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Research on the Mechanism and Realization Path of Green Innovation in Manufacturing Industry Driven by Digital Technology

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Abstract

Based on the resource base view, information asymmetry and other theories, this paper systematically analyzes the mechanism of digital technology driving green innovation in manufacturing industry, and argues that digital technology drives green innovation in manufacturing industry by alleviating financing constraints, solving information asymmetry, improving resource allocation efficiency and reducing costs. Based on the institutional theory, it is believed that the institutional environment, mainly including government policies and the degree of marketization, is the boundary condition for digital technology to drive green innovation in manufacturing. On the basis of the above analysis, the realization path and policy guarantee system of digital technology-driven manufacturing green innovation are proposed.

Keywords

Digital Technology; Green Innovation; Mechanism; Path.

1. Introduction

The Fifth Plenary Session of the Nineteenth Central Committee pointed out that "with the theme of promoting high-quality development, deepening the innovation-driven strategy, promoting the high-end, intelligent and greening of traditional industries". Green innovation is characterized by high efficiency, low carbon and recycling. Under the double constraints of resources and environment, green innovation has become an important path for the transformation and upgrading of the manufacturing industry, which is also an inevitable choice to embark on the road of high-quality development. With the rise of emerging technologies such as digitalization and intelligence, the traditional business environment and factor supply have been subverted, providing unprecedented momentum and opportunities for enterprise innovation activities and green development. Therefore, under the background of digitization, how the manufacturing industry can seize the opportunity to realize the green innovation of enterprises empowered by digital technology, promote the development of manufacturing industry towards greening and decarbonization, and then realize high-quality development and enhance international competitiveness has become a realistic problem that needs to be urgently solved.

2. Review of Related Literature

2.1. Research on Drivers of Green Innovation

Green innovation refers to the strategic initiative of enterprises to incorporate green innovation practices to cope with environmental pollution into the strategic level and take the initiative to reduce the negative impact on the environment in their production and operation activities. Green innovation is an important path for the manufacturing industry to move towards high-

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quality development, improve its competitiveness and realize sustainable development. The current research on the driving factors of green innovation mainly focuses on three levels: institutional level, organizational level and individual level. ① Institutional level. Institutionalism theory believes that enterprises carry out green innovation in response to coercive pressure, normative pressure and imitation pressure to improve organizational legitimacy. ② Organizational level. Based on the resource-based view, organizational resources, capabilities, and corporate strategic orientation are considered to be the main factors driving green innovation. For example, redundant resources, corporate innovation capabilities, and environmental capabilities. ③ Individual level. It mainly includes stakeholders and corporate executives. The pressure exerted by stakeholders on the enterprise helps to promote green innovation, and the executives' awareness of environmental issues and the degree of importance they attach to them have an important impact on the enterprise's green innovation. The theories and representative literature involved are shown in Table 1.

Table 1. Literature related to the drivers of green innovation

Dimension	Theory	Representative Literature
Institutional dimension	Institutionalist theory	Di Maggio &Powell (1983); Schaefer (2007); Eiadat (2008);Horbach (2008); Qin et al. (2017); Qingyuan Li (2020)
Organizational level	Resource base view	Sharma (2000); Pereira et al (2012); Marchi V D (2012);Bowen et al (2002); Chen et al (2012); Cao Hongjun and Chen Zewen (2017)
Individual level	Stakeholder theory and higher level theories	Zhang Xiaojun (2012); He et al. (2015); Bian Yali (2013); Wu Jianzu et al. (2021); Ardito et al.

2.2. The Gradual Emergence of Research on the Drive of Digital Technology to Green Innovation

Digital technology refers to a comprehensive system technology based on communication technology, combined with the application of external knowledge in the process of technological upgrading, which can promote all-round intelligence in the field of management, and the key of digital technology to promote the revolution of informationization is technological innovation. In recent years, with the rise of emerging technologies such as big data and cloud computing, more and more scholars are concerned about the driving role of digital technology on green innovation, and related research is gradually emerging. There are mainly two different views on the relationship between digital technology and enterprise green innovation: ① Digital technology promotes enterprise green innovation. The study of Ai Yongfang and Kong Tao (2021) shows that regional big data can positively promote enterprise green innovation, and this effect is different in different types of enterprises. The research of scholars such as Zhou Huihui (2021) also reached similar conclusions. ② There is a ∩-type relationship between digital technology and green innovation. Digital technology can promote green innovation through information sharing and effective allocation of factor resources, but along with the development of digital technology, data security, data overload and other problems are constantly emerging, and digital technology inhibits green innovation to a certain extent. (Wang Fengzheng et al., 2021).

Previous related literature has a good reference for this paper, but there are still some deficiencies in the existing research and room for further study. Most of the previous studies have explored the driving factors of enterprise green innovation from the institutional level,

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organizational level and individual level, while the studies on enterprise green innovation driven by digital technology are rare and mainly focus on its direct impact, and have not yet reached a consistent conclusion. The lack of in-depth exploration of the internal logic mechanism of digital technology-driven enterprise green innovation and the lack of a systematic theoretical system have provided an opportunity for the research of this paper. The study will provide practical paths and theoretical references for the manufacturing industry to fully apply digital technology, promote enterprise green innovation, enhance the sustainable competitiveness of enterprises, and then realize high-quality development.

3. Research on the Mechanism of Green Innovation in Manufacturing Driven by Digital Technology

3.1. Role Mechanism of Digital Technology-driven Green Innovation in Manufacturing Industry

The main problems facing green innovation in manufacturing industry are: (1) The high investment cost of green innovation and the poor short-term realization of environmental benefits lead to the manufacturing industry facing serious financing constraints in the process of green innovation. (2) Information asymmetry and information transmission lag are important factors affecting green innovation in the manufacturing industry at present, and information asymmetry in terms of enterprise and market demand leads to the fact that green innovative products cannot be well transformed. (3) Low resource utilization of manufacturing enterprises is another important factor affecting their green innovation. (4) Green innovation in manufacturing industry is more costly and risky compared with traditional innovation activities.

Based on the resource base view, information asymmetry and other theories, the analysis concludes that digital technology effectively solves the manufacturing industry green innovation dilemma by alleviating financing constraints, easing information asymmetry, improving resource allocation efficiency and reducing costs. Due to its own advantages, digital technology has gradually become the leading force driving green innovation in manufacturing industry. (1) Digital technology promotes the development of digital finance, broadens the financing channels of the manufacturing industry, improves the financing efficiency, reduces the cost of financing, and then eases the financing constraints and promotes the green innovation of the manufacturing industry. (2) Digital technology can well solve the problem of information asymmetry. Digital technology can enable enterprises to better collect and analyze green product information and consumer preferences, help enterprises clarify the direction of green innovation, promote the matching of enterprise green innovation results and market demand, and enhance the conversion rate of green innovation results. (3) Digital technology promotes the flow, integration and effective allocation of internal and external resource elements through the full integration of knowledge, information and technology resources related to green innovation, and promotes green innovation in the manufacturing industry. (4) Digital technology can reduce the cost of information acquisition, transaction costs, and in the dynamically changing market and technological environment, accurately identify new opportunities for green development and reduce the risk of green innovation in the manufacturing industry.

3.2. Boundary Conditions of Digital Technology-driven Green Innovation in Manufacturing Industry

According to institutional theory, green innovation behavior is not only affected by the internal factors of enterprises, but also by the external institutional environment of enterprises. The institutional environment is the external driving force and boundary conditions for realizing

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digital technology-driven manufacturing green innovation. The institutional environment referred to in this paper mainly includes two aspects, one is government policy and the other is the degree of marketization. The government's environmental regulation and subsidies for enterprises' green innovation can promote digital technology-enabled manufacturing green innovation. The higher the degree of marketization, the better the driving effect of digital technology on green innovation in manufacturing. Through environmental regulations, governments can put pressure on enterprises to promote green transformation. When enterprises face stricter environmental regulations, they will be more motivated to use digital technology to carry out green innovation in order to improve organizational legitimacy and obtain more development resources. Government subsidies for green innovation activities can reduce the cost of R&D inputs and stimulate the enthusiasm of enterprises for green innovation, while helping to reduce the risk of green innovation, which in turn promotes the active use of digital technology by manufacturing enterprises to realize green innovation. Regions with a high degree of marketization have a high level of economic development, a mature product and factor market, a more complete legal system, and a market order that tends to be standardized and fair, and a better innovation environment that is conducive to the use of digital technology by enterprises to promote green innovation.

4. Path Design of Green Innovation in Manufacturing Industry Driven by Digital Technology

According to the above logical mechanism of digital technology-driven green innovation in manufacturing industry, combined with field research and expert interviews, the corresponding realization paths are proposed from the following aspects.

(1) The path design of manufacturing industry to accelerate digital transformation. Manufacturing enterprises use digital technology to transform themselves, from point to point, and ultimately realize the digital transformation of the whole business, the whole process, and stimulate their green innovation kinetic energy.

(2) The path design of digital technology to promote the development of digital finance. Create a digital inclusive financial system, guide financial institutions to use digital technology to promote the development of digital finance, and do a good job of standardization and supervision, alleviate corporate financing constraints, and provide better financial support for green innovation in the manufacturing industry.

(3) Path design of digital technology to build resource sharing mechanism. Accelerate the construction of a resource sharing platform integrating capital, information and talents to promote the flow of green innovation resource elements and the effective allocation of resources.

(4) The path design of digital technology to promote the integration platform construction of industry-university-research. Accelerate the construction of industry-university-research platform, realize the synergy of green innovation resources, accelerate the transformation of innovation results, and inject power for green innovation in manufacturing industry.

5. Policy Guarantee System for Digital Technology-driven Green Innovation in Manufacturing Industry

(1) The government increases environmental regulation and guides manufacturing enterprises to utilize digital technology to enhance green innovation ability. Increase the strength of environmental regulation, such as tightening the energy consumption index, increase the penalty for exceeding the emission standard, etc., and improve the laws and regulations related to environmental protection at the same time.

(2) The government should promote the active use of digital technology by manufacturing enterprises through subsidies, tax incentives and other measures to empower green innovation. On the one hand, the government should increase subsidies to enterprises and focus on the utilization efficiency of subsidies in green innovation. On the other hand, relevant tax and financing preferential policies should be introduced to help enterprises smoothly and continuously utilize digital technology to carry out green innovation activities and promote enterprise transformation and upgrading.

(3) Form a government-led, enterprise-participating linkage mechanism to accelerate the digital transformation of traditional infrastructure, actively promote the construction of new digital infrastructure, and promote the research, development and application of digital technologies.

(4) Create a market-oriented mechanism with value creation as the core, participating enterprises as the main body, and customer demand as the guide. Drive supply by demand and cultivate the endogenous power of the manufacturing industry to carry out continuous green innovation. Reduce government intervention, optimize the market competition environment, accelerate the marketization process, promote the flow of product and factor markets, and create good market resources for the manufacturing industry to utilize digital technology to enhance their green innovation capability.

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