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Original Paper

Review of Research Methods on the Relationship between Enterprise Green Development Construction and Pharmaceutical Project Performance under the Background of Dual Carbon

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Abstract
It is important to identify the key driving factors of green development and project performance of pharmaceutical enterprises, and deeply analyze the specific mechanism of green development level on pharmaceutical project performance. The above research not only helps to reveal the important role of green development construction in enhancing the social responsibility and brand image of pharmaceutical enterprises, but also further discusses the strategic significance of green development for the long-term development of enterprises, and provides theoretical support and practical guidance for enterprises to achieve sustainable development. It can provide scientific basis and practical reference for the government to formulate relevant policies for the green development of the pharmaceutical industry under the background of "dual carbon", so as to promote the coordinated development of the pharmaceutical industry and the "dual carbon" goal, and promote the overall improvement of the industry in terms of economic, environmental and social benefits. This paper mainly introduce the research method of the relationship between enterprise green development construction and pharmaceutical project performance.

Keywords
Green development level, Pharmaceutical project performance, Review of research methods

1. Introduction

The "dual carbon" goals represent a major strategic decision by China to address climate change and promote green development. Carbon peaking refers to the point at which carbon dioxide emissions stop growing, while carbon neutrality means offsetting one's own carbon dioxide emissions through measures such as afforestation and energy conservation to achieve net zero emissions. The proposal of this goal marks a comprehensive shift towards green and low-carbon development in China's economy and society. The construction of green development for enterprises refers to the adoption of clean production technologies, optimization of energy structures, and improvement of resource utilization efficiency during the production and operation process to minimize negative environmental impacts and achieve coordinated development of economic, environmental, and social benefits. Against the backdrop of the "dual carbon" goals, the construction of green development for enterprises is particularly important. It is not only a manifestation of enterprises fulfilling their social responsibilities but also an inevitable path to enhancing competitiveness and achieving sustainable development. As one of the high-energy-consuming and high-polluting industries, the pharmaceutical industry is under tremendous pressure to transform in the context of the "dual carbon" goals. Traditional pharmaceutical production methods often involve significant energy consumption and pollutant emissions, which are contrary to the concept of green development. Therefore, pharmaceutical enterprises urgently need to promote green development construction through technological innovation and management optimization to adapt to the new development requirements.

The impact mechanism of green development construction on the performance of pharmaceutical projects mainly lies in three aspects: technological innovation, management optimization, and resource utilization. Technological innovation can enhance production efficiency, reduce energy consumption and pollutant emissions, thereby improving the environmental and economic benefits of the project. For instance, the application of clean production technologies can reduce waste generation during the pharmaceutical production process and increase raw material utilization, lowering production costs. Management optimization, through the implementation of environmental management systems, can help enterprises identify and control environmental risks and improve resource utilization efficiency, thereby enhancing project performance. By establishing a green supply chain management system, pharmaceutical enterprises can ensure the environmental friendliness of raw materials and reduce procurement costs. Additionally, promoting green human resource management and cultivating employees' environmental awareness can also contribute to improving the overall operational efficiency of the enterprise. In terms of resource utilization, green development construction emphasizes the recycling and efficient use of resources, which can not only lower production costs but also reduce environmental pressure. These impact mechanisms interact with each other, jointly driving the improvement of pharmaceutical project performance. Technological innovation provides technical support for management optimization and resource utilization, while management optimization and resource utilization create a favorable implementation environment for technological innovation. The synergy of these three aspects makes green development construction an important driving force for enhancing the performance of pharmaceutical projects.

This article uses bibliometric analysis, questionnaire surveys, the Analytic Hierarchy Process (AHP), CRITIC weighting method, and matter-element extension evaluation method to first determine the green development level of pharmaceutical projects, then determine the performance level of pharmaceutical projects, and finally explore the relationship between the construction of green development for enterprises and the performance of pharmaceutical projects under the "dual carbon" background, with the aim of providing theoretical support and practical guidance for the sustainable development of the pharmaceutical industry.

2. Assessment Method for Green Development Level

2.1 Comprehensive Index Method

The comprehensive index method has been widely applied due to its systematicness and operability. This method selects scientific and reasonable dimensions and builds a multi-dimensional index system based on the principles of systematicness, scientificity and operability, thereby forming a comprehensive evaluation index to quantify the level of green development. Its core lies in the construction of the index system and the determination of weights. Objective weighting methods such as Analytic Hierarchy Process (AHP) and entropy value method are usually adopted to ensure the scientificity and reliability of the evaluation results. On this basis, the green development level is classified by fuzzy comprehensive evaluation method or object-element extension evaluation method, further enhancing the accuracy and practicality of the assessment. Shi Lijiang et al. (2023) and Li Xuhui et al. (2023) conducted quantitative research on the level of green development by using the entropy method, further enriching the application scenarios of the comprehensive index method.

2.2 Data Envelopment Analysis Method

Data Envelopment Analysis (DEA) is a non-parametric efficiency evaluation method that assesses the relative efficiency levels of decision-making units by constructing a production frontier. This method does not require the preset form of the production function and can effectively handle complex systems with multiple inputs and outputs. DEA is applicable for evaluating the efficiency performance of regions or organizations in terms of resource utilization and environmental protection, and can provide scientific basis for optimizing resource allocation and enhancing the efficiency of green development. For instance, Tian Yun et al. (2024) measured the efficiency of China's agricultural green development and two-stage efficiency based on the network DEA model, analyzed its basic pattern, dynamic evolution and spatial differences, and then explored various potential influencing factors of agricultural green development efficiency and its spatial spillover effects.

3. Performance Evaluation Method

3.1 Analytic Hierarchy Process

The Analytic Hierarchy Process (AHP) is a systematic and hierarchical multi-criteria decision-making analysis method. It was proposed by American operations researcher Thomas L. Saaty in the 1970s. Its core idea is to decompose complex problems into multiple levels and factors, establish a hierarchical structure model, and combine qualitative and quantitative analysis to calculate the weights and prioritize each factor, thereby providing scientific basis for decision-making. This method decomposes problems into target layer, criterion layer and alternative layer, forming a clear multi-level structure, which is conducive to systematic analysis. Through expert scoring and mathematical calculations, subjective judgments are transformed into quantitative data, enhancing the scientific nature of decision-making. The consistency index (CI) and consistency ratio (CR) are used to test the logical consistency of the judgment matrix, ensuring the reliability of the evaluation results. It also has strong universality and adaptability. For example, Peng Guofu et al. (2004) applied the AHP method to the performance evaluation of the government; Zhang Jingfang et al. (2017) applied the AHP method to evaluate the financial informatization level of hospitals, providing effective basis for the construction of hospital financial informatization.

3.2 CRITIC Weighting Method

The CRITIC Weighting Method (Criteria Importance Through Intercriteria Correlation) is an objective weighting method based on data-driven approach, proposed by Diakoulaki et al. in 1995. Its core idea is to analyze the contrast intensity and conflict between evaluation indicators, comprehensively calculate the weights of each indicator, thereby avoiding the deviation caused by subjective weighting. The CRITIC weighting method is particularly suitable for multi-indicator comprehensive evaluation problems and can effectively reflect the intrinsic relationship and quantitative characteristics among indicators. This method can measure the dispersion degree of internal data of each indicator, usually represented by the standard deviation. The larger the standard deviation, the stronger the ability of the indicator to distinguish the evaluation object, and its weight should also be larger. It can measure the correlation between indicators, usually represented by the correlation coefficient. If two indicators are highly correlated, it indicates that the information they provide is redundant, and their weights should be correspondingly reduced. By combining the contrast intensity and conflict, the comprehensive weights of each indicator are calculated to ensure the scientificity and rationality of the weights. This method has the advantages of strong objectivity and wide applicability. For example, researchers evaluated the performance of a university's innovation center based on the CRITIC method (Bu Wei et al., 2023).

3.3 Matter-Element Extension Evaluation Method

The Matter-Element Extension Evaluation Method (Matter-Element Extension Evaluation Method) is a comprehensive evaluation method based on the matter-element theory and extensional mathematics proposed by Chinese scholar Cai Wen in 1983. Its core idea is to combine the evaluation object, characteristics, and quantity values through constructing a matter-element model, using the extension set theory to handle uncertainties and contradictions, and thereby achieving comprehensive evaluation and decision-making for complex systems. For example, researchers Huang Rendong et al. (2012) introduced the entropy weight method into the extensional mathematics theory, established an entropy weight matter-element extension model, and applied this model to obtain the tunnel gas grade and its actual grade being completely consistent, with an accuracy rate of 100%; Wen Xinxin et al. (2014) combined the entropy weight method with the matter-element extension evaluation method to evaluate the comprehensive environmental quality of a certain city.

3.4 Fuzzy Comprehensive Evaluation Method

The Fuzzy Comprehensive Evaluation Method is a comprehensive evaluation approach based on the theory of fuzzy mathematics. It was proposed by L.A. Zadeh, an American control theory expert, in 1965. Its core idea is to handle the uncertainties and fuzziness in the evaluation process by introducing the theory of fuzzy sets, thereby achieving scientific and reasonable evaluation of complex systems. For instance, Tian Shizhong et al. (2015) evaluated the performance of fiscal science and technology expenditure projects by combining the Analytic Hierarchy Process and the Fuzzy Comprehensive Evaluation Method, further enhancing the efficiency of fiscal funds utilization.

3.5 Multiple Weighting Methods

The combination of multiple weighting methods is an important development direction for future research. Objective weighting methods (such as the CRITIC method) eliminate the interference of subjective factors through data-driven approaches, featuring simplicity in operation and high efficiency. However, their results often lack interpretability, resulting in low acceptance rates despite relatively low costs. Subjective weighting methods (such as the Analytic Hierarchy Process) integrate the wisdom and experience of experts, possessing high interpretability and public recognition. However, they rely on expert judgment, have high implementation costs, and are susceptible to subjective biases. Combining objective methods with subjective ones can retain the value of human experience while scientifically correcting subjective judgments based on data characteristics, thereby fully leveraging the advantages of both. This has become an important trend in the field of comprehensive evaluation (Wen Bo et al., 2020). Based on the research questions of this paper and the availability of data, this paper selects the Analytic Hierarchy Process (AHP), the CRITIC weighting method, and the Object-Element Extension Evaluation Method. The AHP is used to capture expert experience and ensure the interpretability of the assessment results; the CRITIC weighting method objectively determines the weights of indicators through data-driven approaches, enhancing the scientific nature of the assessment; the Mattert-Element Extension Evaluation Method uses the construction of an Matter-Element model to handle uncertainties and fuzziness in the evaluation process. The combination of these three methods not only enables the complementary advantages of subjective and objective weighting but also provides a more comprehensive and precise solution to the research problem.

4. The Uniqueness of Performance Evaluation for Pharmaceutical Projects

As a global manufacturing powerhouse, China has long relied on a development model characterized by high consumption and high pollution. Although it achieved rapid economic growth and scale expansion in the short term, this model has led to an imbalance in the industrial structure, excessive carbon emissions, and water pollution. Under the backdrop of the "dual carbon" goals, the green transformation of manufacturing has become an inevitable choice for achieving sustainable development (Liu Yubin et al., 2023). Pharmaceutical enterprises, as an important part of high-tech-intensive manufacturing, involve advanced biotechnologies, chemical synthesis technologies, and formulation technologies in their research and production processes, presenting distinct industry characteristics. Therefore, the performance evaluation of pharmaceutical projects exhibits the following unique attributes: Firstly, the evaluation cycle is long, requiring comprehensive coverage of multiple stages such as research and development, production, and sales; Secondly, the evaluation indicators are highly specialized, with a focus on core elements such as the safety, efficacy, and quality controllability of drugs; Thirdly, subject to strict policy and regulatory constraints, compliance requirements such as GMP certification and drug registration need to be fully considered.

Existing research provides important theoretical support for the performance evaluation of pharmaceutical projects. For instance, Chen Ming (2021) proposed a performance evaluation framework for pharmaceutical projects, constructing a systematic evaluation system from financial, operational, and quality control dimensions; Liu Fang (2022) further constructed a green pharmaceutical project evaluation model, incorporating environmental performance into the evaluation scope. However, overall, research on the performance evaluation of pharmaceutical projects is still in the initial exploration stage, especially in the context of green development, there is still a significant research gap in how to construct a scientific and comprehensive evaluation system.

5. A Review of Research on Green Development and Project Performance

Green development emphasizes the balance between environmental protection and economic benefits, and project performance evaluation provides quantitative tools for achieving this balance. Integrating the green development concept into project performance evaluation not only enhances the environmental benefits of the projects but also provides strong support for enterprises to achieve sustainable development. Through a systematic review of existing literature, this study finds that current academic research on the level of green development and project performance mostly focuses only on independent discussions. For instance, Xia Yingzhe (2022) focuses on the assessment of the level of green development, while Zheng Haichao et al. (2015) mainly concern the measurement of project performance. However, conducting systematic research by combining the two aspects, especially exploring the relationship between green concepts and project performance from the perspective of corporate social responsibility (including environmental responsibility) in the context of "dual carbon" is relatively scarce. Existing related studies mostly take engineering projects as the research objects (such as Lu Xining et al., 2020; Zeng Haiqi et al., 2024), and have not deeply analyzed the intrinsic connection between the level of green development and project performance from the perspective of pharmaceutical projects.

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