbon" goal is the driving force for the endogenous development of the intelligent and green transformation and upgrading of the energy industry. With the increasing importance of the digital economy in China's economic development, the profit margins of traditional energy enterprises are gradually shrinking, so in order to achieve green and sustainable development, energy enterprises must realize the application and integration of emerging digital technologies, and jointly create value for enterprises and customers by providing customers with intelligent and personalized high-quality energy output services. For example, through repeated market research and research, IBM found that customers need more digital and intelligent solutions to deal with the integration of software and hardware.

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Second, the continuous "digital innovation" capability of energy enterprises is the basis for realizing the intelligent and green transformation and upgrading of their industries. Whether it is for the energy industry itself or the development of its upstream and downstream industries, the ability of "digital innovation" is the key to keeping up with the development wave of digital and intelligent industries. In the context of the vigorous development of the digital economy, traditional energy enterprises can only respond to and meet customer needs in a timely manner if they have certain innovation capabilities and R&D teams, and realize the improvement of the final added value of the manufacturing industry through innovation in green product research and development. For example, in the process of transformation and upgrading, IBM has built an innovation platform to promote enterprises to improve their technological innovation capabilities and enhance their value through the integration of internal and external scientific research resources in the industrial chain.

Third, the construction of a digital network platform is a means to realize the intelligent and green transformation and upgrading of the traditional energy industry. With the increasing communication and interaction between industries, the collaboration between enterprises is becoming more and more important, so many enterprises use digital network platforms to achieve more professional division of labor and cooperation between enterprises, and realize the effective allocation of resources, which is more conducive to reducing costs and enhancing competitiveness. For example, IBM uses a network platform for service and marketing, and realizes the integration of resources between enterprises through more comprehensive data.

4. Research on the innovative path of digital economy empowering the intelligent development and green upgrading of dalian's energy industry

Theoretical analysis of the implementation path of green upgrading in the energy industry empowered by the digital economy

One of the core issues that need to be addressed for the intelligent development and green upgrading of Dalian's energy industry under the background of digital economy is through which innovative path the digital economy affects various production links in the energy industry value chain. Based on the perspective of industrial value chain theory and combined with the current development status of the energy industry in Liaoning Province, the digital economy can drive the green upgrading of the energy industry through technological upgrades, cost savings, and configuration optimization.

(1) Technological upgrade path

The digital economy drives the green upgrading of the energy industry through technological upgrades. Essentially, the digital economy can improve the overall green production rate of the traditional energy industry by adjusting and optimizing the input structure of production factors, enhancing management and organizational capabilities, and improving technological innovation capabilities. On the one hand, the digital economy can enable low-end energy enterprises to learn about the development information and technology of emerging industries, providing high-quality services and a solid foundation for their technological upgrading. On the other hand, the digital economy can achieve the construction of a virtual agglomeration platform for energy enterprises. Through modular service innovation, enterprises can re select and configure different market demands, thereby improving their green productivity.

(2) Cost saving Path

For the energy industry that urgently needs transformation and upgrading, the spillover effects generated by the digital economy can promote the flow of cutting-edge knowledge and high-end technology into the traditional energy industry, saving information search costs for enterprises and supporting their green transformation and upgrading. The digital economy can effectively alleviate the problem of information asymmetry between upstream and downstream enterprises in the energy

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industry, improve the efficiency of knowledge spillover and the quality of information transmission within and outside the industry. The "network externality" brought about by the digital development of industries can effectively strengthen the utilization efficiency of related digital infrastructure in the energy industry, reduce the cost of industrial green upgrading and technology introduction, and provide better digital information services for industrial transformation and upgrading.

(3) Configure optimization path

The digital economy can empower the energy industry to achieve large-scale integration of production factors and input resources, reducing and improving resource mismatches, building network information platforms to meet personalized needs of different customers, and improving production capacity utilization efficiency and quality. On the one hand, through digital information services, traditional energy can be produced through large-scale network cooperation, shortening the green transformation cycle of products and responding to low-carbon market demand. On the other hand, the digital economy can encourage upstream or downstream industries to adopt emerging digital technologies, providing high-end and versatile talents for energy enterprises, enhancing resource allocation efficiency, and helping traditional energy enterprises in Liaoning Province achieve output upgrading. In addition, the digital economy is also conducive to improving data sharing and collaborative innovation mechanisms among enterprises, providing strong technical and knowledge support for the green upgrading of the energy industry.

5. Research on the innovative path and countermeasures for empowering the intelligentization of Dalian's industries through digital economy

5.1. Rely on the digital economy to promote the intelligent upgrading of industries

First, leverage the digital economy to promote the deep integration of industrial digitalization and digital industrialization, and adjust and optimize the industrial structure of Dalian. Currently, Dalian is in the early stage of industrial intelligence development, and enterprises in the upstream and downstream of the industrial chain still have problems such as weak digital economy thinking and unclear upgrade paths. Especially, the new digital infrastructure that underpins the development of the digital economy in Dalian is still in the stage of construction and improvement, and there is still a significant gap compared with regions with advanced digital "new infrastructure". Therefore, the government at all levels in Dalian should, based on the actual needs of industrial development within the region, deepen and expand the application of the digital economy in the development and upgrading of various industrial sectors, and use advanced digital technologies to enhance the technological content of products, promoting high-quality development of Dalian's industries.

Second, build a complete industrial innovation system and improve the efficiency of the flow of innovation elements. Against the backdrop of the vigorous development of the digital economy, digital technologies and digital infrastructure can promote the upgrading of regional industrial structure by enhancing the flow of innovation capital and talent. As an important strategic development for China's economy to shift from "resource-driven" to "innovation-driven", the digital economy has significantly improved the efficiency of the flow of innovation elements among regions. On the one hand, the government should provide institutional guarantees for the stable development of the innovation system and solve the problem of insufficient flow of innovation elements caused by the digital "gap" among regions. On the other hand, each region should use the development of the digital economy to enhance the quality of industrial innovation and the efficiency of resource allocation, and explore a development model that can not only achieve structural optimization through "innovation" but also promote a win-win situation between "emerging" and "traditional" industries in the region with the help of digital technologies.

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Third, take the digital economy as a "breakthrough point" to promote the digitalization, intelligence, and high-end development of Dalian's industries. The rapid improvement of China's digital economy level has enabled industrial development to gradually break through the constraints of time and space. The transaction methods have changed from traditional face-to-face transactions to complex and diverse networked transactions. Many problems that hinder the upgrading of the industrial structure, such as information asymmetry, high transaction costs, and low communication efficiency, have been solved one by one by digital technologies. Therefore, local governments in Dalian should increase the development efforts of the digital economy, rely on digital information technologies to save the information search and communication costs between industries, improve product quality and customer experience, and promote the formation of more market-competitive high-end manufacturing models such as "intelligent manufacturing" and "service-oriented manufacturing" among industries. This will maximize the driving role of the digital economy in promoting the intelligent development of industries and ultimately achieve the comprehensive upgrading of Dalian's industrial system.

5.2. Promoting the construction of a management system for empowering industrial intelligence through digital economy in Dalian

Since the central government proposed the concept of sustainable development, Dalian has been committed to the governance direction of empowering industrial intelligence through the digital economy, taking the lead in actively taking measures to improve the quality of intelligence from both enterprises and the public. However, from the current policies and industrial governance measures implemented, the management system for empowering industrial intelligence through the digital economy is still not perfect. A complete management system should be an organic whole that includes government, enterprises, administrative institutions, and other social organizations as well as consumers.

All responsible entities should have a common goal, which is to promote industrial intelligence and enhance industrial competitiveness. The government, as the policy-making body, should play an auxiliary and supervisory role, but the current plan relies entirely on the government's sense of responsibility to restrain all parties from relying on and destroying traditional models. Therefore, the research team believes that a complete management system should be established from the following aspects: First, the transformation of awareness among all parties. From the perspective of enterprises, while the government formulates measures for intelligent development, it should strengthen the education on the concept of economic responsibility, enhance their awareness of intelligent development, and truly change their wrong notion of only focusing on profits and not on innovative development in terms of thinking.

Secondly, the industry differences in policy formulation. Dalian's economy has developed rapidly relying on heavy chemical industry, but heavy chemical industry is precisely the biggest challenge in intelligent transformation. However, for different industries, their demands for intelligent transformation are not the same, and the impacts on industrial upgrading also have their own characteristics. In the face of unified development standards, there may be unbalanced transformation practices in various regions. Therefore, the research group believes that the goals of intelligent transformation should be set according to the specific production models of industries, and the progress of intelligent transformation in each industry should be restricted, so as to achieve the goal of precise governance. The government should combine regional differences with industry differences, and integrate geographical and economic factors into an intelligent system for consideration, so as to truly achieve effective governance of intelligent transformation.

Thirdly, build a reasonable evaluation system. In the actual assessment process, there are some enterprises that report false figures to meet the intelligent standards, which has a significant impact

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on the substantive implementation of intelligent work and greatly reduces the implementation of the intelligent policies formulated by the state. Therefore, in addition to the aforementioned policy formulation should have regional and industry characteristics, the research group believes that the construction of a reasonable evaluation system also needs to consider regional differences, and select appropriate evaluation indicators and assessment methods. In addition, in the intelligent performance assessment system, the participation of the public in intelligent evaluation should be strengthened, and the enthusiasm and supervisory power of the people should be fully utilized, so that all regions can fully implement the various policies of the central government and achieve the intelligent goals without damaging the economy and the quality of people's lives.

Finally, strengthen administrative supervision and punishment. The government, on the one hand, is the subject of policy formulation, and on the other hand, it is also the subject of policy implementation supervision. Whether the intelligent goals can be achieved fundamentally depends on whether the government's supervision is in place during the policy implementation process. It is necessary to start from a strict supervision system to avoid the occurrence of enterprises adhering to backward industrialization behaviors, and truly defend the intelligent achievements from the supervision system.

5.3. Build a complete digital economy empowerment capital support system

In promoting enterprises to carry out technological innovation and promoting industrial intelligence, the government not only takes administrative measures to restrain enterprises to reduce their reliance on traditional models, but also uses fiscal policies such as fiscal expenditure and tax preferences to strengthen financial support for enterprises, in order to accelerate the intelligent pace of industries from both the innovation environment and financial support. It can be seen that building a complete digital economy empowerment capital support system is of great significance for the industrial transformation and upgrading of Dalian. To this end, the research group believes that we should start from the following aspects.

First, give full play to the supporting role of fiscal expenditure. In the previous analysis process, it can be seen that although the total expenditure on research and development in Dalian is constantly increasing, compared with developed countries and regions, the proportion of research and development expenditure in total fiscal expenditure is still slightly low, and there are certain deficiencies in the expenditure structure and usage structure of research and development funds. Science and technology are the fundamental driving force for the sustained and healthy growth of Dalian's economy and the fundamental force for promoting industrial intelligence and achieving economic transformation. Therefore, in order to effectively promote the orderly development of digital economy empowerment in Dalian and inject strong impetus into the intelligentization of Dalian's industries, the government should increase fiscal expenditure, enhance financial support for enterprises' research and development expenses, adjust the proportion of fiscal expenditure in the use of research and development expenses, improve the rationality of the structure of research and development expenditure in Dalian, encourage enterprises to actively conduct technological research and development, so that enterprises not only have sufficient freedom in the use of funds but also enjoy certain rewards for research and development achievements, and ensure the legitimate and reasonable rights and interests of innovative enterprises through the implementation of patent law, providing sufficient protection for innovation subjects during the research and development process.

Secondly, formulate differentiated tax preferential policies. In the current tax policies of our country, most policies are implemented in the post-event stage, which has a certain time lag in governance. However, the generation and diffusion of dependence have the characteristics of rapid time and significant impact. This requires the government to have a deep understanding of the current situation in the governance process, establish a clear and definite orientation for the specific

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intelligentization goals to be achieved, and have detailed planning for the governance standards to be reached, so as to be able to formulate differentiated tax preferential policies for different regions and industries. Among them, through the reasonable allocation of tax division ratios, the income sources of local governments can be broadened, the enthusiasm of local governments for governance can be mobilized, the awareness of local governments in developing intelligent industries can be enhanced, the attention of local governments to China's intelligentization cause can be increased, and the determination of local governments to achieve intelligentization goals can be strengthened, so that local governments can better cooperate with the central government to win the intelligentization defense battle.

Finally, expand the sources of enterprise funds and reduce the financing barriers for enterprises to achieve intelligentization. Technological innovation by enterprises requires strong financial support, and thus financing has become one of the important issues for enterprises. National fiscal expenditure can only play an auxiliary role in the innovation research of enterprises and cannot be the main source of funds for enterprises' innovation activities. If Dalian wants to promote the intelligentization of industries, it must promote technological innovation by enterprises. To achieve the transformation of the production mode of enterprises, a relaxed financing environment must be provided for enterprises, allowing them to rely on themselves to achieve the transformation goals through the operation of funds. According to the current policies in our country, the state has not implemented too many encouraging policies for enterprise financing. If enterprises want to obtain sufficient research and development funds, they must seek loans and other means. However, in the actual financing process, banks tend to lend funds to large enterprises with high credit and scale, while small and medium-sized enterprises do not have the financing advantages of traditional channels. This undoubtedly forms an invisible constraint on the innovation activities of enterprises, especially small and medium-sized private enterprises. With the development and application of Internet technology, although online financing can become a way for enterprises to finance, this method has a certain impact on the stability of the entire financial system. Therefore, the government should actively expand reasonable financing channels for enterprises and formulate policies conducive to enterprise financing. On the one hand, the government should formulate financing policies to reduce the financing barriers for enterprises and broaden their resource sources, so that enterprises can obtain legal and reasonable support from the government in financing. On the other hand, as the main body of financing, enterprises should fully consider the financing costs and risks, rationally use financing methods, broaden the channels of funds, and achieve the intelligentization upgrade of industries.

6. Conclusion

In summary, to achieve intelligent industrial development in Liaoning Province through the digital economy, three steps are critical: promoting intelligent industrial upgrades, building smart management systems, and creating a supportive funding system. Enterprises must actively follow national policies, upgrade technologies independently, and shift development models to accelerate digital, intelligent, and high-end growth in Liaoning’s energy sector.

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