

Analysis of the Impact of the Maturity of Digital Transformation Capability of Prefabricated Construction Enterprises on Green Innovation

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Abstract: In the context of sustainable development, countries around the world place greater emphasis on green innovation in environmental policies, and the maturity of digital transformation capabilities may play an important role in improving green innovation. This article aims to explore the impact of the maturity of digital transformation capabilities of prefabricated construction enterprises on green innovation. The article first elaborates on the concepts of digital transformation and green innovation; secondly, the meaning, development process, and evaluation methods of the maturity evaluation model were explained. Finally, the impact of the maturity of digital transformation capabilities of prefabricated construction enterprises on green innovation was explained. Through analysis, the importance of digital transformation and environmental green innovation has been highlighted. This analysis can help businesses understand their current situation and identify potential improvement methods.

Keywords: Prefabricated Buildings; Digital Transformation; Maturity Evaluation; Green Innovation

1. Introduction

With the increasing severity of global climate change and resource scarcity, green innovation has become an important direction for the development of the construction industry. Prefabricated construction, as a new type of construction method, has the advantages of energy conservation, environmental protection, and high efficiency, and has received widespread attention. Digital transformation, as a key means to enhance the competitiveness of prefabricated construction enterprises, is of

great significance for promoting green innovation. Therefore, studying the impact of the maturity of digital transformation capabilities of prefabricated construction enterprises on green innovation has important theoretical and practical value for promoting green development in the construction industry.

With the development of new technologies such as blockchain, big data, and cloud computing, digital technology has brought profound changes to the socio-economic field. Digital transformation has become a key strategic decision for modern management and information system transformation of enterprises, attracting widespread attention from the international community and making research on digital transformation of enterprises one of the hot topics of academic concern. In the Outline of the 14th Five Year Plan, the Chinese government proposes to promote the reform of production and lifestyle governance through digital transformation. In 2014, the Development and Reform Commission of China proposed the "Digital Transformation of Partnership" initiative. In 2020, the Chinese government work report proposed to accelerate digital development, create new advantages in the digital economy, and jointly promote digital industrialization and industrial digital transformation, indicating that digital transformation has risen from the enterprise level to social.

Green innovation, as an innovative paradigm that integrates ecological environment protection and sustainable development concepts, mainly manifests in the design and development of new processes, technologies, and products that are conducive to energy conservation, emission reduction, and environmental protection. With the deepening penetration of sustainable development concepts, green innovation also emphasizes

the innovation of renewable design and environmental process management throughout the entire industry chain. Under the global low-carbon development methods, green innovation is seen as a key factor in coordinating economic growth and green low-carbon development, and is an important path to achieving sustainable regional economic development.

2. The Meaning of Digital Transformation and Green Innovation

2.1 Digital Transformation

As an important phenomenon in the research of strategic information systems, digital transformation represented by digital technology has brought tremendous impact to enterprises in terms of value creation and value acquisition methods. At the organizational level, many scholars believe that enterprises should seek ways to utilize digital technology and further improve their resource utilization efficiency through digital transformation to obtain sustainable competitive advantages.

There are three characteristics of digital transformation: firstly, the goal of digital transformation is not limited to enterprises, but may also be the transformation of individuals, organizations, and even society; The second is that digital transformation is a goal, not a completed movement; Thirdly, digital technology in digital transformation is a broad and vague definition, which includes many emerging technologies related to digital transformation. The most digital transformation is mainly driven by digital technology, guided by digital strategies for enterprises, and strategic activities that change the current profit model of enterprises by implementing structural transformation and overcoming transformation obstacles [1]. Digital transformation mainly utilizes new generation digital technologies such as big data, artificial intelligence, and the Internet of Things. It can not only improve the efficiency and space of factor utilization, but also optimize resource allocation and achieve dynamic adjustment of enterprises [2]. Digital transformation is an activity supported by digital technology, with data as the key element, value release as the core, and data empowerment as the main line, aimed at

upgrading, transforming, and reengineering all factors in the upstream and downstream of the industrial chain [3].

Digital transformation can be defined as a strategic orientation for enterprises to transform existing production and sales activities and management models based on digital technology and data support. Based on this, existing literature on digital transformation can be divided into digital transformation of production activities, digital transformation of sales activities, and digital transformation of management models. Digital technology is playing an increasingly important role in driving global economic development, affecting society, businesses, and people's lives. These technologies include but are not limited to big data, artificial intelligence, cloud computing, blockchain, and the Internet of Things [4]. From a global perspective, digital transformation has triggered the transformation of new business models and created and acquired enterprise value based on new logic and ideas, becoming one of the key factors in disrupting and reshaping business models.

Generally speaking, digital transformation can be divided into business digital transformation and strategic digital transformation. Enterprise digital transformation tends to emphasize the application of digital technology in processes and systems, refining and expanding business processes at the business level, in order to achieve the digitization of organizational operations [5]. Compared with enterprise digital transformation, strategic digital transformation emphasizes the implementation of deeper changes within the enterprise, achieving value creation, including changes in business processes, business models, organizational culture, and other aspects. In practice, digital transformation has been proven to have a profound impact on business activities. Digital transformation can effectively reduce communication and transaction costs, improve the availability and transparency of market information, and enable enterprise management to timely perceive opportunities and challenges in business processes, thereby improving the financial performance of the enterprise. Digital transformation can also provide specific advantages for enterprises in international competition, such as changing corporate

governance structure, business processes, and business models, improving the business perception and decision-making ability of managers, and enabling enterprises to gain competitive advantages in uncertain economic environments. Digital transformation can enhance the ability of enterprises to respond to external environmental changes, form and maintain the driving force for sustainable development, thereby helping to improve their innovation capabilities [6]. The digital transformation of enterprises can greatly enhance their information processing capabilities and enhance financial operational efficiency through their own digital technology, enabling them to reach the maximum efficiency boundary of fund utilization under limited financial resource constraints [7]. In other words, the advancement of digital transformation in enterprises can effectively improve their financial situation.

2.2 Green Innovation

In the past few years, many countries have implemented corrective policies that can reduce or mitigate environmental damage through them [8]. Innovation includes any new practices added to an organization, including equipment, products, processes, policies, and projects [9]. Technological innovation involves products, services, and production technology; It is related to basic activities and products or processes. According to academic literature, green innovation is a subset of general innovation and has many common characteristics. The concept of green innovation has three main dimensions: process, product, and organization. Regarding the first two, the goal is to combine environmental goals with "process innovation (production efficiency) and product innovation (product quality)" [10]. There is complementarity between these three terms as they all involve resources: their nature, how they are collected, used, and managed.

Scholars have different understandings of the definition of green innovation. The earliest definition of green innovation came from James, who believed that enterprises should tend to reduce environmental impact in the process of development and incorporate it into the basic goals of enterprise development. This can not only achieve coordination between the

environment and the economy, but also help enterprises develop new products and master new processes. Green innovation is not only about developing new products and mastering new processes, but also about making efforts in discovering new markets, developing new systems, and creating new business strategies [11]. Green innovation refers to the development of environmentally friendly products and processes, through the adoption of organizational practices, namely more environmentally friendly raw materials, and the use of fewer material ecological design principles in the product design process, aiming to reduce emissions and reduce the consumption of water, electricity, and other raw materials [12]. Green innovation refers to the development of environmentally friendly products and processes, including the use of green raw materials, adherence to ecological product design principles, reduction of material use, reduction of pollutant emissions, and reduction of consumption of raw materials such as water and electricity. The research on green innovation in our started relatively late, and innovative activities that achieve coordinated development of the environment and economy through green innovation can be included in the scope of green innovation [13]. Green innovation is a strategic behavior in which enterprises actively incorporate environmental awareness and responsibility into their daily production and operation, reduce environmental pollution through innovation in green technologies, products, and processes, and create new market opportunities. It has both environmental protection and innovation attributes [14]. Green innovation refers to the research and development of new technologies, ideas, and policies throughout the entire process of product development, manufacturing, organizational management, and marketing, in order to reduce resource and energy consumption, reduce environmental pollution, bring environmental benefits to society, and help enterprises improve input-output efficiency to increase economic benefits.

Based on the above analysis, green innovation of enterprises is regarded as a key factor in coordinating economic growth and green low-carbon development, and is an important path to achieve sustainable regional economic development.

3. Maturity Evaluation

The development of maturity models first originated in the software industry in the United States. In 1991, the Software Engineering Institute at Carnegie Mellon University developed the first set of Capability M (CMM) models and corresponding maturity questionnaires, which were widely recognized by various industries. The concept of capability maturity model can improve the evaluation index system of internal control capability maturity, evaluate the level of internal control capability maturity of enterprises, and achieve the transformation of internal control from static analysis to dynamic evaluation [15]. On the basis of traditional technology maturity models, the comprehensive integration relationship of manufacturing maturity, product maturity, and system maturity models has been explored and improved, and a generalized technology maturity model has been constructed to measure technology research and development progress and monitor the threshold of engineering transformation stage [16]. In the process of development, enterprises need to clarify which maturity level their own situation belongs to. In terms of maturity models based on the perspective of potential performance, a maturity model for project management can also be constructed from three dimensions: the level of executive support, the overall level of project management process, and corporate culture and organizational structure. The maturity of enterprise project management can be divided into five stages: confusion, simplicity, standardization, excellence, and continuous optimization.

Maturity models are often used as conceptualization and measurement processes for an organization or a specific goal state, or as tools to facilitate internal or external benchmarking, while also showcasing future improvements and providing guidance for the evolutionary process of organizational development and growth [17]. Digital maturity can be divided into digital readiness and digital intensity, and a two-dimensional matrix of digital maturity has been established based on these two dimensions [18]. The maturity model is a structured collection of elements that describe the effective process characteristics at different stages of

development. It also proposes boundary points between stages and methods for transitioning from one stage to another. The concept of digital maturity is subdivided into three levels: digital readiness (organizational readiness for digitization), digital intensity (organizational transformation performance based on digital technology), and digital contribution (organizational performance after implementing digital transformation).

There are two measurement methods for maturity models: qualitative measurement and quantitative measurement, mainly based on the questionnaire set by the Lister scale. The qualitative measurement methods vary depending on the application stage of the model, which is divided into the development and improvement stage and the evaluation stage [19]. In the model development stage, the main suitable methods include Delphi method, case study method, and conceptual modeling. The main methods suitable for the evaluation stage include business model canvas, problem-based learning methods, value chain framework, and value process diagram; The main quantitative measurement methods in the model development stage include fuzzy analytic hierarchy process, hierarchical clustering analysis, and Monte Carlo simulation; There is also a mixed use of qualitative and quantitative methods. Every business organization has its own unique corporate culture, governance approach, and digital foundation. Therefore, different qualitative and quantitative methods can be mixed according to the different situations of the enterprise organization.

4. The Impact of Maturity of Digital Transformation Capability of Prefabricated Construction Enterprises on Green Innovation

The impact of the maturity of digital transformation capabilities of prefabricated construction enterprises on green innovation is a complex and far-reaching issue. With the rapid development of information technology, digital transformation has become a key means for many enterprises to pursue innovation and enhance competitiveness. For prefabricated construction enterprises, the improvement of digital transformation capability maturity not only helps to optimize production processes and improve management efficiency, but also

has a positive and far-reaching impact on their green innovation.

Firstly, the maturity of digital transformation capabilities can significantly improve the resource utilization efficiency of prefabricated construction enterprises [20]. In traditional construction processes, resource waste is often an unavoidable problem. However, with the advancement of digital transformation, enterprises can achieve comprehensive monitoring and precise management of resources by introducing advanced information management systems. Through big data analysis, cloud computing and other technological means, enterprises can real-time understand the consumption of resources, predict future resource demands, and thus develop more scientific and reasonable resource allocation plans. This can not only reduce resource waste, but also improve the economic benefits of enterprises, providing strong support for green innovation.

Secondly, digital transformation helps to reduce the energy consumption of prefabricated construction enterprises [21]. During the construction process, a large amount of energy is often consumed, which not only increases the operating costs of enterprises, but also puts considerable pressure on the environment. However, with the deepening of digital transformation, enterprises can optimize their production processes and reduce energy consumption by introducing intelligent and automated production equipment and technology. For example, by applying intelligent monitoring technology, enterprises can monitor the operating status and energy consumption of equipment in real time, adjust equipment operating parameters in a timely manner, and reduce unnecessary energy waste. In addition, enterprises can also utilize renewable energy technologies such as solar and wind energy to provide clean energy for the production process, further reducing energy consumption and environmental pollution.

In addition, the improvement of digital transformation capability maturity can also promote innovation in green material research and application for prefabricated construction enterprises [22]. Green materials are an important component of green innovation, which is of great significance in reducing building energy consumption and improving

building quality. However, the research and application of green materials often involve knowledge and technology from multiple fields, requiring enterprises to have strong research and development capabilities and resource integration capabilities. Digital transformation provides enterprises with a more open and efficient collaboration platform, enabling them to engage in closer collaborative research and development with suppliers, research institutions, and other partners. By sharing data, exchanging experiences, and jointly tackling key issues, enterprises can accelerate the research and development speed of green materials and promote the application of green materials in the construction field.

Meanwhile, digital transformation also helps optimize the production process and management mode of prefabricated construction enterprises. The traditional construction process often faces problems such as information asymmetry and poor communication, leading to low production efficiency and serious resource waste [23]. Digital transformation can achieve real-time monitoring and intelligent management of production processes by introducing technologies such as the Internet of Things and cloud computing. Enterprises can obtain real-time information on production progress, equipment status, personnel configuration, etc. Through data analysis, bottlenecks and problems in the production process can be identified, and corresponding measures can be taken to optimize and improve. This can not only improve production efficiency, but also reduce unnecessary waste and pollution, providing strong support for green innovation. In addition, the improvement of the maturity of digital transformation capabilities also helps prefabricated construction enterprises to build a green innovation culture. Digital transformation not only changes the production and management methods of enterprises, but also profoundly affects their culture and values. With the advancement of digital transformation, enterprises are increasingly focusing on concepts such as environmental protection, energy conservation, and sustainable development, and integrating these concepts into their core values and business philosophy. The formation of this green innovation culture will help promote

continuous innovation and pursuit of excellence in enterprises, and contribute to the green transformation and sustainable development of the industry.

In summary, the maturity of digital transformation capabilities of prefabricated construction enterprises has a profound and positive impact on green innovation. By enhancing the maturity of digital transformation capabilities, enterprises can achieve significant results in optimizing resource allocation, reducing energy consumption, promoting the research and application of green materials, optimizing production processes and management models, and providing strong support and guarantee for green innovation. In the future, with the continuous deepening of digital transformation and technological progress, it is believed that prefabricated construction enterprises will achieve more fruitful results in green innovation.

5. Conclusions

Digital transformation and green innovation are emerging hot topics that scholars are currently paying attention to. Studying the impact of digital transformation capability maturity on enterprise green innovation and its economic consequences has more theoretical and practical significance. Through this article's research on the application of digital transformation in the context of prefabricated buildings, digital transformation, maturity evaluation, and green innovation, it can be found that:

Firstly, for the government, evaluating and analyzing the maturity of digital transformation in prefabricated construction enterprises can help them better understand the current situation of digital transformation in the prefabricated construction industry and its connection with sustainable development. It can also clarify the gap between the expected and actual effects of digital transformation in the prefabricated construction industry on green innovation and provide guidance for the government in formulating digital transformation policies for the prefabricated construction industry to achieve sustainable development. Secondly, for prefabricated construction enterprises, "sustainable development" and "digital transformation" are inevitable choices for their future development.

This study helps construction enterprises to have a more comprehensive understanding of the role of digital transformation represented by digital technology in improving resource allocation efficiency, improving construction production processes, enhancing operational management efficiency, and achieving sustainable development. It also increases the enthusiasm of enterprises for digital investment; Meanwhile, through the digital maturity model provided in this study, prefabricated construction enterprises can understand at which stage of digitalization they are in, clarify the necessary conditions for enterprises to achieve sustainable development through digital transformation, and identify the corresponding changes that need to be made in the current situation of the enterprise, thereby providing reference for enterprise leaders to make decisions.

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