Comprehensive Evaluation of Ecological Civilization Construction Level and Social Governance Efficiency by Big Data Algorithm Analysis

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ABSTRACT Accurate assessment of complex urban systems requires efficient acquisition, integration, and analysis of large-scale heterogeneous data. This study proposes a big-data-driven evaluation framework for multi-dimensional performance assessment by integrating parallel computing and the analytic hierarchy process (AHP). A distributed information-processing architecture is developed to collect and fuse data from environmental monitoring, economic development, public services, transportation systems, and governance-related platforms. To improve evaluation efficiency, a parallel computing strategy is employed to process large-scale datasets and construct weighted multi-indicator representations. The proposed framework further incorporates hierarchical decision analysis to quantify interactions among ecological, economic, social, and governance factors. Experimental evaluation using two representative cities demonstrates that the proposed method achieves comprehensive assessment scores of 76.7 and 80.6, respectively, improving evaluation performance by 12.5 and 12.9 points compared with conventional approaches. By combining multi-source information fusion, distributed data processing, and intelligent decision analysis, the proposed framework provides an effective methodology for large-scale monitoring, dynamic system evaluation, and data-driven decision support in complex networked environments. Furthermore, the framework offers a scalable information-fusion and data-processing architecture for distributed monitoring systems, providing methodological references for intelligent sensing, networked information acquisition, and data-driven assessment in complex communication and infrastructure environments.

INDEX TERMS multi-source information fusion, distributed monitoring systems, big data analytics, intelligent data processing

I. INTRODUCTION

SINCE the implementation of the reform and opening-up policy, China has been committed to promoting its own economic development. During the rapid development of industrialization, China has transformed from a state of poverty and backwardness to the second largest economy in terms of total economic output, and has moved towards an all-round well-off. Compared with developed countries such as the United Kingdom and the United States, a large number of ecological and resource problems have appeared in the Chinese social and economic development process, and serious environmental pollution has caused great damage to the Chinese ecological environment. Therefore, in recent years, China has vigorously developed green industry, built ecological civilization, and strengthened social governance. For many regional economies dominated by manufacturing which faces critical requirements for wastewater treatment and energy efficiency—this transition to a green model is imperative. However, the previous evaluation methods were time-consuming and laborious. Today, with the development of information technology, it is undoubtedly a more effective method to use big data technology to analyze and evaluate it.

The innovation of this paper is that it explains the process of ecological civilization construction, and builds a social governance framework under big data and an evaluation system for the level of ecological civilization construction. And through the test of multiple indicators, the advantages of using big data algorithm for evaluation are illustrated.

II. RELATED WORK

The level of ecological civilization construction is the embodiment of the soft power of cities and countries, and the efficiency of social governance is the embodiment of the government's ability to govern. Regarding the construction of ecological civilization and social governance, many scholars have conducted relevant research on it. Among them, Yongsheng Z examined the evolution of environmental governance from industrial to ecological perspectives [1]. Guo Y et al. assessed the progress of ecological civilization construction through the lens of environment and public health [2]. Xue B et al. analyzed the concept of ecological civilization within its political and scientific contexts [3]. Chen S et al. explored the representation of China's ecological civilization in global media discourse [4]. Weins N W et al. investigated the practical construction of the climate-forestry nexus under this paradigm [5]. Ying H A N et al. reviewed tourism ecological security as a component of ecological civilization [6]. These studies provide a multidimensional foundation for understanding the field, yet many remain focused on theoretical or specific applied domains, with fewer integrated implementations and quantitative evaluation measures, limiting the persuasiveness of their assessment outcomes. To this end, some scholars proposed to use big data algorithms to analyze the level of ecological civilization construction and social governance efficiency. Among them, Liu D et al. employed a network SBM model to assess the construction efficiency of National Ecological Civilization Pilot Zones [7]. Li M examined the role of big data analytics in green governance and corporate social responsibility [8]. Zhang X et al. researched the impact of industrial big data on the collaborative governance of pollution and carbon reduction [9]. Chang J investigated the effect of digital technology on promoting ecological civilization construction [10]. These studies have promoted the construction of ecological civilization and social governance efficiency to a certain extent, but these studies are not proficient in the application of big data algorithms, and the evaluation of construction level and governance efficiency is not so ideal, so it needs to be further improved.

Based on the reviewed literature, it becomes evident that while existing studies have laid a multidimensional foundation for understanding ecological civilization and social governance, they often remain confined to theoretical exploration or isolated application domains. A persistent limitation is the lack of integrated evaluation frameworks that combine quantitative analysis with comprehensive indicator systems. This study seeks to address this gap by constructing an evaluation system that not only incorporates multiple dimensions of ecological civilization and social governance but also leverages big data algorithms to enhance analytical precision and adaptability. The proposed model is designed to move beyond fragmented assessments and offer a more holistic and data-driven approach, thereby responding directly to the need for more systematic and applicable evaluation methods identified in prior research.

III. COMPREHENSIVE EVALUATION OF BIG DATA

A. CONSTRUCTION OF ECOLOGICAL CIVILIZATION

The construction of ecological civilization is to build a civilization concept of sustainable development and green development. As shown in Figure 1, the construction of ecological civilization includes important ideas such as health, ecology, beauty, and harmony. At present, many provinces and cities are constantly promoting the construction of ecological civilization, from point to point to promote the construction of ecological civilization. However, the status quo dominated by traditional industries in China has not fundamentally changed, and the shortage of supply of main energy and minerals has exacerbated the pollution of the ecological environment. Therefore, it is necessary to analyze the current ecological and environmental problems in China, and propose countermeasures to alleviate Chinese resource and environmental constraints.

At present, the construction of ecological civilization in China is still facing many problems, mainly as follows: First, many cities lack the awareness of the overall situation, and it is difficult to realize the organic unity of economy and ecological civilization; secondly, the Chinese ecological civilization system and institutional system are not perfect, which is manifested in the existence of institutional obstacles, imperfect evaluation and supervision mechanisms, and uncoordinated inter-regional cooperation and coordination mechanisms; third, the Chinese emission permit trading system and environmental protection system are not perfect, so there are certain defects in the Chinese emission permit trading system. Therefore, when constructing an ecological civilization assessment system, it is necessary to analyze the existing problems and find their reasons based on the current ecological civilization construction status. This is the top priority of ecological civilization construction in the future [11].

The construction of ecological civilization is not only a concrete manifestation of the scientific concept of development proposed by China, but also a huge driving force for building a moderately prosperous society in an all-round way in China. The basic goal of ecological civilization construction is to build China into a resource-saving and environment-friendly society. By improving the current land use pattern in China, it can effectively protect the ecological environment of major cities in China, reduce resource waste and pollution, change the mode of economic development, and promote the sustainable development of cities [12,13]. The research on ecological civilization construction in this paper is mainly carried out from several aspects shown in Figure 2. First, this paper defines the goals of civilization construction, then sets goals from theoretical, practical and related policy perspectives, and finally evaluates the research results.

In the era of planned economy, China pursued economic development excessively and neglected environmental protection, resulting in a lot of waste of resources. Extensive economic development has caused serious damage to the natural environment and ecological environment, leading to environmental problems in various parts of the country, such as garbage siege, water pollution, and river stoppage [14,15]. To solve Chinese environmental problems, we must explore the traditional economic development mode, extensive economic growth mode, understand the construction process of ecological civilization, and establish an ecolog-

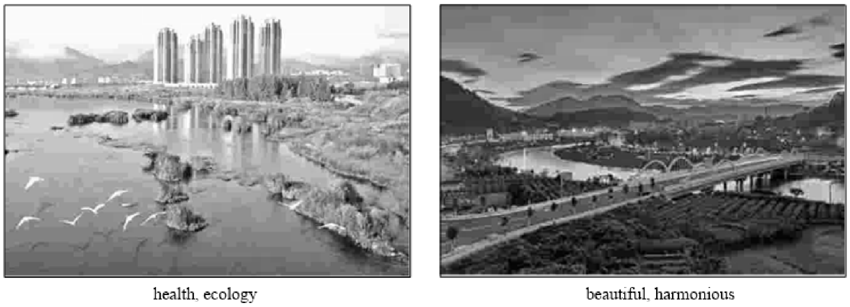


FIGURE 1. Concept of ecological civilization

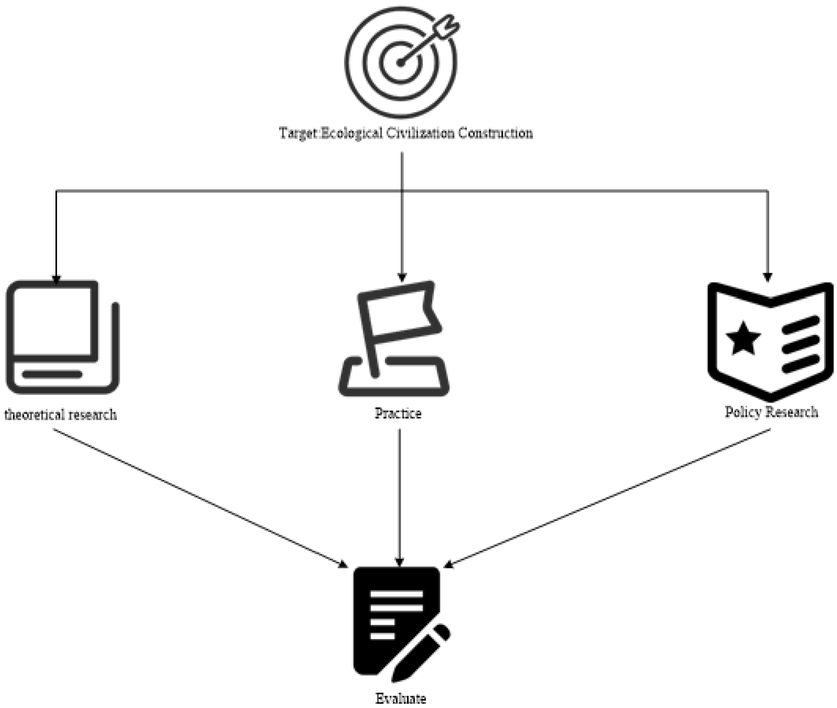


FIGURE 2. Research on ecological civilization construction

ical civilization system. To this end, this paper expounds the construction process of ecological civilization from the two aspects of the government and the public, as shown in Figure 3. For the construction of ecological civilization, we must first make specific plans for the construction content, formulate a construction plan, and then implement the plan according to the construction requirements. At the same time, strict supervision is carried out during the implementation process to ensure the safety of the construction process. After each project is completed, it is necessary to evaluate the construction results, and the evaluation results will be fed back to the implementation process to improve the implementation content and make the construction of ecological civilization more comprehensive and complete.

In order to change the traditional economic development and consumption patterns in China, the relevant green development index must be incorporated into the evaluation index system of ecological civilization[16,17]. Driving by science and technology, reducing unit energy consumption, developing modern service industry, and improving economic efficiency of enterprises are the main ways to promote the development of Chinese green economy. Therefore, in the process of establishing the evaluation index system of ecological civilization, more indicators related to green development must be introduced. At the same time, the government should increase the management and support of green industry, and increase the investment in green industry [18].

The evaluation index system constructed in this study relies on multi-source data, primarily from national and provincial statistical yearbooks of the past three years, publicly released annual bulletins from local governments, and real-time data from ecological and environmental monitoring platforms. This data possesses high timeliness and

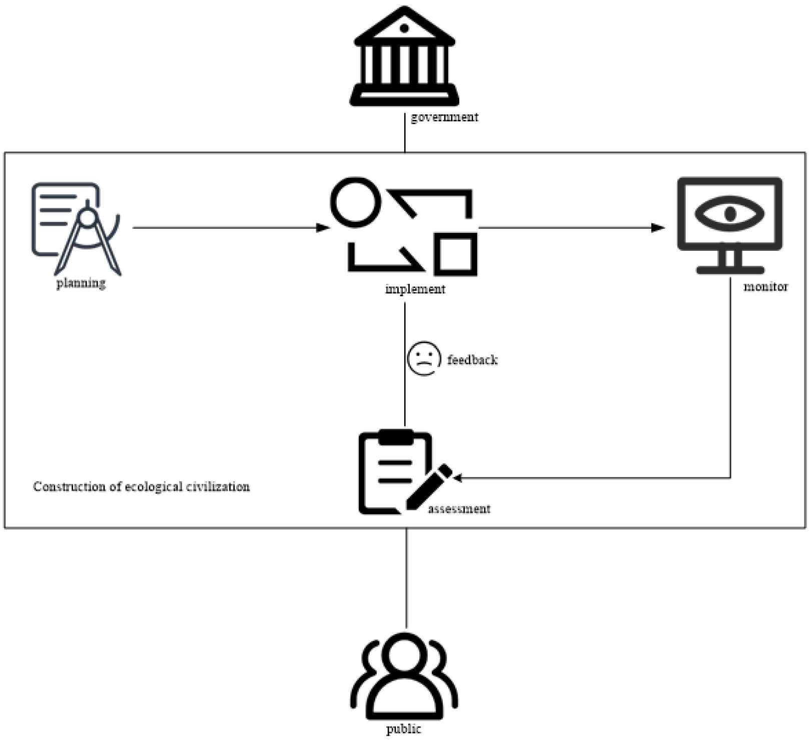


FIGURE 3. The process of ecological civilization construction

authority, reflecting the actual progress of ecological civilization construction in various regions. The index system is designed with a dynamically adjustable structure, allowing for updates based on the evolution of national policies and advancements in data collection technology, thereby maintaining the scientific rigor and adaptability of the evaluation work.

B. SOCIAL GOVERNANCE

The application of social governance theories in different countries is different. Western political ideology is more inclined to public management, while the unique discourse system with Chinese characteristics pays more attention to coordination and participation. Compared with national governance, pluralistic social governance has more institutional advantages, and its pluralistic participation can solve more social problems and improve the efficiency of government governance. The promotion of social governance to traditional unified governance can also be interpreted in a linear way: among them, government management tends to regulate, while social management tends to serve and participate. In these two aspects, the former pays more attention to the management of key issues and grasps the key points, but cannot be all-encompassing; while the latter pays more attention to the handling of details, expands the management work to a wider scope, and also pays more attention to the needs of the people [19,20].

Literature analysis, inductive reasoning and other methods have unique advantages in analyzing China's social management work, and can effectively explore how to effectively improve China's social governance. The research of this paper is mainly from a large number of books on big data platforms and social management, and then combs it in the form of literature to establish the theoretical framework of this paper [21]. This paper searches and selects 500 documents through the keywords of the CNKI website, and summarizes the relevant documents on big data and social governance, as shown in Figure 4. With the passage of time, the number of references has increased significantly. In the past five years, the number of relevant documents has increased, and the number of citations has also increased significantly. The highest number of citations is more than 300, which shows that the use of big data for social governance method has certain feasibility.

In social management, government management is an important work, which has the important function of regulating and solving social problems and contradictions. Even in terms of management, the government can determine the overall management style through competition among social groups. On the surface, the government only plays the role of bidding and supervision, but at a deeper level, it is constantly deepening the selection of talents. This is a reform, from choosing the number of people to choosing the talent, from a higher cost institution to a flexible and cheap institution. In terms of management cost, it is lower than the original administrative agency, and in terms of cooperation within the organization, it also relies on the continuous development of social organizations. Compared

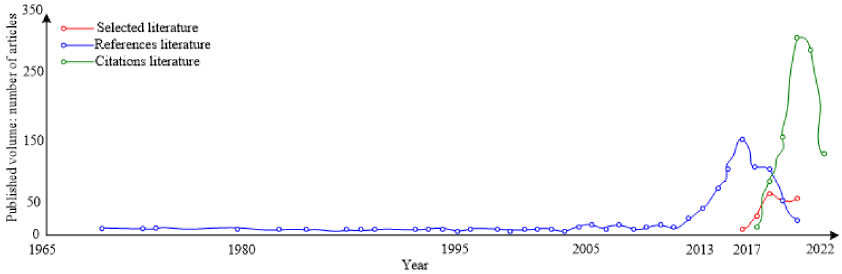


FIGURE 4. Research literature on social governance and big data

with national governance, the most fundamental progress of social management is its independence, which is an institutional superiority and cannot be replaced by simple government mobilization [22].

At present, the existing system has been unable to play its due function, but the new system has not yet been truly formed, and it is still in a blank state. Due to the diversification of participants, the cost distribution of social governance activities is borne by the participants, and the government only pays a certain price for social management. In this invisible case, the cost is not obvious, but it would be a huge amount if all governance factors were calculated using the government procurement method.

C. BUILDING BIG DATA

Big data is a huge amount of diverse data, usually in units of more than TB, with complex and variable, real and valuable data. Under the current civilization construction and social governance, big data is mainly obtained from the social environment, economic development, medical system, transportation system, supervision system, and education system, as shown in Figure 5. These large amounts of data are processed by using big data algorithms to obtain the required data information or hidden data value [23].

Due to the diversification of social management subjects and governance methods, the amount of data generated by the government in the process of social management is also increasing. If it can effectively use big data computing, then we can devote a lot of time and experience to the core business of the enterprise. This paper starts from the mechanism of the government's social governance, and constructs a governance framework as shown in Figure 6. It mainly includes precise governance, participation governance and overall governance mechanisms. These governance mechanisms are analyzed through big data algorithms to achieve efficient social governance effects.

The evaluation of ecological civilization construction is a summary and reflection of the construction results, mainly to measure the effect achieved in all aspects of a certain ecological civilization construction work, and to measure whether the ecological construction involving environmental, economic, social, cultural and institutional aspects has achieved good improvement. For the aspects with better evaluation of the construction effect, it can be used for reference in the later ecological civilization construction. It can supervise and promote the aspects with poor construction effect evaluation, find out the lack of construction through evaluation, and point out the direction of efforts for further improvement in the future. In addition, according to the evaluation results of ecological civilization construction, the resources and funds of ecological civilization construction projects can be allocated reasonably. For the ecological civilization construction project with good construction effect, the expected investment of resources and funds can be partially transferred to the ecological civilization construction effect evaluation project with poor construction effect to improve the construction effect of the overall project. The ecological civilization evaluation system constructed in this paper using big data is shown in Figure 7. It includes evaluation purposes and functions, analysis objects, evaluation methods and standards, and evaluation content. At the same time, the evaluation process is characterized by fairness, continuity, and commonality. Equity requires that both the use of existing resources and the development needs of the next generation should be taken into account in the construction process; sustainability requires consideration of sustainable use of resources; commonality requires that people of all countries work together on a global scale, both as one and in part, and the cooperation of various regions is common and coordinated development.

In addition, the establishment of an evaluation index system must proceed from a people-centered perspective. Secondly, through the investigation and analysis of the basic conditions of the Chinese ecological environment and the characteristics of social and economic development, the reasonable ecological environment evaluation indicators are determined, which ensures the scientificity of the evaluation system; in the evaluation index system, scientific and objective principles must be adhered to to ensure scientific and reasonable evaluation. The evaluation index system of ecological civilization construction should start from multiple fields and perspectives, and coordinate economic, political, cultural and social aspects, so as to comprehensively evaluate the effectiveness of ecological civilization construction in various fields. The principle of system integrity fully reflects the characteristics of each level, and comprehensively evaluates the generality of the whole, so that the evaluation results are universal and can be used for the

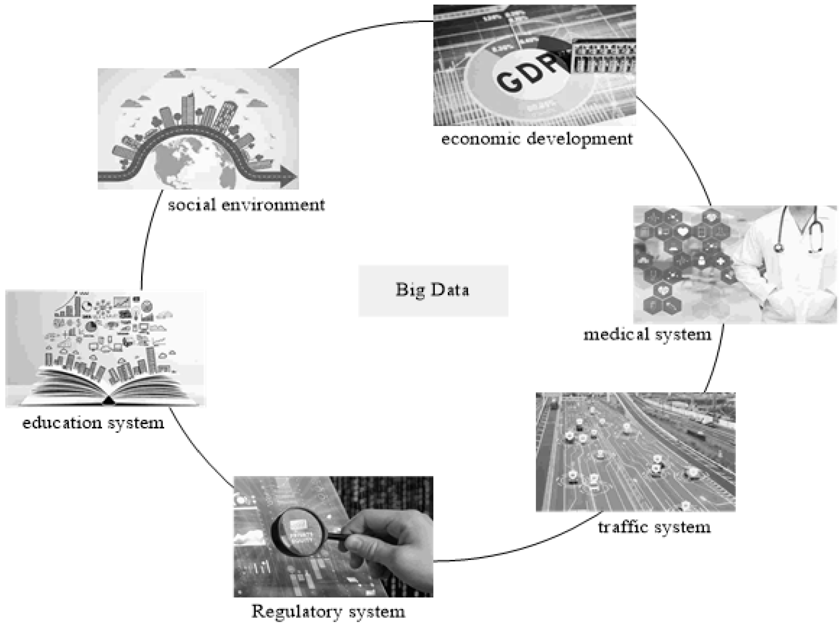


FIGURE 5. Sources of Big Data

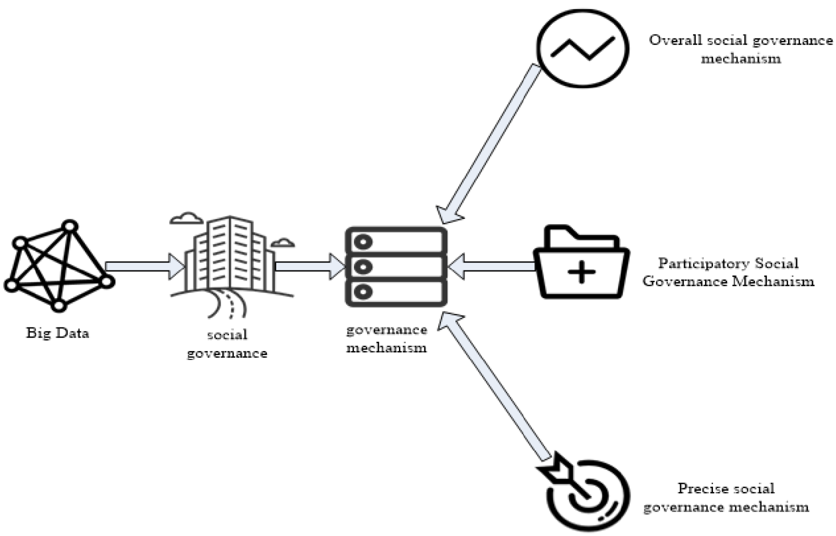


FIGURE 6. Social governance framework under big data

construction of ecological civilization in different regions. Ecological civilization evolved from primitive civilization and continues to develop.

D. BIG DATA PARALLEL ALGORITHMS AND COMPREHENSIVE EVALUATION

Parallel computing is one of the common algorithms for big data, which can effectively improve the computing speed. AHP is a common method to obtain a comprehensive score by combining the weights of indicators with hierarchical evaluation. This paper uses AHP to conduct big data analysis and comprehensive evaluation on the index data of ecological civilization construction and the index data of social governance: Assuming that the evaluation of ecological civilization includes m types of civilization, which are represented by A, and the evaluation of social governance includes n governance levels, which are represented by C, namely:

$$A = \{A_1, \ldots, A_m\} \tag{1}$$

$$C = \{C_1, \ldots, C_n\} \tag{2}$$

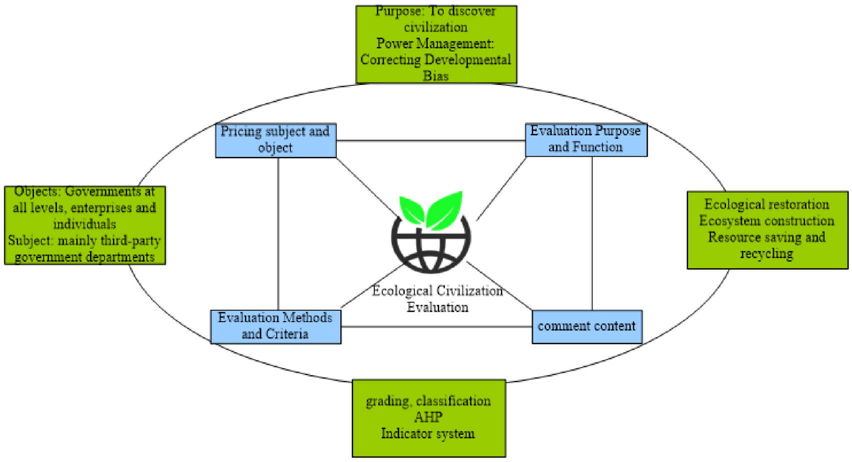


FIGURE 7. Ecological Civilization Evaluation System

The index for evaluating the level of civilization construction is denoted by r, and the index for evaluating the efficiency of social governance is denoted by t, namely:

$$R = \{r_1, \ldots, r_i\} \tag{3}$$

$$T = \{t_1, \ldots, t_j\} \tag{4}$$

The indicator weight in the indicator set R is represented by w, and the indicator weight in the indicator set T is represented by v, then:

$$W = \{w_1, \ldots, w_i\} \tag{5}$$

$$V = \{v_1, \ldots, v_j\} \tag{6}$$

Finally, the evaluation values of each index are denoted by s and g respectively, namely:

$$s_i = w_i \cdot r_i \tag{7}$$

$$g_i = v_j t_j \tag{8}$$

Then the final overall evaluation is as follows:

$$S = \sum_{i=1} w_i \cdot r_i \tag{9}$$

$$G = \sum_{j=1} v_j t_j \tag{10}$$

If the evaluation scores are evaluated in different fuzzy languages, and the evaluation sets are E and L, then:

$$E = \{e_1, \ldots, e_c\} \tag{11}$$

$$L = \{l_1, \ldots, l_d\} \tag{12}$$

For the average similarity D of the evaluation set, it can be expressed as:

$$D_i(e_c) = \frac{1}{Q_i - 1} \sum_{Q_i} S_i \tag{13}$$

$$D_i(l_d) = \frac{1}{P_i - 1} \sum_{P_i} G_i \tag{14}$$

In formulas 13-14, $c = 1, 2, \ldots, Q_i$, $d = 1, 2, \ldots, P_i$. The relative similarity R is:

$$R_i(e_c) = \frac{D_i(e_c)}{\sum_{Q_i} S_i} \tag{15}$$

$$R_i(l_d) = \frac{D_i(l_d)}{\sum_{P_i} G_i} \tag{16}$$

The composite average index is denoted by F, then:

$$F(A_i, C_i) = \frac{R_i(e_c) + R_i(l_d)}{D_i(e_c) + D_i(l_d)} \tag{17}$$

It obtains the average result of the i-th index of m ecological civilizations and the j-th index of n social indicators:

$$H(A_i, C_j) = \sum_{ij} w_i v_j F(A_i, C_j) \tag{18}$$

IV. EVALUATION SYSTEM DESIGN AND RELATED DATA

This study selects cities K and Y as case studies. These two cities share high similarities in total population and GDP, providing a foundation for examining the applicability of the algorithm at different geographical scales. In terms of research design, both big data algorithms and traditional algorithms are independently applied to each city for comprehensive evaluation. By comparing the results obtained from the two algorithms in the same city, the actual effectiveness of the big data algorithm in evaluating ecological construction and social governance is assessed. This design avoids directly comparing the two cities as experimental and control groups, thus eliminating selection bias that may be introduced by inherent differences between cities. The selection of cities K and Y is based on the comparability of their development levels, ensuring that the evalu ation of the algorithm's effectiveness can be carried out within a relatively consistent macro-level context, making the research conclusions more robust.

Data collection for this study covered the period from 2020 to 2023. Data was collected in real-time by connecting to multiple big data platforms and underwent a rigorous cleaning and integration process to ensure that the evaluation results reflect the latest construction achievements. Data updates were set at a quarterly frequency, ensuring the continuity of the evaluation process and the timeliness of the results.

This paper selects two cities K and Y with comparable development, and uses big data algorithm and traditional algorithm respectively to comprehensively evaluate the ecological civilization construction level and social governance efficiency of these two cities. Table 1 shows basic information about the two cities. Although the two cities differ greatly in size, their populations and economic conditions are quite similar.

TABLE 1. Basic city information

City	K	Y
population	4.47million	4.82 million
area	25283km2	6239km2
GDP	252.6 billion	255.7billion

Then, this paper selects the ecological civilization construction evaluation indicators shown in Table 2, which includes 4 primary indicators and 8 graded indicators.

TABLE 2. Selection of evaluation indicators for ecological civilization construction

Code	Primary indicator	Grading index
R1	humanity	density of population
	cultural facility	human resources
R2	Ecological economy	The proportion of the planned building area
	ecological condition	Coverage rate of cultural facilities
R3	humanity	per capita GDP
	cultural facility	Per capita consumption index
R4	Ecological economy	Greening rate
		Transportation convenience

Secondly, this paper also selects the evaluation indicators of social governance as shown in Table 3, including four indicators of social security, economic development, environmental governance and security level, and each indicator contains multiple graded indicators.

TABLE 3. Selection of social governance evaluation indicators

Code	Primary indicator	Grading index
T1	Social Security	insurance coverage
		human resources
T2	Security level	Number of firefighters
		Number of security managers
T3	Economic development	Per capita GDP
		Per capita consumption index
T4	Environmental governance	Carbon dioxide emissions
		water quality

Finally, this paper determines a set of comments for each evaluation target, as shown in Table 4. The comments on ecological environment construction are divided into four types, namely, super-civilized cities, civilized cities, uncivilized cities and backward cities. The evaluation of social governance efficiency is divided into three types, namely high efficiency, medium efficiency and low efficiency.

TABLE 4. Determination of evaluation vocabulary

Code	Comments on ecological civilization	code	Evaluation on social governance efficiency
E1	very civilized	L1	high
E2	generally	L2	medium
E3	uncivilized	L3	low
E4	very poor	d	3
c	4	c*d	12

V. EVALUATION RESULTS AND DISCUSSION

The scoring results presented in Figures 8 to 10 are based on the latest data from 2023. The study also compares and analyzes the results of this evaluation with historical data from the past three years, revealing the development trends in the level of ecological civilization construction and social governance efficiency. These evaluation results not only depict the current state of urban development but also provide empirical reference for the dynamic adjustment of relevant policies in the future.

In this paper, by comparing the final evaluation results obtained by the big data algorithm and the traditional algorithm, the results of each index of the ecological civilization construction of the two cities summarized by the percentage system are shown in Figure 8.

According to Figure 8(a), using the big data algorithm, the humanities construction score of K City is 76.4 points, the cultural facilities construction score is 78.4 points, the ecological economy construction score is 80.9 points, and the ecological environment construction score is 75.4 points. The index scores of R1 to R4 calculated by the traditional algorithm are 58.6 points, 67.3 points, 59.9 points and 73.5 points respectively. As can be seen from Figure 8(b), according to the big data algorithm, the humanities construction score of Y city is 76.6 points, the cultural facilities construction score is 80.4 points, the ecological economy construction score is 81 points, and the ecological environment construction score is 87.3 points, the scores calculated by the traditional algorithm are 70.9 points, 73.6 points, 75.1 points, and 62.4 points respectively. This shows that the scores of each index obtained by the big data

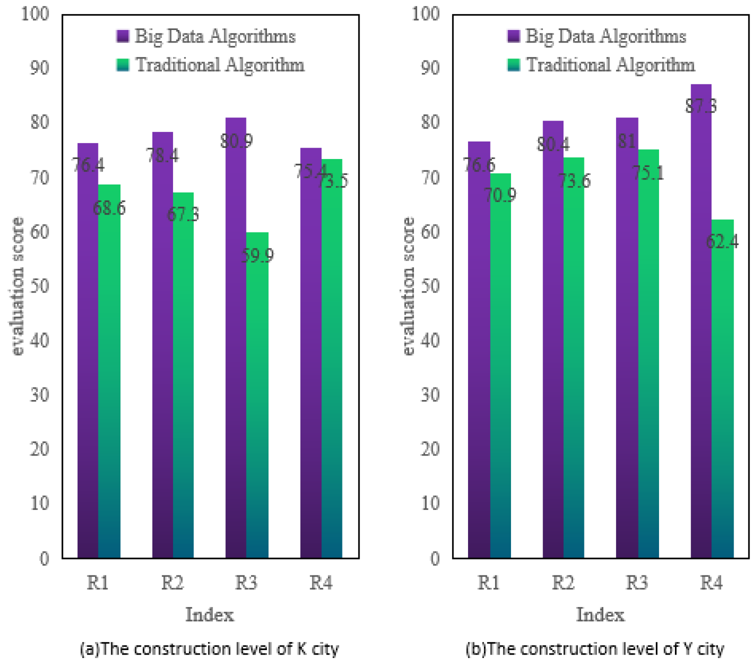
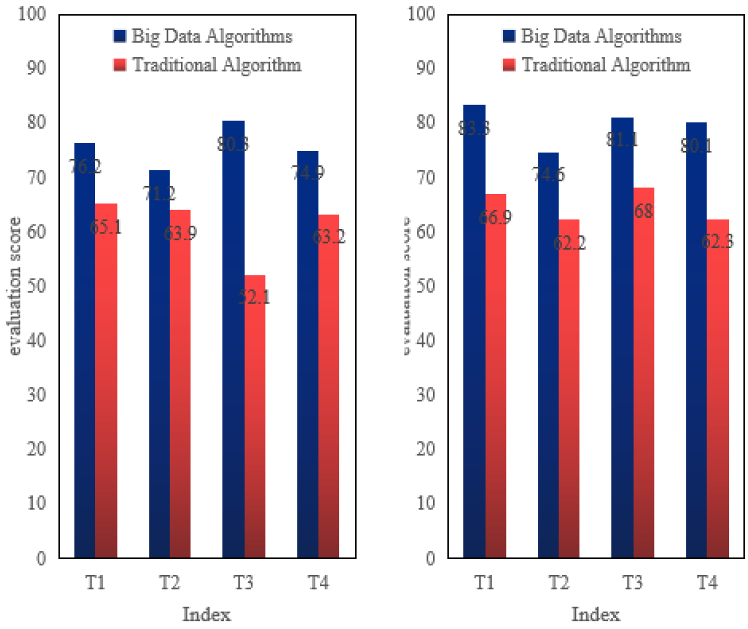


FIGURE 8. Comparison of ecological civilization construction levels

algorithm are higher than those of the traditional algorithm, and the same index score of Y city is generally higher than that of K city. This pattern coincides with the smaller geographical area of city Y, though further analysis would be required to explore the factors underlying this association.

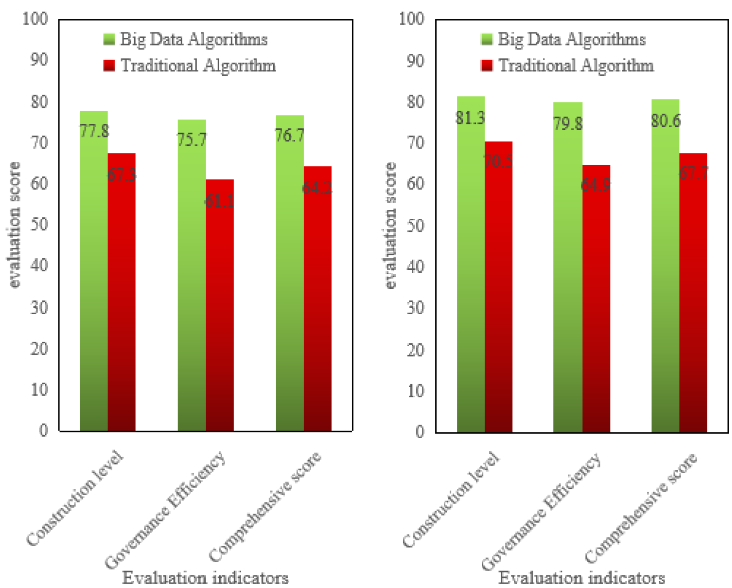
Secondly, this paper compares the indicators of the social governance efficiency of the two cities, and the scoring results are shown in Figure 9. As can be seen in Figure 9(a), under the big data algorithm, city K has the highest T3 index score of 80.3 points and the lowest T2 index score of 71.2 points. Under the traditional algorithm, the T1 indicator has the highest score of 76.2 points, and the T3 indicator has the lowest score of 62.1 points. As can be seen in Figure 9(b), under the big data algorithm, the T1 index of city Y is the highest with a score of 83.3, the T2 index is the lowest with a score of 74.5, and under the traditional algorithm, the T3 index is the highest, with a score of 81.1, and the T2 index is the lowest, with a score of 62.2. This shows that under the big data algorithm, the social governance efficiency of the two cities is also significantly higher, and the efficiency of city Y will be slightly higher than that of city K.

Finally, this paper comprehensively evaluates all the indicators, and the results are shown in Figure 10. It can be seen from Figure 10(a) that the ecological civilization construction level of K city under the big data algorithm score is 77.8 points, the social governance efficiency score is 75.7 points, and the overall score is 76.7 points. Under the traditional algorithm, the score of the ecological civilization construction level of K City was 67.3 points, the social governance efficiency score was 61.1 points, and the overall score was 64.2 points. It can be seen from Figure 10(b) that the ecological civilization construction level of Y city under the big data algorithm score is 81.3 points, the social governance efficiency score is 79.8 points, and the overall score is 80.6 points. Under the traditional algorithm, the score of ecological civilization construction level is 70.5 points, the score of social governance efficiency is 64.9 points, and the overall score is 67.7 points. The scores of each indicator improved significantly, among which the comprehensive score of city K increased by 12.5 points, and the comprehensive score of city Y increased by 12.9 points. This shows that the use of big data algorithms has obvious advantages in the evaluation of ecological civilization construction and social governance efficiency.



(a)Governance Efficiency of K City (b)Governance Efficiency of Y City

FIGURE 9. Comparison of Social Governance Efficiency



(a)The composite Score of K City (b)The composite Score of Y City

FIGURE 10. Comprehensive evaluation

VI. CONCLUSION

Against the backdrop of promoting sustainable development, major cities in China have begun to gradually transform, yet challenges remain in resource efficiency and governance methods. Traditional approaches to evaluating ecological civilization construction and social governance efficiency have proven inefficient and yield limited insights. This study, grounded in an understanding of ecological civilization and social governance, constructed an evaluation framework that integrates big data algorithms and the analytic hierarchy process. The framework was tested using data from two comparable cities. Results indicate that the big data algorithm produced higher evaluation scores across all indicators compared to traditional methods, with comprehensive scores increasing by 12.5 points for City K and 12.9 points for City Y. Given these results, the proposed framework demonstrates strong scalability, making it potentially applicable to assessing the green performance of resource-intensive industries, which requires systematic monitoring of environmental and social governance efficiency. These findings demonstrate the enhanced effectiveness of big data-based evaluation in capturing the multidimensional aspects of ecological civilization and social governance. The study contributes to the methodological advancement in this field, though limitations remain in the depth of algorithmic exploration and the comprehensiveness of indicator selection. Future work will address these areas to further refine the evaluation system.

AUTHOR CONTRIBUTIONS

Liyan Qian is the sole author of this article

CONFLICTS OF INTEREST

The author declares no conflict of interest.

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