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Research Article

Evaluation of Coordinated Development of Logistics Development and Low-Carbon Economy in Wuhan Based on Big Data

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Logistics industry in Wuhan city under the influence of economic development and related logistics policies, consumer demand is increasing, achieving a steady and rapid sustainable development. However, the ensuing high-energy consumption and high pollution have caused great pressure and negative impact on the environment of Wuhan city, and the pollution control problem has gradually aroused the common concern of the government, people, and relevant scholars, and the future development trend of low-carbon logistics has become a research hotspot of this new industry of logistics. In recent years, Wuhan city has been deeply affected by haze, and low-carbon and sustainable development is an important driving force for activities related to energy saving and emission reduction in Wuhan city at present. The logistics industry, as a high potential industry with high-speed development, is a key industry for environmental management and supervision, and the contradiction between the high-speed development of logistics industry and environmental pollution problem needs to be properly handled. This paper measures and analyzes the comprehensive efficiency of the logistics industry in Wuhan city from the perspective of low-carbon development, describes the current situation of the development of low-carbon logistics in Wuhan city and the problems that exist, analyzes them, and proposes feasible policies and establishments to make a contribution to the future development of low-carbon logistics in Wuhan city. This paper analyzes and organizes a large amount of literature, defines the definition of low-carbon logistics and performance evaluation, and selects the performance evaluation method that meets the research topic of this paper. On the basis of theoretical support, combined with the current situation of the development of low-carbon logistics industry in Wuhan city, reasonable indicators are selected for regression analysis of impact factors, and this paper's low-carbon logistics efficiency evaluation index system is established to evaluate the performance of the low-carbon logistics industry in Wuhan city from 2010 to 2019, and finally put forward targeted policy recommendations.

1. Introduction

In recent years, the low wind speed and low range of cold air activity in winter in China have prevented cold air from the northwest from reaching Wuhan due to the obstruction of the mountains in the North China Plain. Few or even no winds in the city in winter [1] have led to the gradual emergence of the haze problem in Wuhan city. The annual use of coal in Wuhan city is large, and its combustion process is accompanied by the production of large amounts of sulfur dioxide and carbon dioxide substances, which are the main sources of pollution in the haze; the emissions of pollutants in the atmosphere are also large and have far exceeded the purification capacity of the atmosphere itself. In addition, due to the dense population of the municipality, the consumption of resources is increasing year by year, and the accumulation of citizens' household waste and industrial production waste is not well treated, resulting in the emission of large amounts of carbon dioxide gas. All the above reasons have aggravated the duration and severity of the haze in Wuhan city [2]. If we want to solve the problem of haze in Wuhan city, we should control the air pollution from the early warning, and on this basis, we should urge the transformation and upgrading of various industries in Wuhan city to protect the ecological environment on which human beings live [3]. Therefore, the development of low-carbon economy in Wuhan city is a necessary path to achieve stable socio-economic growth and sustainable development. As the pace of socio-economic and industrialization development continues to accelerate, the modern logistics industry appears in front of people's eyes. The State Council released the Medium and Long-term Plan for the Development of Logistics Industry (2014-2020) in 2014, in which it was pointed out that the logistics industry has become an important part of the national economic development and is a basic and important strategic industry supporting the national economy of China [4–10].

Wuhan city is the center of Wuhan Metropolitan Area; Wuhan city circle is a comprehensive supporting reform pilot area for the construction of China's resource-saving and environment-friendly society. With this favorable geographical location, Wuhan city is becoming an increasingly important part of the national logistics map. Along with the booming development of the logistics industry, its high-energy consumption and the emergence of a large number of pollutants make this crude development model a great threat to environmental protection issues [11]. According to relevant statistics, the CO_2 emissions per unit GDP of the five major industries, such as agriculture, industry, and commerce, have been decreasing year by year, but the carbon emissions per unit GDP of the logistics industry are still high, and there is a large room for improvement, while the energy consumption generated by the logistics industry is about 10% of the total energy consumption in China. In 2017, Premier Li Keqiang, in the work report of the Party Central Government, proposed that in the future, China should focus on enhancing low-carbon sustainable development and ecological civilization construction, and carry out targeted special treatment actions for key industries such as the logistics industry that may produce greater pollution [12]. As a result, the logistics industry, as one of the major modern service industries, plays a crucial role in the development of a low-carbon economy. Therefore, if Wuhan city wants to improve the carbon intensity and alleviate the current situation of haze pollution, it is necessary to change the current crude logistics industry production methods to achieve the long-term green and sustainable development of Wuhan city's low-carbon logistics economy from the source. Nowadays, the environmental pollution problem in Wuhan city needs to be solved, and the logistics demand remains high or even continues to grow, so it is necessary to evaluate and study the performance of the logistics industry in Wuhan city based on the development perspective of low-carbon economy [13–18]. This paper will analyze and measure the low-carbon logistics performance of Wuhan city from 2010 to 2019 from several perspectives, and use Beijing as reference object to study the current situation of low-carbon logistics performance in Wuhan city and its influencing factors, and give reasonable suggestions for improvement. The logistics industry is a basic and service-oriented industry for social and economic development, an important modern service industry and a pillar industry of the national economy, and the higher the level of development, the higher the market activity and the more rapid the social and economic development, that is, it is the gas pedal and lubricant of social and economic development. Today, China has become the world's largest logistics market and developed into a logistics power that can influence the world. In 2017, China's civil aviation cargo volume is the second in the world, and the road cargo volume, container throughput, railroad cargo delivery volume, port throughput, railroad cargo turnover, and express delivery volume are the first in the world [19].

The logistics industry has become a new growth point for the economic development of the Yangtze River Economic Zone. Many empirical studies have shown that growth based on increased factor inputs is not sustainable, and a more sustainable and high rate of total factor productivity improvement is the key to economic growth [20]. Therefore, the important driving force of high-quality development is to improve total factor productivity, which is of great significance to China's success in building a moderately prosperous society. In-depth understanding of the connotation and requirements of improving total factor productivity is conducive to taking appropriate measures to accurately target key areas of reform, thereby promoting high-quality development. Therefore, the logistics industry has a pivotal position in the national economy and the Yangtze River Economic Zone, while there are also some problems, such as poor quality and efficiency and environmental pollution, and the Yangtze River Economic Zone is one of the most densely populated economic zones in China. In order to achieve green and high-quality economic development, we should do so in accordance with the requirements of "strengthening the construction of infrastructure networks such as water conservancy, railway, highway, water transport, aviation, pipeline, power grid, information and logistics" put forward in the report of the 19th National Congress of the Communist Party of China. In order to achieve green and high-quality economic development, and to fulfill the requirement of the 19th Party Congress, we should actively explore how to improve the green total factor productivity of the logistics industry in the Yangtze River Economic Zone.

2. Materials and Methods

2.1. Low-Carbon Logistics. Low-carbon logistics is a new disciplinary concept that integrates ecological civilization, logistics management, environment and science, and knowledge from a variety of other disciplines. The core of the concept is the integration of environmental impact factors and logistics management related research and planning, and the development of logistics industry should pay attention to the coordination and synchronization of environment and economy [21]. They proposed in a special issue of International Distribution and Logistics Management on "The State of the Environment in the Logistics Industry" that the recycling of packaging could be a way to achieve low-carbon logistics. This was the first time that the definition of "low-carbon logistics" appeared in academic circles. Along with the rapid development of the logistics industry, many new logistics management methods have emerged, and the concept of low-carbon logistics has been constantly updated and iterated, but its original intention has not changed, that is, to achieve more economic benefits on the basis of saving logistics resources and protecting the ecological environment, so that the synergistic development of the environment and the economy becomes a reality. This concept will also be a new concept that pays more attention to the overall situation and effectively enhances the long-term economic benefits.

Logistics companies are engaged in the operation of logistics systems and the design of logistics operations within the basic functions of logistics. Such enterprises have information management systems suitable for their own company development business, and are an economic organization that can assume its own civil responsibility and conduct independent economic accounting. In other words, a logistics enterprise needs to have more than two logistics activities such as warehousing, transportation, loading and unloading, packaging, distribution, distribution processing, and information processing, integrated and multifunctional operation and management according to certain consumer needs, and through an information management system suitable for its own business, it is an economic organization that can assume its own civil responsibility and conduct independent economic accounting. The logistics industry is an emerging industry in the current society and belongs to the complex industry. It is the result of the integration of transportation, storage, and communication industries, which effectively ensures the supply of social life and production. For the definition of the concept of logistics industry, it cannot be regarded as just one industry such as transportation or warehousing. Because such an aggregated industry is not simply a superposition of all industrialized logistics resources, but through effective integration and optimization, so as to achieve the effect of "one plus one more than two." Therefore, this paper defines the logistics industry as transportation, warehousing and logistics, and postal logistics.

At present, there is no specific definition of the concept of logistics performance at home and abroad, and most of them are based on the concept of efficiency and then extended. Efficiency refers to the amount of work done per unit of time, or the ratio of labor to the amount of labor. From the point of view of economic activities, the Dictionary of Economics, an economic dictionary that is quite authoritative in the West, argues that "efficiency is actually the efficiency of resource allocation, which can be seen as the maximum satisfaction of the operating conditions required by the customer under economic, technical and resource constraints, i.e., the reasonable input required to achieve maximum output." According to the Italian economist Pareto, a given state of resource allocation is considered optimal by Pareto if no change would make the situation better for at least one person and worse for no one at the same time. The concept of Pareto efficiency has also become an accepted concept of efficiency by many economists. An efficient economic structure must ensure that its production model is possible. Based on the above text on efficiency, we define logistics efficiency as the ratio of logistics inputs to outputs. The formula can be expressed as $E = Y/X$, where E is logistics efficiency, Y is total logistics output, and X is total logistics input. For enterprises, logistics efficiency refers to whether the logistics system can effectively meet the requirements of customers at a certain service level, as shown in Table 1. Since the logistics process related to economic activities in modern society is very complex, its form and content are also different.

For the current logistics research status, trying to properly measure logistics efficiency is a flexible operation, and different methods should be used for different aspects. Based on the concept of logistics efficiency, an objective assessment and measurement of the efficiency level of the logistics industry from a low-carbon perspective will help the government to have a better grasp of the future development direction of low-carbon logistics and thus plan the logistics industry in a more reasonable way. Therefore, it is very necessary to establish an effective low-carbon logistics performance index system based on the current development of the logistics industry. Nowadays, the low-carbon development of logistics industry is still in the early stage of exploration, the research time is relatively short, and the evaluation of low-carbon logistics performance has not yet been clearly defined by domestic and foreign academics. According to the definition of the concept of low-carbon logistics, it can be concluded that the evaluation of low-carbon logistics performance should contain two levels, namely, the current level of economic development and the level of energy and environmental development. Therefore, this paper defines low-carbon logistics performance evaluation as the process of deriving performance values by effectively measuring and analyzing the current state of economic development and energy and environmental development under the condition that the output level of overall or regional logistics behavior remains stable within a certain administrative and economic scope.

2.2. Methods and Models for Measuring Low-Carbon Logistics Performance. Data envelopment analysis, also known as DEA, is a new interdisciplinary research field that integrates multiple disciplines such as management and science, operations research, and mathematics and economics into one, as shown in Figure 1. The specific principle is: first, with the help of linear programming method in mathematics discipline, a production possibility frontier, which can contain all input and output data, can also be called efficiency frontier surface, is established. Each set of input and output data can correspond to a decision unit, considered its observation point; afterwards, the distance from each of these decision units' observation points to this efficiency frontier surface is compared to obtain the specific value of the relative effectiveness of each decision unit. Assuming that this computational process is free from any random errors, the results can be broadly classified into two categories: the first, when the relative

Table 1: Logistics efficiency and input-output.

Time	Logistics efficiency	Total logistics output	Total logistics input	E
2010	1.82	2.80	2.67	1.04
2015	1.44	1.94	1.85	1.04
2020	1.26	4.94	4.52	1.09

efficiency takes the value of 1, the DEA of the DMU is invalid, indicating that the observation points of the different input and output data composed of this DMU coincide perfectly with the efficiency frontier surface. In the second one, the DEA of DMU is invalid when the derived relative efficiency value ranges from 0 to 1, indicating that the observation points of different input and output data composed of this DMU deviate from the performance frontier surface, and the straight-line distance between the observation points and the performance frontier surface can indicate the level of relative efficiency, and the farther the distance, the higher the level of relative efficiency, and vice versa, the lower the level of relative efficiency. After obtaining the different efficiency values of each decision unit, the system can also rank the efficiency values, which is helpful to compare more intuitively the gaps existing between different decision units and give the theoretical basis for the proposed decision recommendations. At the same time, since the evaluation results also reflect to some extent the increasing, constant, or decreasing change state of the scale efficiency of each decision unit, it allows decision-makers to make effective decisions when adjusting the current production scale level.

With the gradual expansion of its application area, scholars have derived more scenarios to evaluate. They believe that data envelopment analysis models can evaluate the relative efficiency among multiple scenarios, provide scientific and effective recommendations for the selection of various scenarios, and can also be used to study whether new decisions affect the relative effectiveness of previous decisions. Therefore, today's data envelopment analysis models consider the same kind of enterprises or sectors as the decision unit of their research, and after evaluating the technical efficiency (e.g., labor force) and scale efficiency (e.g., capital invested) of these enterprises or sectors separately, they then evaluate the social efficiency and economic efficiency of the output and other indicators for relative effectiveness, thus completing the evaluation process of data envelopment analysis models. At present, many domestic and foreign researchers have applied the DEA method to measure the comprehensive efficiency, mainly focusing on various fields such as evaluation of economic system, evaluation of bank management efficiency, and evaluation of technological innovation efficiency. In this paper, through an in-depth study of the characteristics of the logistics industry, the DEA method was selected to evaluate the level of logistics performance in Wuhan city, and its raw data are shown in Table 2.

The main reasons are as follows: (1) the logistics industry is a new industry in the society at present and belongs to the complex industry. It is the result of the integration of industries such as transportation, storage, and communication. In the evaluation process, the input and output indicators needed for the decision unit need to be selected from different fields, and there is no clear functional relationship between these input and output indicators, which is very much in line with the requirements of the data envelopment analysis model for indicators. (2) The different selection of indicators in the logistics system determines the different measurement units of the indicators, but the DEA method has no specific requirements for the measurement units and does not require normalization of data, which greatly reduces the computing process. When using DEA method to measure logistics performance level, it can be divided into two types of models: one is Input-Oriented model, which refers to how to minimize the input of the model at this time when the output is within a certain output range.

The other type of model is the output-oriented model, Output-Oriented, which refers to how to maximize the output of the model at this time when the input is within a certain input range. The indicators selected for different models are different, but Tim Corelli has mentioned in his previous article that the differences between the two models do not have much impact on the final efficiency evaluation results. Therefore, the evaluation index system can be established by selecting the more accessible indicators starting from the principle of indicator desirability. Through the analysis of the relevant characteristics of the former logistics industry, it can be seen that logistics input elements are easier to handle and control than logistics output elements. In this paper, according to this characteristic, the input-oriented data envelopment analysis model will be selected to measure and analyze the low-carbon performance level of the logistics industry in Wuhan city.

Data envelopment analysis models can be classified into nonradial and radial models based on the difference in their methods of improving inefficient DMU. In this paper, the nonradial data envelopment analysis model, the SBM model, is selected, and its improvement process is designed with both slack variables and equiproportional variables, and the efficiency is evaluated by the average of the reduced inputs or outputs. The SBM data envelopment analysis model is:

$$\min p = 1 - \sum_{i=0}^{n} Si_i / x_{ij}, \tag{1}$$

$$X\alpha + Si = x_i, \alpha \leq 1, \tag{2}$$

where X and Y denote the input and output indicators, respectively, the weight vector, and S- denotes the slack variables of the input indicators. The performance value of the selected decision unit is used in the model to measure the degree of DEA invalidity from the level of input indicators, expressed by the formula:

$$\frac{\sum_{i=0}^{n} Si}{n} = x_i. \tag{3}$$

The technical performance of SBM-DEA based on the assumption of constant scale efficiency involves a

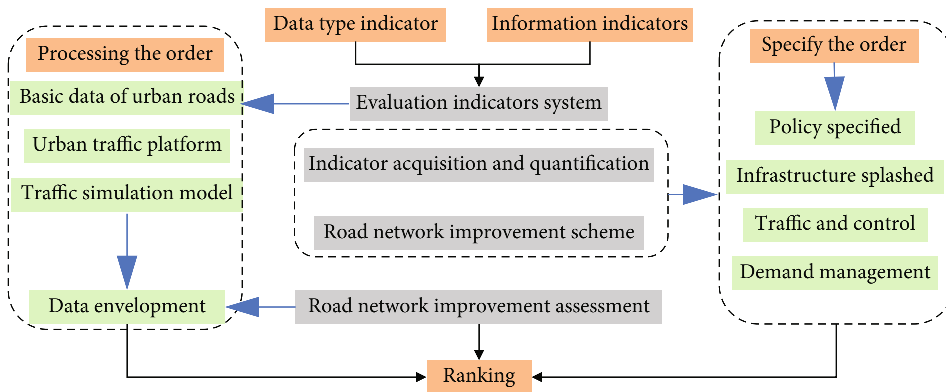

Figure 1: Data envelopment analysis workflow.

component of returns to scale, adding valid constraints to the SBM data envelopment analysis model.

$$\sum_{i=0}^{n} \alpha_i = 1. \quad (4)$$

So that the selected decision unit and the production function where the projection point is located are on a horizontal line, after which it is possible to derive the value of the scale efficiency benefit under variable conditions, i.e., the value of pure technical efficiency. Using the technical efficiency (TE) and the pure technical efficiency (PTE), it is possible to measure the value of its scale performance (SE), i.e., SE = TE/PTE.

As mentioned above, the data envelopment analysis model not only measures performance but also provides suggestions on how to improve ineffective decision units. Comparing the actual energy consumption and CO2 output with the resulting projections provides an effective measure of the energy-saving and emission reduction performance of the logistics industry. The planned energy input represented by the energy consumption projection points on the front surface is denoted by Etarget and the actual energy input is denoted by Factual, then the energy performance Logistics Total Factor Energy Efficiency, or L, is calculated as:

$$L = 1 - \frac{Ei}{\text{Eenrgy}_{\text{actual}}}. \quad (5)$$

The annual Logistics Saving Potential of Energy, or Q, for the logistics industry in different regions is calculated as:

$$Q = \text{Eenrgy}_{\text{actual}} - \frac{Ei}{\text{Eenrgy}_{\text{actual}}}. \quad (6)$$

The performance values calculated by the DEA method are stage values and in most cases fall within the range of 0 to 1. The regression analysis is done on the basis of the measured low-carbon logistics performance. If the least squares method is used to complete the regression analysis process, the data obtained from the parameter evaluation will be biased. Tobit is a regression analysis model in which the dependent variable is distributed with a constant positive value and some observations have a positive probability of 0. Tobit is a regression with a constrained dependent variable. The Tobit regression analysis model was selected to analyze the level of low-carbon performance and its influencing factors in the logistics industry in Wuhan city.

Table 2: 2010-2019 Wuhan input-output raw data table.

Year	Total investment in fixed assets (billion yuan)	Length of transportation lines (million km)	Gross value of logistics industry (billion yuan)	Carbon emissions (million tons)
2010	1175	1.04	18.12	1.22
2011	2352	1.76	22.05	1.38
2012	2413	2.27	45.70	1.05
2013	1816	2.49	45.19	1.11
2014	1520	3.26	40.37	1.82
2015	1425	3.94	40.65	2.20
2016	1336	4.52	40.24	2.67
2017	1296	5.32	43.43	3.20
2018	1398	5.72	45.94	3.44
2019	1498	7.92	46.88	5.51

3. Results

3.1. Selection of Indicators for Low-Carbon Logistics Performance Impact Factors. There are many factors that can influence the low-carbon development of the logistics industry, such as the degree of marketization, the level of economic development, the degree of informationization, the policy environment, and the synergy between e-commerce and the logistics industry. This paper collates the influencing factors of low-carbon logistics in existing studies, as shown in Table 3.

Based on the above table for the reference and combing of previous literature, combined with the principles of index selection, this paper will analyze and study the influence factors of low-carbon logistics industry in Wuhan city from five dimensions.

Table 3: Sorting out indicators related to impact factors.

Influencing factors	Total logistics output	Total logistics input	E
1	4.70	6.15	0.76
2	3.48	5.85	0.59
3	5.65	6.33	0.89
4	8.32	4.42	1.88
5	7.89	4.36	1.81
6	7.56	4.32	1.75

Location factors. Location factor mainly refers to the possible influence of regional location on the development of logistics industry. A favorable geographical location is essential for the prosperous development of the logistics industry, which can not only promote the development of the local logistics and transportation industry and improve the efficiency of warehousing and logistics distribution services, but also reduce the input of transportation costs, improve the flow rate of resources between local and surrounding areas, optimize the reasonable allocation of logistics infrastructure and resources, and better improve the overall efficiency of the logistics industry. Wuhan economic circle, a metropolitan area in the middle reaches of the Yangtze River in southern China, is located in Hubei Province. The locational entropy represents the proportion of the gross product of the logistics industry to the gross product of a region, or refers to the proportion of the GDP of the national logistics industry to the GDP of the national gross product, i.e., it is used to measure the proportion of the logistics industry's intensity compared to other industries within a certain region.

Economic development status. The level of regional logistics industry performance and the regional economic development status are closely related. The development of economic level will tap many potential transportation demands, thus enhancing the market share of low-carbon logistics industry. At the same time, high level of economic development can effectively enhance the technical efficiency of production factors and logistics industry, thus improving the overall efficiency of low-carbon logistics industry. The economic development status is considered by most scholars as one of the important elements affecting the low-carbon performance of logistics industry, so this paper takes the level of residential consumption as a secondary metric to measure the development status of central Yangtze River.

Logistics information level. The higher the degree of informationization, the more quickly the customer's needs can be received, and the more effective and rational distribution of business between different processes in the logistics process, thus saving time and costs and improving the overall efficiency of the logistics industry. Nowadays, most of the demands of the logistics industry come from the express transportation services derived from the rapid development of e-commerce, and the scope and coverage of the network will have a direct impact on the express transportation services. Therefore, this paper selects the number of Internet access ports as a secondary metric to measure the degree of logistics informatization.

Human resource level. Manpower is an essential element for any industry, and the development of the logistics industry today is also inseparable from the high quality and high level of professionals. In the past few years, the development of logistics industry has gradually realized the change of automation and informationization, and this status quo makes logistics professionals become scarce. Therefore, in analyzing the influence elements of human resource level, we should focus on both quality and quantity elements of human cost input. In this paper, logistics professional talent input is used as a secondary metric to measure the impact of human resource level on logistics industry. However, due to the complexity of obtaining relevant data, this paper takes the proportion of the gross product of logistics industry in Wuhan city to the gross product of Wuhan city in that year and multiplies the number of college graduates in Wuhan city in that year to get the result as the index of professional talent input in logistics.

Level of government intervention. Scientifically, sound policy interventions can solve the problem of infrastructure and resource allocation, thus enhancing the related benefits. For any industry, the level of government intervention will have a significant impact. Nowadays, the transportation industry is one of the areas where the state focuses on regulation and control, and it is precisely this area that maintains a close connection with the logistics industry. Therefore, this paper selects the ratio of pollution control investment to fiscal expenditure in Wuhan city as a secondary indicator to measure the intervention level of Wuhan government on the current development of local low-carbon development and industrial economy.

Since the measurement of low-carbon logistics performance involves energy efficiency values, emission reduction efficiency values, and comprehensive technical efficiency values of the logistics industry, the analysis process requires three regression processes. In this paper, the regression results are calculated using Stata 15.0 software, and then ranked and analyzed as shown in Figure 2.

The regression results show that a value of P less than or equal to 0.05 indicates that the effect of the explanatory variables on the dependent variable completes the significance test at a 5% significance level, as shown in Figure 3. From the perspective of the energy performance of the logistics industry, the entropy of location (X1), the level of consumption of the population (X2), and the investment in pollution control (X6) have a significant positive impact. In other words, the location factor, economic development status, and the government's measures and instruments for pollution control can assist the logistics industry in Wuhan city to reduce energy consumption better to a certain extent.

For the value of emission reduction efficiency of logistics industry, four explanatory variables, namely, location entropy (X1), investment in logistics professionals (X4), total government financial expenditure/GDP (X5), and investment in pollution control (X6), all have significant positive effects. In other words, the location factor, economic development status, policy financial investment, and the means of pollution control measures can assist the logistics industry in Wuhan city to improve the efficiency of emission reduction. From the perspective of the comprehensive technical performance level of the logistics industry, the four explanatory variables of location entropy (X1), population consumption level (X2), investment in logistics professionals (X4), and investment in pollution control (X6) have significant positive effects on the comprehensive technical efficiency of the logistics industry in Wuhan city, as shown in Figure 4, that is, location factors, economic development status, human resource level, and government measures and instruments for pollution control. All of them can effectively improve the comprehensive technical performance of logistics industry in Wuhan city.

3.2. Low-Carbon Logistics Evaluation. The performance assessment system is a complete system used to assess the relationship between indicators and their variables. For the logistics industry in Wuhan city, the performance of low-carbon logistics should be how to maximize low-carbon efficiency, and its indicators contain multiple dimensions, which can promote the healthy development of the logistics industry, but also to achieve low-carbon environmental protection as the premise of sustainable development; both to compare the logistics industry in Wuhan in different years, but also to compare with different cities on the level dimension, analyze the evaluation results of the shortcomings to improve, in order to achieve the advantage of the synergy between the development of the logistics industry and the environment in Wuhan city as a whole.

3.3. Data Envelopment Analysis. In this paper, the input-oriented SBM-DEA model of the data envelopment analysis model is selected, and Max DEA Pro software is used to evaluate and analyze the performance level of low-carbon logistics in Wuhan city from both vertical and horizontal levels. The vertical evaluation results of the efficiency value of low-carbon logistics industry in Wuhan city from 2010 to 2019 help to better understand the current status of low-carbon development of logistics industry in Wuhan city in recent years. And the results of the cross-sectional study are divided into two parts: economic development, energy and environment. Technical efficiency, pure technical efficiency, and scale efficiency are selected to measure the current economic development of Wuhan logistics industry in the central Yangtze River region, and the research results represent the efficiency values of the economic development dimension. Energy saving and emission reduction efficiency, energy efficiency, and energy emission reduction are selected to measure the low-carbon development capability of Wuhan logistics industry in the central Yangtze River region, and the results represent the benefit value of energy and environment dimension, as shown in Figure 5.

The data related to the efficiency table of the logistics industry in Wuhan city in the figure below shows that the mean value of technological efficiency in Wuhan city during 2010-2019 is 0.05, the mean value of pure technological efficiency is 0.24, the mean value of scale efficiency is 0.66, and the comprehensive technological performance value from 2010-2013 is equal to 1, indicating the logistics industry in Wuhan city The technological development during this

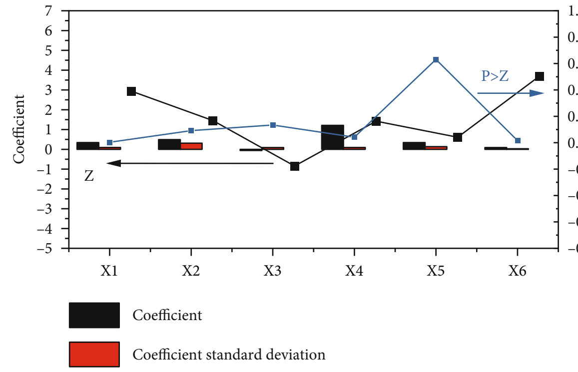

Figure 2: Tobit regression results of factors influencing energy efficiency values in the logistics industry.

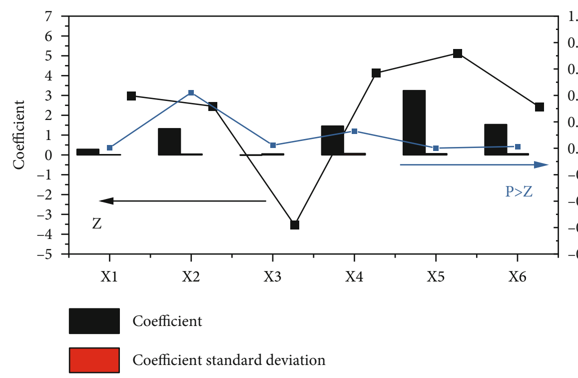

Figure 3: Tobit regression results of the factors influencing the overall technical efficiency value of the logistics industry.

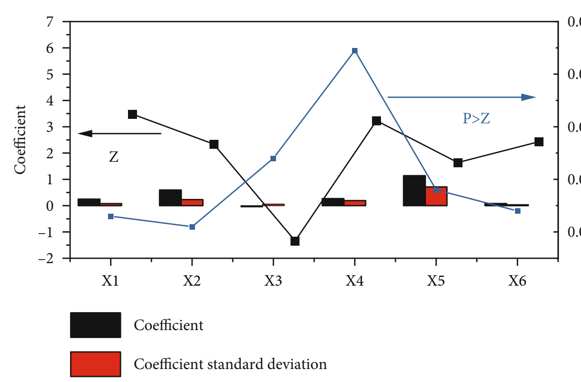

Figure 4: Tobit regression results of factors influencing emission reduction efficiency values in the logistics industry.

period has kept pace with the development of the overall logistics industry and achieved DEA effectiveness, as shown in Figure 6. However, after 2013, the performance of Wuhan logistics industry fluctuates, and the integrated performance value of logistics industry is smaller than 1, and DEA is ineffective, which indicates that the inputs of Wuhan logistics resources are not fully utilized and the outputs are not optimized. The reasons may be as follows: ① Under the constraints of investment capital and scale, there are few large

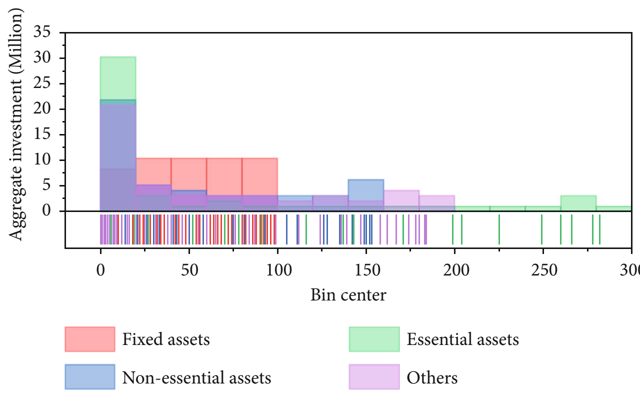

FIGURE 5: Benefit values for energy and environmental dimensions.

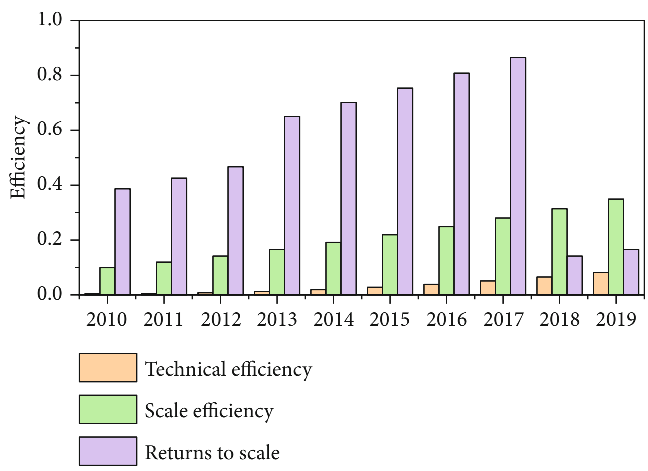

FIGURE 6: Wuhan logistics industry efficiency table 2010-2019.

logistics enterprises in Wuhan city, and many small logistics enterprises lack the operation of advanced logistics equipment and the introduction of professional logistics personnel, which leads to the waste of resources in the investment of logistics resources. ② No good play of Wuhan port's location advantage, port resource allocation needs to be further optimized; port distribution system needs to be further improved; port logistics development needs to be further expanded. ③ The transport tools of most logistics companies in Wuhan city at this stage are mainly ordinary trucks, and the construction of warehouse storage facilities is also relatively backward. Although some enterprises have started to establish warehouse management systems and data exchange systems, there are few enterprises using new logistics technologies such as radio frequency identification and automatic sorting systems. Although there are still certain problems in the development of logistics industry in Wuhan city, they can be effectively solved through effective measures such as resource allocation, asset investment, and talent introduction. Although the integrated logistics performance value is still less than 1 in recent years, the overall trend shows a positive trend, and the technical efficiency, pure technical efficiency, and scale performance of the logistics industry in Wuhan city in 2019 take values above 0.9. Therefore, it is practical to make the logistics efficiency in Wuhan city improve through relevant data analysis.

Analyzed from the perspective of the mean value, the average value of the integrated technical performance of China's logistics industry is equal to 0.997, which is the highest value of China's integrated technical performance within this region of the central Yangtze River, indicating that China's logistics industry has a relatively low investment balance and good resource allocation. Except for 2018, the composite performance takes a value of 1 for all remaining years, i.e., DEA is valid, indicating that the technological development of the Chinese logistics industry is highly effective and has reached a relatively stable state. However, this does not mean that there is no investment redundancy in China's logistics industry, but the performance in the relevant evaluation indicators selected in this paper is relatively effective. Beijing's comprehensive technical efficiency is the least efficient among the three regions in the central Yangtze River, with an average value of 0.614. This phenomenon indicates that the efficiency level of Beijing's logistics industry has not reached the optimal state in the context of both scale and technology, and there is still much room for improvement and development of investment redundancy under the condition of ensuring the optimal output.

4. Conclusion

(1) The measurement of the logistics industry in this paper relies on scale efficiency and pure technical efficiency. Scale efficiency reflects the gap between the existing scale of the logistics industry and the optimal production scale. Only if the prerequisite of the optimal production scale is met, then the resource input at the same output can be minimized, thus achieving cost minimization. And pure technical efficiency reflects the degree of utilization of various production factors that a certain regional logistics industry can achieve after excluding the interference of scale efficiency

(2) In this paper, Maxdea Pro is used as the calculation software to analyze and study the scale efficiency and pure technical efficiency of the logistics industry in the central Yangtze River region. It is feasible to improve the logistics efficiency in Wuhan city through relevant data analysis. The results of the cross-sectional evaluation show that from the economic development dimension, the pure technical efficiency of the logistics industry in Wuhan city is already at a high level, while the scale efficiency still has more room for progress, and the future development of the logistics industry in Wuhan city should focus on the optimization and upgrading of the industrial scale, the scientific and reasonable allocation of logistics resources, and the improvement of the utilization rate of logistics resources, so as to improve the efficiency of the logistics industry

Data Availability

The figures and tables used to support the findings of this study are included in the article.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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