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Research Article

Sustainable Development Analysis Model Using Multi-objective Optimization and Regional Efficiency Evaluation

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Regional efficiency refers to the ratio of the effective total output and the total input of regional factor resources under certain production technology conditions. At present, China's traditional economic growth mode is based on the mode of sacrificing the environment for economic growth. At the same time, the influence and restriction of natural resources and natural environment on human social and economic development are more obvious than ever before. The contradiction between social and economic development, resources, and environmental preservation has become increasingly prominent. Problems such as resource shortage, environmental pollution, and ecological imbalance have exposed the disadvantages of the traditional development model, and so human beings have begun to seek new high-quality development models. Therefore, the research on regional efficiency in this paper is based on the idea of coordinated development of resources, environment and social economy, and multi-objective optimization algorithm, which constructs the evaluation index system of regional efficiency, comprehensively measures the regional efficiency, and inspects the development status. Evaluating the regional efficiency is conducive to analyzing the problems existing in regional development, saving resources, and promoting the sustainable development of the region.

1. Introduction

In today's world, development is more than just economic progress; it is a four-in-one, coordinated advancement of society, economy, resources, and the environment, resulting in overall societal progress [1]. As a result, for macro-management and decision-making, a country or region must consider the coordinated development of society, economy, resources, and environment. Mankind must examine the path that has been travelled, reflect deeply on the blind development of the environment, resource abuse, and pollutant discharge at random, summarise these errors, and propose a new mode of production for the harmonious development of resources, environment, economy, and society [2]. China is currently undergoing industrialization, and resource and environmental issues are becoming increasingly prominent, posing a bottleneck to economic development and social progress. The key to doing a good job in environmental preservation in the new situation is to implement "three changes" [3] as quickly as possible. As a result, we must shift from extensive to intensive growth, abandoning the practise of sacrificing the environment for economic growth in favour of maximising economic growth while protecting the environment. At the same time, the impact of natural resources and the natural environment on human social and economic development is more visible than ever [4]. Economic and social development at the expense of resources, energy, environmental degradation, and ecological destruction is not sustainable development, and it should be pursued within resource and environmental carrying capacity [5].

If you wish to coordinate the development of the four, you must first assess the coordination status, then create a strategic programme to support the coordinated development of the four, and then forecast the coordinated development of the four's future [6]. The clashes between social and economic progress, resource conservation, and environmental protection are becoming more apparent. Issues

including resource scarcity, pollution, and ecological imbalance have exposed the faults of the classic development model [7]. Despite China's great achievements in economic development, the contradiction of an unreasonable economic structure has built up over time, costing the country dearly in terms of demand imbalances, uncoordinated supply structures, low factor utilisation efficiency, large environmental damage, and unreasonable spatial layout, among other things [8]. For the integrated growth of society, economy, resources, and environment, both qualitative and quantitative trend analyses are required [9]. According to the Asian Development Bank, if China's energy efficiency matches that of Western countries, GNP may quadruple from that in 1992 without increasing energy intake, considerably lowering the strain on China's environment [10]. The notion of "optimizing economic growth by environment" is a major breakthrough in the interaction between environment and development, and it will undoubtedly propel China's economic development and growth to new heights. The basic goal of sustainable development is to accomplish the coordinated development of humans, resources, and the environment, with the coordinated development of resources, environment, and social economy being the key to achieving this goal [11].

Regional efficiency refers to the ratio of the effective total output of regional element resources to the total input under certain production technology conditions. Improving efficiency is important to relying on economy, by improving production technology, optimizing management, saving resources, and increasing the ratio of input to output [12]. The final foothold of the coordinated development of resources, environment, and social economy must be a certain area [13]. The evaluation of regional efficiency is conducive to analyzing the problems existing in regional development, saving resources, and promoting regional sustainable development. The coordinated development of society, economy, resources, and environment is not only the core content of sustainable development, but also the key and fundamental means to achieve sustainable development [14]. Therefore, we should establish a scientific, rigorous, reasonable, and easy to operate comprehensive index system to evaluate the coordination of the four. At the same time, the evaluation of coordinated development is an important link between theory and practice of the coordinated development research because the region is a large complex system including the economic system, the social system, the resource system, and the environmental system [15].

2. Analysis of Human-Resource-Environment Problems

2.1. Human Factor Analysis. In the human-resource-environment system, people are the main body, the key to creating wealth and achieving set goals, and the main factor affecting resources and the environment. For a long time, the quality of human life has been tirelessly matched with nature to promote social and economic development. Environmental pollution and ecological damage are becoming more and more common, the environment is deteriorating, and even evolving into related economic and political contradictions and crises, thus threatening human beings [16]. Assuming that there is a fast resource table large enough to record the information of successful resource scheduling, the resource can be searched from the fast table, and the model is shown in Figure 1 below.

People are accustomed to thinking in linear terms to comprehend and solve linear and nonlinear problems "Naturally! To understand and deal with complex things with nonlinear relationships, use linear thinking! It is a significant factor in our decision-making errors! For many years, it has also been a significant issue in planning work " (17). When researching complex systems such as the economy, natural resources, and the environment, people are accustomed to focusing their attention on the system's object, but they frequently overlook the system's subject and environment, making it difficult to grasp the system's essential connotation [17]. As a result, it is clear that coordination is a good correlation between systems, and development is a system's evolution process. The growth of the population, the improvement of economic development, and the expansion of the scale of cities and towns should all be guided by resource and environmental constraints, such that the negative impact of human activities on the environment and resources is kept within the carrying capacity of the resources and the environment [18]. Population growth hastens environmental and resource destruction, which is exemplified by the destruction of forests and grasslands, which leads to soil erosion and desertification. Simultaneously, population growth will put more pressure on environmental pollution, such as air and water pollution that are particularly noticeable.

On the one hand, it is difficult to improve significantly once the employment rate and investment ratio have reached a certain level; on the other hand, increasing input without improving the efficiency with which these inputs are used will inevitably result in diminishing returns. The resource and environment system's logistics and energy flow are the sources of the socio-economic system's logistics and energy flow, and the socio-economic system is the guarantee of the resource and environment system's logistics and energy flow's continuous flow. Continuous population growth will inevitably necessitate more food, fuel, and other necessities of life, all of which must be provided by the Earth's limited resources [19]. Many places are still on the path of grey development, with the traditional economic development model of "pollution first, treatment later, development first, preservation later" dominating. Resources have a carrying capacity, and social and economic development must stay within that range. Exceeding this limit will result in resource scarcity and environmental degradation. According to statistics, southeast China accounts for the vast majority of the total national discharge of sewage, waste gas, waste residue, and major pollutants, indicating that less than half of the land area in southeast China bears the vast majority of the national pollution load. The degree of coordination and the level of coordinated development are then used to evaluate the system's time series of coordinated development, and the grey GM(1, N) model is used to

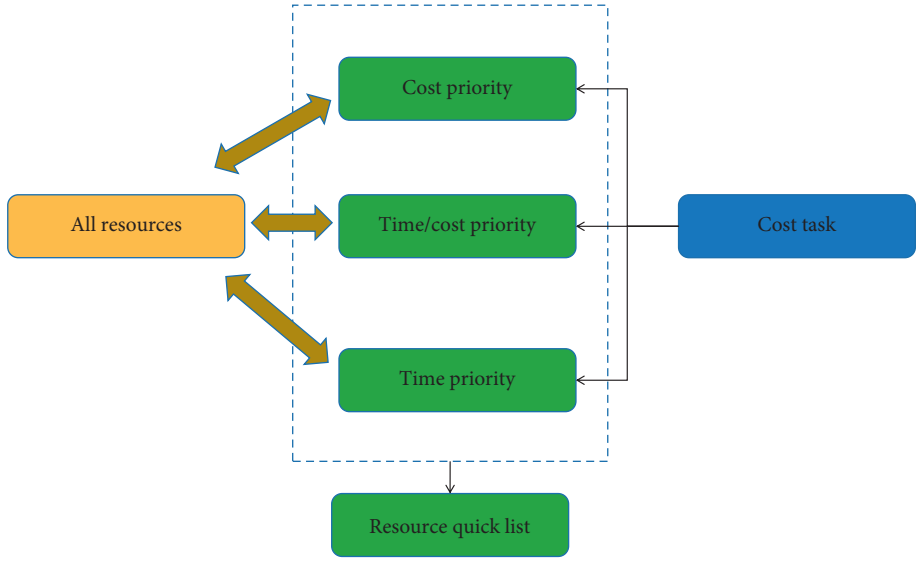

Figure 1: Search model of computing resources.

evaluate the coordination between the system and its criterion level, as shown in Figure 2.

It is clear that China's current economic growth mode is primarily defined by the "three highs and one low": high investment, high energy consumption, high growth, and low efficiency. The dominant mode of development is development, and the economic development model based on the heavy chemical industry, which ignores the preservation of the natural ecological environment, has become increasingly unsuitable for the needs of the times [20]. As a result, "coordinated development" can only be defined as the intersection of "coordination" and "development." From low to high, and from simple to complex, it is the system or the elements within the system that are based on harmony, proper coordination, and a virtuous circle, i.e., the overall transformation from disorder to order. How to develop the social economy within the constraints of resource and environmental carrying capacity while pursuing social and economic development maximisation has become a critical issue. The basic principle of human survival is symbiosis between man and nature. Human beings must first comply with natural laws and deal with the relationship between good people and nature; they must also comply with social development laws and deal with the relationship between good people and society. Human progress and social and economic development, on the other hand, should be adept at utilising nature, transforming nature, and encouraging to develop in a manner that meets human needs. Human beings arose and developed as a result of the dynamic balance of the natural complex's overall relationship [21]. The system's connotation includes concepts such as economy, resources, and the environment. It also includes the object's related subject as well as the subject's surrounding environment. We must recognise the environmental safety problem, which is a threat to human society's survival and development caused by environmental issues (environmental pollution, ecological destruction, and global environmental problems). It's also the warning bell for human society's survival and development, the late bell of modern industrial civilization, and the early bell of the coming green new civilization [3].

2.2. Manufacturing Resource Optimization Method. Manufacturing resources are the physical manifestation of a company's production capacity. Manufacturing resources are defined as the physical elements of all production activities that an enterprise completes throughout the life cycle of a product in a broad sense. The process of a system or its constituent elements changing from small to human, simple to complex, low-level to high-level, and disorder to order is referred to as development. According to the "Zero Growth Theory," economic growth and technological progress are depleting resources, and environmental pollution is becoming increasingly serious, putting human survival at risk. Economic "zero growth," which advocates population and citizens, is the most fundamental way to protect humans from disaster or destruction. The gross value of production cannot continue to rise. Within the limits of resource and environmental carrying capacity, rationally allocate various resources, maximise human socio-economic activities, realise the coordination of economic development, social progress, resource development, and environmental preservation, and continuously improve the order of the large system of human society in order to achieve the greatest harmony, optimization, and overall benefit maximisation [22]. The increase in factor input is theoretically limited, whereas technological progress is unbounded. Scientific and technological advancements can increase the input and output of the same amount of resources. Exploring regional efficiency is important for countries to formulate and adjust regional development policies, as well as to understand the utilisation efficiency of regional factor resources. China accounted for 16 of the world's 20 most polluted cities, according to the World Bank's 2001 development report [23]. The factors reflecting the system's coordinated

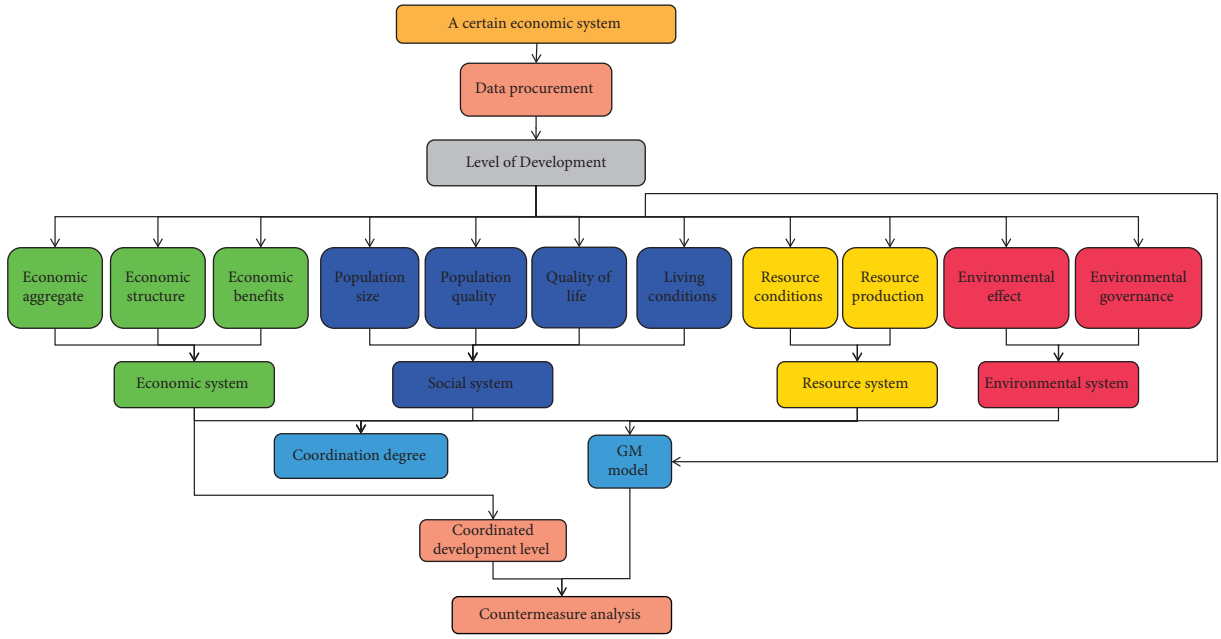

Figure 2: Coordinated development process.

development are analysed and reasonably synthesised, and a comprehensive evaluation index system is proposed, based on design principles and understanding and research of the social, economic, resource, and environmental systems. The economic-environmental system is a multi-layered system in which the environmental system serves as the foundation and the economic system serves as the main body. As shown in Figure 3, the essence of coordinated economic-environmental development is to fully utilise and promote the positive relationship between economy and environment, realise the virtuous circle between them, make the economy develop steadily, use resources reasonably and efficiently, and have a good environment.

To begin, establish an environmental priority principle and implement a comprehensive decision-making mechanism. The basic idea behind system coordination is to use a specific method to organise and regulate the studied system, find solutions to contradictions and conflicts, and transform the system from disorder to order and coordination [24]. The enterprise can be divided into five levels based on its organisational structure: enterprise, workshop, unit, workstation, and equipment layers. Each layer represents manufacturing resources with specific characteristics and functions. In comparison to the view that economic development ignores environmental impact and views nature as a simple object of claim, the "zero growth theory" is a step forward, but it goes too far in the opposite direction, treating nature as a simple object of preservation. We should consider not only the regional economic benefits, but also the social and environmental benefits, and create an index evaluation system that integrates the resources, the environment, and the socio-economic factors to measure regional efficiency.

Second, alter people's perceptions of political accomplishments, strengthen the administrative accountability system, and put the government's environmental responsibilities into action. To achieve environmental optimization of economic growth, we must prioritise environmental preservation as a means to adjust the economic structure and change the growth mode, solve environmental problems in development, and seek development through environmental preservation, which is a major issue in China's socialist modernization process, and we must create an overall social system to support it. Observing the current state of China's development in the face of numerous constraints, we must adopt the correct transformation strategy and choose the correct path in order to implement the scientific development concept and build an ecological civilization, as well as to realise the transformation of economic growth mode from extensive to intensive. Integrity, comprehensiveness, and internality are all important aspects of coordinated development. It is the "development" of multiple systems or elements under the beneficial constraints and regulations of coordination, rather than the "growth" of a single system or element.

3. Evaluation of Coordinated Development of Resources, Environment, and Social Economy

3.1. Coordination Degree of System. China's current national economic accounting system is based on the internationally accepted SNA model, which does not include depletion cost accounting for natural resources and the environment, restricting resource allocation rationality and exacerbating resource waste and pollution. Coordination is a control and management function that adjusts the relationship of various activities in the whole around the coordinated person's development goal, such that these activities can reduce contradictions and develop together, and promote the coordinated person's target realisation. The concept of

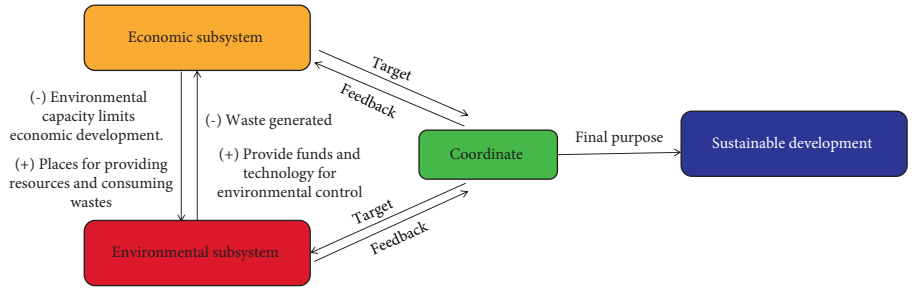

Figure 3: Framework of coordinated development of the economic-environmental system.

sustainable development encompasses the economy, society, culture, technology, and natural environment. Economic development can create the most optimised living and industrial environments for human development by developing and utilising the natural environment; it can create more social wealth to protect and improve the environment; and provide a strong material basis for solving environmental problems. It can promote the modernization of technical equipment, prompt humans to improve environmental quality, and provide modern technical equipment with good environmental conditions, as well as provide an inherent power guarantee for the development of environmental preservation.

In the stage of knowledge economy, people mainly rely on knowledge and technology to produce products with low material consumption and high quality and function, and rely on knowledge and technology to achieve efficient management. By analyzing the history of industrial social development, especially the development process of developed countries, it can be found that there is such a relationship between the level of economic development and environmental damage: in the early stage of economic development, environmental quality may decline and deteriorate with economic growth, but at a certain inflection point, environmental quality may gradually improve with the further development of economy. The degree of information repetition between two indicators can be reflected by their simple correlation coefficient. We cannot simply measure the amount of repeated information between an index and other indexes by summing the simple correlation coefficients between the index and other indexes. Therefore, it can be weighted by the method of complex correlation coefficient. Firstly, the correlation coefficient matrix r of p evaluation indexes is obtained by the following formula:

$$r_{ij} = \frac{\sum(x_i - \overline{x_i})(x_j - \overline{x}_j)}{\sqrt{(\sum x_i - \overline{x}_i)^2 (x_j - \overline{x}_j)^2}},$$

$$R = \begin{bmatrix} 1 & r_{12} & \Lambda & r_{1p} \\ r_{21} & 1 & \Lambda & r_{2p} \\ \Lambda & \Lambda & \Lambda & \Lambda \\ r_{p1} & r_{p2} & \Lambda & 1 \end{bmatrix}. \quad (1)$$

Calculate the complex correlation coefficient between the P index X_p and other P-1 indexes, and decompose the matrix R as follows:

$$R = \begin{bmatrix} R_{-p} & r_P \\ r_p^T & 1 \end{bmatrix}_1^{p-1} \left(\mathrm{R}_{-\mathrm{p}}\text{represents the correlation matrix of removing.} X_p\right). \quad (2)$$

Thus, the calculation formula of p_i^2 is

$$p_i^2 = r_i^T R_{-i}^{-1} r_i, \quad (i = 1, 2, \ldots, p). \quad (3)$$

Synergy determines the cooperation ability of the subsystems within the system. It is the intermediary of the disaster connection of the subsystems and elements of the system. It is the reason for an orderly and stable system structure. It affects the characteristics and the laws of system phase transition (state change). We should reform the current national economic accounting system, replace the traditional GNP with "Green GNP," ensure the internalization of environmental costs and resources to users, and promote them to use resources and environmental property in a sustainable way.

10 users and 10 resources are randomly generated. There are three optional scheduling strategies: Optimise Cost, Optimise Time, and Optimise Cost and Time. Conduct 10 scheduling experiments. After each experiment, the user randomly generates one. Although the user's name is the same, the data have changed and belong to different users. The resource scheduling situation under Optimise Cost and Optimise Time is shown in Figure 4.

Sustainable development is a combination of three issues: economic, social, and environmental. Make each system produce a coherent effect, in which the overall function of the system is greater than the sum of the local functions, and finally achieve a coordinated state of the system; if the synergy is poor, the resulting negative force will destroy coordination between the subsystems and constituent elements, resulting in reverse amplification, causing the overall function of the system to be less than the sum of its parts, pushing the system to a U-shaped state. According to the characteristics of the regional PRED system and its meaning of coordinated development, two different types of coordination degree calculation formulas are proposed to quantitatively describe the coordination degree of the regional PRED system. These two coordination degree calculation formulas are as follows:

(1) Natural resource type

$$H = K\sum_{i=1}^{n}\cos\frac{\pi}{2}\frac{M_i}{M_{io}}\left(\sum_{j=1}^{1}\frac{G/m_j}{G_0/m_{j0}}e\frac{G/N}{G_0/N_0} - e\sum_{k-1}^{m}\lambda_k\frac{pk}{pk0}\right). \tag{4}$$

(2) Social resource type

$$H = K\left(\sum_{j=1}^{1}\frac{G/m_j}{G_0/m_{j0}}e\frac{G/N}{G_0/N_0} - e\sum_{k-1}^{m}\lambda_k\frac{pk}{pk0}\right). \tag{5}$$

This transition form must be correctly understood and grasped. "Basically realising modernization ahead of time will play a huge role in building a prosperous society in Zhejiang." Economically developed countries are in a better position to deal with environmental issues, as evidenced by the majority middle class's strong awareness of environmental preservation; developed countries' strong economic strength allows them to invest significantly in environmental preservation; and developed countries' science and technology. They have more options and room for manoeuvring in environmental technology because of their technical strength. If there is a significant spatial distribution pattern among spatial objects, then global spatial autocorrelation is present. In the global spatial autocorrelation analysis, the specific form of Moran's I statistics is as follows:

$$I = \frac{N}{s_0}\frac{\sum_{i=1}^{n}\sum_{i=1}^{n} = 1w_{ij}\left(x_i - \overline{x}\right)\left(x_j - \overline{x}\right)}{\sum_{i}^{n}\left(x_j - x\right)^2}, \tag{6}$$

where N is the number of research objects, x_i is the the observed value at the ith spatial position, S_0 is the sum of all elements of the spatial weight matrix W, w_{ij} is the element of the spatial weight matrix W($n \times n$).

To truly realise this adjustment, it is necessary to predict the environmental impact caused by human social and economic activities on the basis of understanding the process of environmental changes, master the laws of natural ecology and economy, restrict production by resources, environment, and moderate consumption, and use nature and economy.

Neither the optimal cost nor the optimal time is used as the scheduling policy, and the load is not very balanced. This shows that it is difficult to achieve load balancing based on a single index, but if the average of optimize cost and optimize time is taken, the situation is very different, as shown in Figure 5.

The average load under Optimise Cost and Optimise Time, and Average is more evenly distributed than the load under Optimise Cost and Time. As a result, classifying tasks can help not only to meet user needs and improve service standards, but also to balance the load and make better use of system resources. On the one hand, we should choose regions with better conditions to lead in exploring how to cultivate knowledge economy, and we should strive to become a demonstration area of knowledge economy in the province by vigorously developing the knowledge industry.

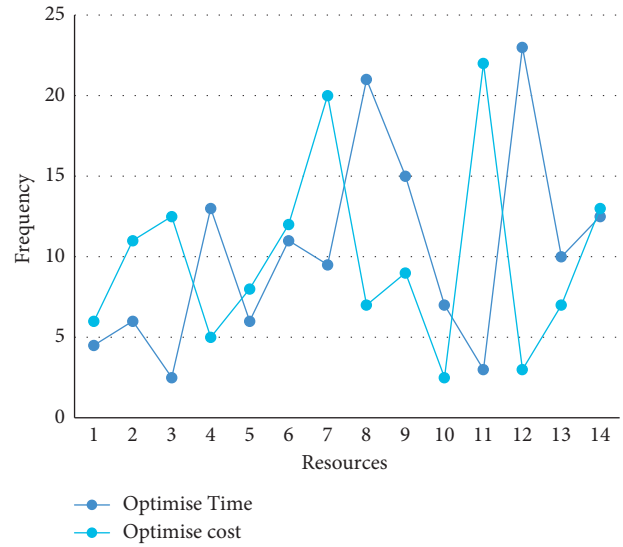

Figure 4: Load comparison between Optimise Cost and Optimise Time.

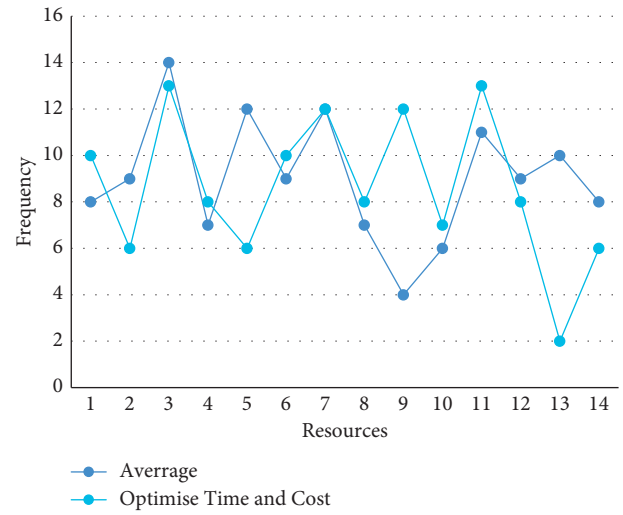

Figure 5: Load comparison between Average and Optimise Cost and Time.

On the other hand, we should introduce some new development ideas for most regions, work to better combine industrialization with intellectualization and informatization, and prioritise the creation of a resource-coordinated national economic system as a strategic choice.

3.2. The Level of Coordinated Development of the System. The development of the economic-environmental system is coordinated. Economic development indicators and environmental development indicators are the two major systems in the indicator system. The old path of industrialised countries' "pollution first, treatment later" and the current model of "high investment and high technology to control environmental problems" can no longer be followed. In terms of resource and environmental management, whether through market mechanisms or government regulations,

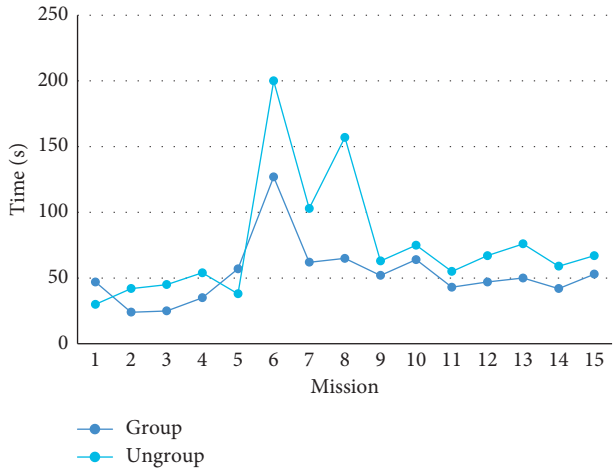

Figure 6: Comparison of the time spent on task grouping and no grouping.

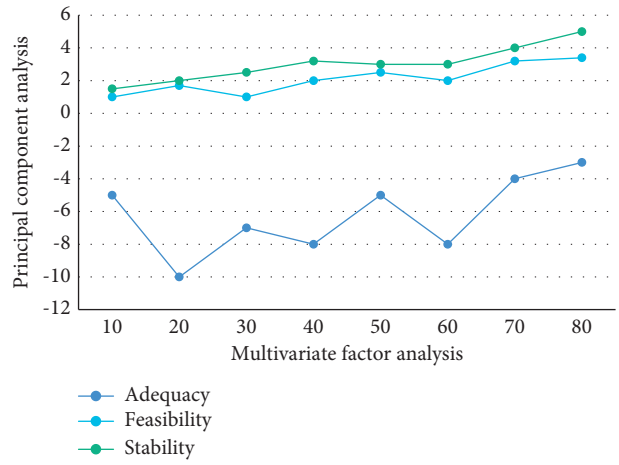

Figure 7: Comparison of the scores of adequacy, feasibility, and stability search results.

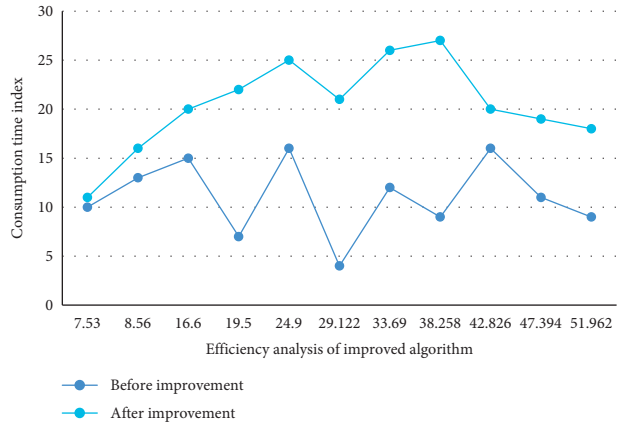

Figure 8: Efficiency analysis of the improved algorithm.

each has its own set of benefits and drawbacks in terms of resource allocation and environmental protection. Between the market and the government, there are two "failures." The government plays the primary role, and they work together to minimise their respective "failures" and achieve a more optimal configuration effect. Group and ungroup are simulated for 15 times. The specific value of the throughput is not given in the simulation results, but the total time spent at the end of the task is given. Submit 15 tasks each time and simulate them in group and ungroup, respectively. The comparison results of the final running time are shown in Figure 6.

Indeed, economic growth at the expense of the environment and natural resources has a limit. The ability to repay must be the limit of environmental "debt-based" economic development, and the result will inevitably impede the economy's long-term development. Where should the development mode of "environment in exchange for growth" change, according to this analysis? There are two options: the first "growth reduction in exchange for the environment," and the second, which shifts in a different direction, i.e., promoting and optimizing economic growth while also preserving the environment in order to achieve both growth and environmental goals. This is referred to as a new type of "environmental optimization growth." As a result, for macro-management and decision-making, a country or region must consider the coordinated development of society, economy, resources, and environment. Not only qualitative but also quantitative trend analysis is required for the coordinated development of society, economy, resources, and environment.

Because the current socio-economic development and resource and environment management belong to different departments, it is difficult to coordinate the relationship between them in specific operations. In order to effectively resolve the contradiction between environment and economy and promote their unity and coordination, we must change the practice of achieving one, affecting or even hurting the other, and instead explore and practice the ways in which the two achieve, complement, and promote each other. In other words, we must move from exchange to optimization. The most commonly used measure index of local autocorrelation is local Moran's I. It is developed from the global autocorrelation index Moran's I. The calculation formula is:

$$I_i = \frac{(X_{it} - \overline{X}) \sum_{j \neq i}^{n} w_{ij}(X_{jt} - X)}{S^2},$$
$$S^2 = \frac{1}{n} \sum_{i=1}^{n} (X_{it} - \overline{X}). \tag{7}$$

Qualitative analysis is mainly based on the purpose and principles of evaluation, considering factors such as the adequacy, feasibility, stability of the evaluation index, and the coordination between the index and the evaluation method. For a specific question, the score comparison of adequacy, feasibility, and stability search results is shown in Figure 7.

ISO14000 is an international standard on "environmental management" formulated and constantly improved

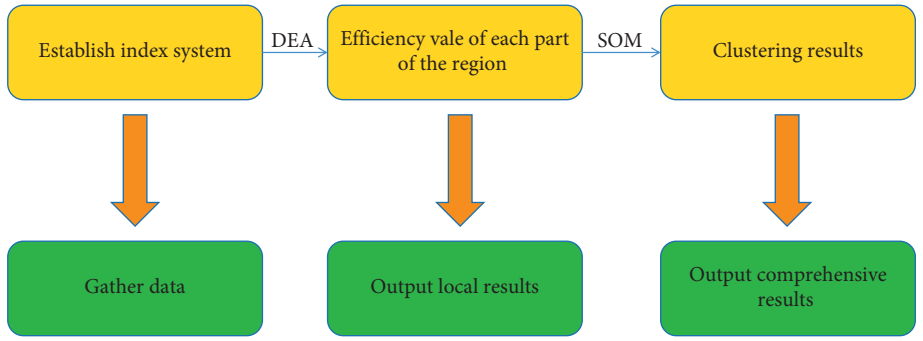

Figure 9: Evaluation flow chart combining DEA and SOM.

Figure 10: Relationship between the actual value and the calculated value of stepwise linear regression.

by the International Organization for Standardization (ISO). It emphasizes strengthening environmental management, preventing pollution, continuously improving environmental behavior, and reducing resource waste, with the ultimate goal of promoting sustainable development. An important reason for the generally low efficiency of resource allocation in various regions and the imbalance in the effect of allocation is the imbalance of regional economic development. According to the algorithm, statistics of several representative multi-analysis cases found that the average time spent is shown in Figure 8.

The evaluation process includes two stages: first, evaluate the efficiency of each part in the region, and get the local evaluation results; for the evaluation of the efficiency of each part in the region, learn from the existing research results and consider the advantages of data envelopment analysis (DEA), and choose data envelopment analysis (DEA) to realise the "local" stage; secondly, the efficiency values of each part are synthesised in some way to obtain comprehensive evaluation results. The clustering function of SOM can realise this process. The specific evaluation process is shown in Figure 9.

From the characteristics of the social, economic, resource, and environmental systems, the realisation process of coordinated development is a complex and changeable process. In the economic model, the linear regression curve is calculated according to the stepwise multiple linear regression equation, as shown in Figure 10.

The core and key to promoting coordinated development is to learn how to build simplicity from complexity and order from chaos and disorder. Furthermore, the organic combination of legislation and law enforcement should reflect the soundness of the environmental rule of law. In terms of the development of the environmental rule of law, most Western countries focused on environmental legislation in the 1960s and 1970s, but the focus has shifted to environmental law enforcement since the 1900s because "the law is not designated for the law itself, but becomes a social constraint through the implementation of the law, such that each part of the country has its own way." China should gradually focus on the implementation of laws and the development of environmental law enforcement capabilities, based on the track and trend of environmental law construction in Western developed countries.

4. Conclusions

The current state of China's economy, resources, and environment is becoming increasingly critical; the energy consumption ratio is rising, and the environmental system is in grave danger. The proper handling of their relationship is a critical issue for society's advancement. If we do not fundamentally alter our economic growth model, we will inevitably see increased resource waste and environmental issues. Finally, it impedes the economy's and society's long-term development. Statistical analysis and grey system theory are combined to create a comprehensive quantitative model for assessing the coordinated development of society, economy, resources, and environment. The degree and level of coordination are used to describe the coordinated development of society, economy, resources, and environment. The research on the coordinated development of society, economy, resources, and environment is broad, thorough, and time-consuming. It can not only sustain and accelerate economic growth if properly regulated, but it can also gradually alleviate the resource-environment conflict. On

the contrary, the state of resources and the environment will deteriorate, impeding or even destroying the economy's healthy growth. Optimizing environmental economic growth is a new environmental requirement and a new countermeasure to meet environmental challenges. We must recognise the mutually beneficial relationship between economy and environment, incorporate environmental preservation into the overall situation of economic and social development, and fundamentally realise the coordinated development of economy and environment.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

All the authors do not have any possible conflicts of interest.

Acknowledgments

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