

Analysis of Low-carbonization of Hebei's Construction Industry based on BP-DEMATEL Model

Shan Wu, Yuxuan Wang

College of Civil and Architectural Engineering, North China University of Science and
Technology, Tangshan 063210, China

Abstract

With the increasing global concern about climate change, the low-carbon development of the construction industry has become an important issue. This paper takes the construction industry of Hebei Province as the research object, and uses the BP-DEMATEL model to analyze the factors affecting the low-carbon development of the construction industry of Hebei Province. This paper expounds the urgency and importance of low-carbon construction industry in Hebei Province. As a large energy consumption and carbon emission, the low-carbon construction industry is an inevitable requirement to cope with environmental challenges, which helps to reduce air pollution, reduce greenhouse gas emissions, and create a healthy and comfortable living environment for residents. Promoting the low-carbon construction industry in Hebei is in line with the sustainable development strategy, which can save energy resources, reduce building operating costs, and improve the economic efficiency and competitiveness of buildings. Through literature research and expert interviews, numerous influencing factors including building material selection, construction technology, energy management, policies and regulations, etc. are referred to, which constitute the input layer of the model. Then, the analysis results are input into BP neural network for training and prediction, so as to accurately grasp the development trend of low-carbon construction industry in Hebei Province, and provide scientific basis for government decision-making and enterprise actions. A series of strategic suggestions are put forward to promote the low-carbon development of Hebei construction industry. Promote innovation in building materials, promote advanced construction technologies and processes, and strengthen energy management. We will strengthen low-carbon awareness and professional skills training for construction workers and cultivate professional talents. Encourage public participation, raise public awareness and understanding of low-carbon buildings, promote the concept of green building, and form a good atmosphere for the whole society to jointly promote the low-carbon construction industry. As far as the current actual situation is concerned, the low carbon level of the construction industry in Hebei is currently at a medium level. This situation clearly means that the construction industry in Hebei still has a huge potential for improvement in the low-carbon development. In the future, by adopting a series of more active and effective measures, Hebei's construction industry is expected to take a more solid step on the road of low-carbon development, achieve a higher level of development, and make greater contributions to environmental protection and sustainable development.

Keywords

BP-DEMATEL Model; Low-carbon; Construction Industry.

1. Introduction

In the present era, global climate change has become one of the major challenges facing mankind. The continuous increase of greenhouse gas emissions has led to the rising

temperature of the earth and the frequent occurrence of extreme climate events, posing a serious threat to human survival and development. As a large energy consumption and carbon emission, the low-carbon development of the construction industry is of vital significance to cope with climate change.

Hebei Province as an important industrial base and construction province, the construction industry in the province's economic development occupies an important position. However, for a long time, the development of the construction industry in Hebei Province mainly relies on the traditional mode of high energy consumption and high emission, which not only causes a lot of energy waste and environmental pollution, but also restricts the sustainable development of the construction industry. Under the general trend of global low-carbon economic development, Hebei's construction industry urgently needs to realize low-carbon transformation to meet the requirements of The Times and its own development needs.

BP-DEMATEL model is used to analyze the key factors affecting the low-carbon development of Hebei's construction industry, providing strong theoretical support and decision-making basis for formulating a scientific and reasonable low-carbon development strategy of Hebei's construction industry. The application of BP-DEMATEL model to the low-carbon analysis of Hebei construction industry has enriched the methods and theoretical system of low-carbon research in the construction industry. Through the identification and analysis of the influencing factors, the inherent law and mechanism of the low-carbon development of the construction industry in Hebei is revealed, which provides a new idea and direction for further research on the low-carbon development of the construction industry. It provides scientific basis for Hebei Provincial government and relevant departments to formulate low-carbon policies for the construction industry, which helps guide construction enterprises to actively adopt low-carbon technology and management mode, and promote the sustainable development of Hebei construction industry. At the same time, this study also has certain reference significance for the low-carbon development of the construction industry in other regions. BP neural network is a multi-layer feedforward network trained according to error backpropagation algorithm, which has strong nonlinear mapping ability and self-learning ability. In this study, the BP neural network is used to calculate the weight of the factors affecting the decarbonization of the construction industry in Hebei.

2. BP-DEMATEL Model

Decision and Laboratory Analysis (DEMATEL), proposed by the National Laboratory of the United States, is based on the principles of graph theory and matrix theory to analyze system factors. This method can analyze the importance of each factor in the system of influencing factors and the influence relationship among the factors. For this reason, it is widely used in the research field of influencing factor identification and analysis. However, this method also has some shortcomings, among which the most obvious is that it mainly relies on the subjective score of experts when determining the direct influence matrix, which weakens the reliability of the research conclusions to a certain extent. For complex comprehensive problems involving multiple interrelated factors, BP-DEMATEL model can provide an effective solution. In the study of urban sustainable development, economic growth, environmental protection, social equity and other factors need to be considered. The model can help analyze the relationship between these factors and provide a basis for formulating a comprehensive sustainable development strategy.

The DEMATEL method first needs to construct the matrix of the direct influence relationship between the factors. Experts are invited to rate the degree of direct influence between the various factors in the system. In the study of the low-carbon construction industry in Hebei, experts need to evaluate the degree of direct impact of energy factors, scientific and

technological factors, social factors, etc. BP neural network has input layer, hidden layer and output layer. In the model combined with DEMATEL, the results of the center degree and cause degree of the factors analyzed by DEMATEL can be used as the input data of BP neural network. Firstly, DEMATEL method is used to determine the mutual influence relationship and importance degree among energy, science and technology, society and other factors.

3. ANALYSIS

In the DEMATEL method, centrality and causality are metrics used to measure how important a factor is in the overall system. It takes into account the influence of a factor on other factors and how the factor is influenced by other factors. The factors with a high degree of centrality are at the core of the system's interrelationship network, and these factors often play a key role in the overall operation and development of the system. If the cause degree of a factor is positive, then the factor is mainly a "cause factor", that is, the degree of its influence on other factors is greater than the degree of its own influence by other factors, and it tends to actively cause changes in the system. Conversely, if a factor has a negative causation degree, then that factor is primarily a "consequence factor," meaning that it is more influenced by other factors than it is by other factors, and reacts more passively to changes in other factors in the system.

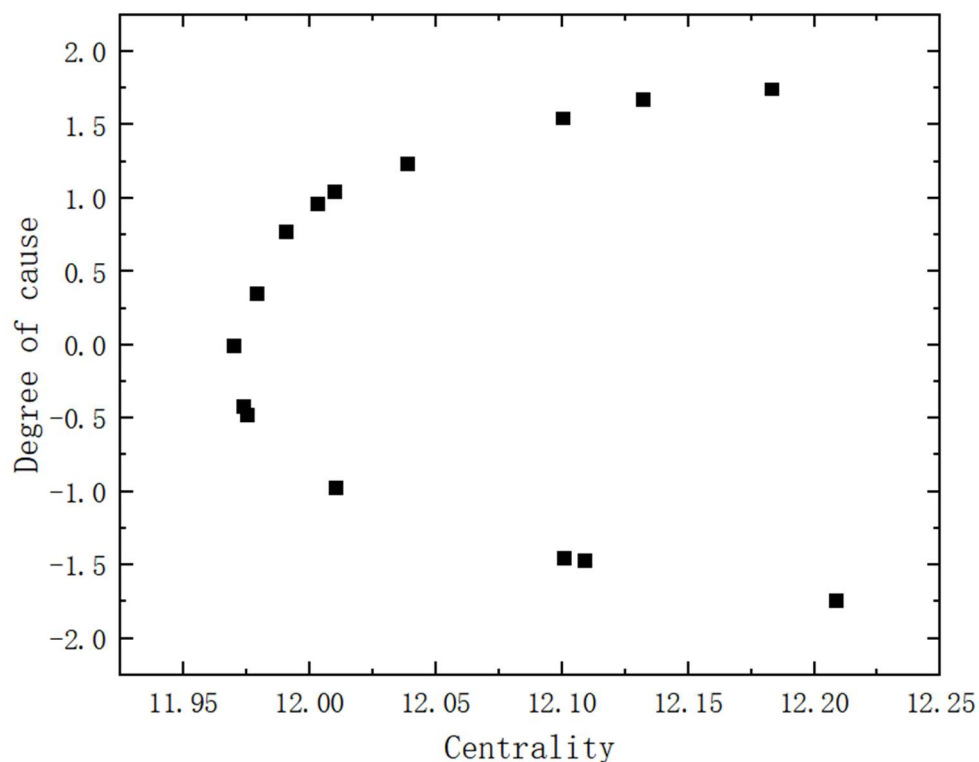
When analyzing the factors of low-carbonization of the construction industry in Hebei, considering centrality and causality simultaneously can more comprehensively evaluate key factors. Combining centrality and causality helps to construct a complete causal chain to understand the low-carbon construction industry system. It can identify which are the main causal factors, and these factors affect other result factors with higher centrality through their positive causality. The collaborative analysis of centrality and causality can help us grasp the dynamic balance of the low-carbonization system of the construction industry in Hebei. Through this analysis, we can formulate countermeasures in advance to maintain the dynamic balance development of the system in the direction of low carbonization.

Table 1. Index system of driving factors for low-carbon construction industry in Hebei Province

Index type	Level 1 Indicator	Secondary indicators
Input metrics	Energy	D1. Share of coal energy production in total energy production (%)
		D2. Total annual power of machinery and equipment (million kilowatts)
		D3. Energy use (tons of standard coal / 10,000 yuan)
	Technology	D4. Internal expenses (billion yuan)
		D5. Investment intensity (%)
		D6. Number of patents (pieces)
	Society	D7. Natural population growth rate (%)
		D8. Urbanization rate (%)
		D9. Population aging rate (%)
	Economy	D10.GDP(billion yuan)
		D11. Industrial structure (%)
		D12. Per capita income (Yuan)
	Industries	D13. Labor Productivity (Construction)(Ten thousand Yuan)
		D14. Total building area (10,000 square meters)
		D15. Total output value (construction industry) (100 million yuan)
Output index	Carbon emissions from construction	Carbon emissions from construction

Table 2. Low carbon centrality and cause degree of construction industry in Hebei Province

Primary index	Secondary index	Centrality	Degree of reason
Energy	D1. Share of coal energy production in total energy production (%)	12.0032	0.9637
	D2. Total annual power of machinery and equipment (million kilowatts)	12.1087	-1.4648
	D3. Energy use (tons of standard coal / 10,000 yuan)	11.9752	-0.4778
Science and Technology	D4. Internal expenses (billion yuan)	11.9907	0.7746
	D5. Investment intensity (%)	12.0387	1.2415
	D6. Number of patents (pieces)	12.1321	1.6741
Society	D7. Natural population growth rate (%)	11.9739	-0.4147
	D8. Urbanization rate (%)	12.1831	1.7471
	D9. Population aging rate (%)	12.1008	-1.4473
Economy	D10.GDP(billion Yuan)	12.2087	-1.7437
	D11. Industrial structure (%)	11.9698	-0.0061
	D12. Per capita income (Yuan)	12.1001	1.5483
Industries	D13. Labor Productivity (Construction)(Ten thousand Yuan)	12.0099	1.0463
	D14. Total building area (10,000 square meters)	12.0103	-0.9726
	D15. Total output value (construction industry) (100 million yuan)	11.9792	0.3549

**Figure 1.** Cause-and-effect diagram

The study takes energy, technology, society, economy and industry as five first-level input indicators. Based on the proportion of coal energy production in energy output, total annual power of machinery and equipment, energy use, internal expenditure, intensity of expenditure input, number of patents, natural population growth rate, urbanization rate, population aging rate, GDP, industrial structure, per capita income, labor productivity (construction industry), total floor area of housing, total output value (construction industry), The output index is carbon emission of the construction industry. It is shown in Table 1. Construct a direct association matrix between the input metrics to get the centrality and source factors. This is shown in Table 2. The relationship between the degree of center and the degree of reason is shown in Figure 1.

4. Conclusion and Recommendations

This study focuses on the important issue of low-carbon construction industry in Hebei Province, and uses advanced BP-DEMATEL model to conduct a comprehensive and in-depth analysis. In the research, the comprehensive use of literature review and expert interviews and other methods, successfully identified a series of energy, technology, society and economy and other key factors that have an important impact on the low-carbon construction industry in Hebei. Through careful analysis, it is found that science and technology and economy play a core role in promoting the process of low-carbon construction industry in Hebei.

The evaluation results of the low carbonization level of Hebei's construction industry show that it is currently at a medium level, which means that there is still a huge potential for improvement. Based on this, the paper puts forward some suggestions for development strategy. At the enterprise level, it is necessary to increase the investment in the research and development of low-carbon technology, actively carry out technological innovation activities, improve the energy utilization efficiency of buildings, pay attention to improve the management level, strengthen the low-carbon management of the whole process of construction engineering, and ensure the double improvement of project quality and efficiency. At the social level, we should strengthen the public's environmental protection education, enhance the public's environmental awareness and responsibility, cultivate the market demand for low-carbon buildings, improve the public's understanding and acceptance of low-carbon buildings, encourage the public to actively participate in the construction and management of low-carbon buildings, and jointly create a good social atmosphere conducive to the low-carbon development of the construction industry.

The results of this study not only provide scientific theoretical basis and practical strategic guidance for the low-carbon development of the construction industry in Hebei Province, but also provide valuable reference experience and innovative ideas for the low-carbon development of the construction industry in other regions. However, it must be clearly recognized that there are still some limitations in this study. There may be errors in data collection and processing, and the applicability and generality of the model also need to be further verified. Future research can continue to expand the scope of data collection, optimize the structure of the model and strengthen the dynamic monitoring and evaluation of the low-carbon development of the construction industry, so as to continuously promote the sustainable development of the construction industry.

The low-carbon development of the construction industry in Hebei is a complex and arduous systematic project, which requires the government, enterprises and the public to work together and make joint efforts. It is believed that with the joint efforts of all parties, Hebei construction industry will be able to successfully realize the low-carbon transformation, and make greater contributions to building a beautiful China and promoting the sustainable development of the global construction industry.

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