The Harmonious Development of Big Data Industry and Ecological Civilization Construction in Guizhou

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Abstract: With the development of the times, people have seen new opportunities to solve ecological civilization in the Internet, big data and other high-tech industries. The construction of ecological civilization provides a good environment for the development of big data. Based on the 2015 data of Guizhou Province, this paper uses an intuitive analytic hierarchy and a coupled coordination model to analyze the state of the state's big data industry and its ecological and cultural coupling. The research results show that the comprehensive level of big data industry in Guizhou varies greatly, and the comprehensive level of ecological civilization construction is mostly concentrated between 0.2 and 0.5. The degree of coupling reflects the gap between big data industry and ecological civilization construction in cities. Coordination spans three intervals.

1. Introduction

Data is the basic strategic resource of the country and the "diamond mine" of the 21st century. China attaches great importance to the role of big data in economic and social development. In order to comprehensively promote the development of big data and accelerate the building of a powerful data country, the 18th national congress of the CPC proposed the "implementation of national big data strategy". Big data as an emerging technology industry is not limited by time and space, its wide application value in each industry is gradually revealed, and transformed into a kind of new pattern of industrial development, using big data technology to change the industrial structure to promote industrial upgrading, this provides a new path for our country's ecology civilization construction. In the general plan for the construction of big data of ecological environment released by the state in March 2016, it was clearly pointed out that great importance should be attached to the status and role of big data in promoting the construction of ecological civilization, promoting the networking and sharing of national ecological and environmental monitoring data, and carrying out the analysis of big data of ecological environment. Therefore, the integration of big data industry and ecological civilization construction can realize complementary advantages and promote the coordinated development of big data industry and ecological civilization construction in China, which is of great significance for the construction of "beautiful China".

From previous research, the foreign concept, value in big data, large data industry research is more. Delia (2014)[1] focused on analyzing the current situation of China's big data industry from the perspective of the types, characteristics and development environment of big data industry abroad. Tea hongwang and zheng tingting (2018)[2] analyzed the development status of China's big

data industry from six aspects, such as industrial scale and industrial form, and further explained the problems faced by China's big data industry from seven aspects, such as safety. Studies on ecological civilization are also abundant. Foreign countries mainly start from the perspective of ecology. E. h. heckd (2003)[3], a German biologist, first proposed the concept of "ecology". Famous expert a.g. ansley (2010)[4] further studied the concept of "ecosystem" on the basis of ecology. Gu shuzhong et al. (2013)[5]respectively explained the connotation of ecological civilization construction from three aspects: the relationship between human and nature, the relationship between ecological civilization and modern civilization, and the relationship between ecological civilization and era development, and put forward specific Suggestions on the path selection, design and promotion mechanism of ecological civilization construction.

Although domestic and foreign researches on big data industry and ecological civilization are relatively mature, only a few experts and scholars have combined the analysis of big data industry and ecological civilization. Wen xianqing (2015)[6]demonstrated that big data thinking and ecological civilization thinking are highly compatible in both possibility and necessity by integrating them. Wang luxiao et al. (2017)[7]applied big data to construct a new model of ecological civilization construction, aiming to form a preliminary framework of ecological environment big data. So in order to develop the interactive relationship between the two studies, the intuitionistic fuzzy analytic hierarchy process (ahp) through the use of big data in Guizhou industry development level and evaluate the ecological civilization construction level, the big data industry and the construction of ecological civilization as two sub-systems, with coupling coordination degree model to carry out the relationship between research, to explore the rule between development present situation.

2. Construction of comprehensive evaluation system of big data industry and ecological civilization

2.1. Evaluation index system research method

Intuitionistic fuzzy analytic hierarchy process (ahp) is an integrated method, which combines intuitionistic fuzzy sets with analytic hierarchy process (ahp) to form a comprehensive evaluation method. The main calculation steps of intuitionistic fuzzy analytic hierarchy process are as follows:

(1) In order to eliminate the specified indicators due to disunity of units and different orders of magnitude, dimensionless judgment matrix is carried out:

For indicators where the big is the best:

$$X'_{ij} = \frac{x_{ij} - \min x_{ij}}{\max x_{ij} - \min x_{ij}}, (i = 1,2...m, j = 1,2...n)$$

For indicators where the smaller is the better:

$$X'_{ij} = \frac{\max x_{ij} - x_{ij}}{\max x_{ij} - \min x_{ij}}, (i = 1,2...m, j = 1,2...n)$$

(2) Establishment of intuitive judgment matrix:

By comparing the relative importance of evaluation indexes, the intuitionistic fuzzy judgment matrix can be obtained $R = (a_{ij})_{mn}\ a_{ij} = (u_{ij} v_{ij}), (i = 1,2...m, j = 1,2...n)$ .U_{ij} for membership and v_{ij} for non-membership, π_{ij} for hesitation, π_{ij}=1-u_{ij}-v_{ij}. Therefore, in order to quantitatively analyze the importance of evaluation indicators, the corresponding relationship between qualitative evaluation language and intuitionistic fuzzy number is defined as shown in table 1.

Table 1 qualitative evaluation language and intuitionistic fuzzy number corresponding table

Qualitative evaluation language	Intuitionistic fuzzy number	Qualitative evaluation language	Intuitionistic fuzzy number
Extremely important	(0.90,0.10,0.00)	Less important	(0.40,0.45,0.15)
Very important	(0.80,0.15,0.05)	Not important	(0.30,0.60,0.10)
important	(0.70,0.20,010)	It's not important	(0.20,0.75,0.05)
A more important	(0.60,0.25,0.15)	Not very important at extreme	(0.10,0.90,0.00)
Equally important	(0.50,0.30,0.20)	.....	.....

(3) Consistency inspection and correction

In order to get reasonable evaluation results in intuitionistic fuzzy hierarchy analysis, the consistency of intuitionistic judgment matrix needs to be tested. Consistency test indicators established according to (2).

When the j > I + 1,make $\overline{R}=(\overline{r_{ij}})=(\overline{u_{ij}},\overline{v_{ij}})$,

$$\overline{v_{ij}}=\frac{\sqrt[j-i-1]{\prod_{t=i+1}^{j-1}v_{it}v_{tj}}}{\sqrt[j-i-1]{\prod_{t=i+1}^{j-1}v_{it}v_{tj}}+\sqrt[j-i-1]{\prod_{t=i+1}^{j-1}(1-v_{it})(1-v_{tj})}},\ j>i+1$$

$$\overline{u_{ij}}=\frac{\sqrt[j-i-1]{\prod_{t=i+1}^{j-1}u_{it}u_{tj}}}{\sqrt[j-i-1]{\prod_{t=i+1}^{j-1}u_{it}u_{tj}}+\sqrt[j-i-1]{\prod_{t=i+1}^{j-1}(1-u_{it})(1-u_{tj})}},\ j>i+1$$

When the j=i+1 orj=i,make $\overline{r_{ij}}$ =rij ;When the j<i+1or j<i, make $\overline{r_{ij}}=(\overline{v_{ij}},\overline{u_{ij}})$.

If R and the $\overline{R}$ satisfy the following conditions,it is considered that the consistency of intuition judgment matrix R is acceptable: $d(\overline{R},R)<0.1$ .Otherwise failed.D is the measure of the distance between R and $\overline{R}$,

$$d(\overline{R},R)=\frac{1}{2(n-1)(n-2)}\sum_{i=1}^{n}\sum_{j=1}^{n}(\left|\overline{u_{ij}}-u_{ij}\right|+\left|\overline{v_{ij}}-v_{ij}\right|+\left|\overline{\pi_{ij}}-\pi_{ij}\right|)$$

(4) Correct intuitionistic judgment matrix that does not satisfy consistency test. For those that fail the consistency check, you need to set the parameter sigma to iterate. In this case of $\sigma\in[0,1]$, you can use the following formula until you pass the consistency check:

$$\tilde{u}_{ij}=\frac{u_{ij}^{(1-\sigma)}u_{ij}^{(\sigma)}}{u_{ij}^{(1-\sigma)}\overline{u_{ij}}^{(\sigma)}+(1-u_{ij})^{(1-\sigma)}(1-\overline{u_{ij}})^{(\sigma)}},\quad i,j=1,2,...,n$$

$$\tilde{v}_{ij}=\frac{v_{ij}^{(1-\sigma)}\overline{v_{ij}}^{(\sigma)}}{v_{ij}^{(1-\sigma)}\overline{v_{ij}}^{(\sigma)}+(1-v_{ij})^{(1-\sigma)}(1-\overline{v_{ij}})^{(\sigma)}},i,j=1,2,.$$

(5) Calculate the weight according to the intuitionistic fuzzy consistency judgment matrix.

$$\omega_i=(\frac{\sum_{j=1}^{n}u_{ij}}{\sum_{i=1}^{n}\sum_{j=1}^{n}(1-v_{ij})},1-\frac{\sum_{j=1}^{n}(1-u_{ij})}{\sum_{i=1}^{n}\sum_{j=1}^{n}v_{ij}}),i=1,2,\ldots,n$$

(6) Use the operator of intuitionistic fuzzy number to calculate the combined weight of each layer of indicators and obtain the comprehensive evaluation of intuitionistic fuzzy number of each indicator.

$$a_1 + a_2 = (\mu_1 * \mu_2, \nu_1 + \nu_2 - \nu_1 * \nu_2), \quad zw = (1-(1-\mu_w)^z, \nu_w^z)$$

$$a_1 \oplus a_2 = (\mu_1 + \mu_2 - \mu_1 * \mu_2, \nu_1 * \nu_2)$$

$$F_i = \oplus_{j=1}^{n}(Z_{ij} \oplus W_j) = (1-\prod_{j=1}^{n}(1-\mu_{a_j})^{z_j}, \prod_{j=1}^{n}\nu_{a_j}^{z_j}$$

(7) Calculate the comprehensive evaluation value. Scoring function: $S_L(a) = u + u(1-u-v) \in [0,1]$

2.2. data source and index system construction

This paper selects the data of 9 cities of Guizhou province in 2015. The data came from China regional economic statistical yearbook, Guizhou statistical yearbook, statistical yearbooks of nine prefectures and municipalities, prefectural water resources bulletin, environmental bulletin and national economic development bulletin.

On the basis of comprehensive analysis and understanding of the development status of big data industry and ecological civilization, the basic principles of operability, representativeness, scientificity and preciseness should be followed in order to construct a scientific and reasonable index system and comprehensively reflect the reality. On the premise of following the basic principles of index system construction, this paper draws on the research of Lin zhen, Shuang zhimin (2014) [8] and others to build an index system of big data industry measurement with 12 secondary indicators from two aspects of industrial scale and infrastructure. In the four aspects of eco-economy, ecological environment, ecological health and ecological culture, we have to construct the index system of the ecological measure of 23 levels of ecological civilization.

3. Research on the coupling and coordination degree between big data industry and ecological civilization

3.1. Coupling degree model

Coupling was originally a concept in physics, referring to the phenomenon of two or more subsystems interacting through various interactions to achieve synergy. Coupling degree is a measure of the degree of interrelation between subsystems. The higher the degree of coupling, the greater the relationship between subsystems, and the more orderly the development. Conversely, the smaller the correlation, the more confusing the direction of development. Referring to the concept of capacity coupling in physics, the coupling degree model of multi-element interaction can be obtained, namely: $C = n\{f(u_1) \times f(u_2) \times \bullet\bullet\bullet \times f(u_n) / (f(u_1) \times f(u_2) \times \bullet\bullet\bullet f(u_n))^n\}^{\frac{1}{n}}$

Since this study only involves the two subsystems of big data industry and ecological civilization, the coupling degree model constructed is as follows: $C = \{(U_1 \times U_2)/(U_1 + U_2)\}^{1/2}$

As shown in the above formula,C refers to the coupling degree of big data industry and ecological civilization, and U1 and U2 are the comprehensive scores of big data industry subsystem and ecological civilization subsystem respectively. According to the literature, the degree of coupling is divided into four levels: C=0, no coupling;0< C≦0.3 means that the system is at a low level of horizontal coupling and at a starting stage. 0. 3< C≦0.8means that the system is in the mid-level coupling and development stage; 0. 8< C≦1means that the system is in a high level of coupling and mature stage.

3.2. Coupling coordination model

Coupling coordination degree is a quantitative measurement of the degree of coordination and win-win in the process of mutual influence and interaction between systems. It can reflect the trend of coupling between systems or elements from disorder to order and the degree of quality of coordinated development. This paper introduces the coupling coordination theory, takes the big data industry and ecological civilization as two coupling coordination subsystems, analyzes the symbiotic mechanism of interaction and mutual promotion of harmonious development between the two from the perspective of coupling coordinated development, and measures the degree of

coupling coordination between the two. The coordination degree of interaction and coupling between big data industry and ecological civilization is shown as follows: $D=(C\times M)^{1/2}, M=\alpha U_1+\beta U_2$

Where, the degree of coupling and coordination between D big data industry and ecological civilization is set as D in [0,1]. C is the coupling degree; M is the coupling coordination index of big data industry and ecological civilization, reflecting the overall synergistic effect of the two. Both alpha and beta are undetermined parameters (alpha + beta =1).

In the process of practical application, according to the size of the coupling coordination degree, draw lessons from Bai Cai full (2014) [9] et al. Research the coupling coordination degree is divided into ten levels (as shown in table 2).

Table 2 The coupling coordination degree among the two subsystems is divided

First level type	The standard	Level 2 type (type D)
Coordinated development	[0.90,1.00]	Quality coordination
	[0.80,0.89]	Good coordination
	[0.70,0.79]	Intermediate coordinate
	[0.60,0.69]	Primary coordination
Transitional development class	[0.50,0.59]	Barely coordination
	[0.40,0.49]	Verging on disorder
ataxia	[0.30,0.39]	Mild disorder
	[0.20,0.29]	Moderate disorders
	[0.10,0.19]	Severe disorder
	[0.00,0.09]	Extreme imbalance

3.3. Empirical results analysis

According to the established coupling and coordination degree model of big data industry and ecological civilization, this paper successively calculated the comprehensive score of big data industry U1, the comprehensive score of ecological civilization U2 and the coupling degree C. In the process of studying the coupling and coordination of the two subsystems, the big data industry can provide a new channel for solving ecological civilization, and the construction of ecological civilization provides a good environment for the development of big data, so the coupling analysis of this paper believes that the big data industry and ecological civilization are equally important, and combined with the literature of relevant scholars, the undetermined parameters are determined as alpha = beta =1/2, that is, M=(U1+U2)/2. Through table 5, the results of the calculation of the degree of coupling and coordination degree of the two sub-systems in Guizhou province are analyzed and the following conclusions are drawn:

Table 3 Coupling and coordination degree of big data industry and ecological civilization in 9 prefectures and prefectures of Guizhou province

region	The coupling of C	C type	Coordination degree of D	D type
Guiyang	0.4777	Moderate coupling	0.4853	On the verge of disorder
Liupanshui	0.2265	Low coupling	0.1832	Severe disorder
zhunyi	0.4523	Moderate coupling	0.4448	On the verge of disorder
Anshun	0.1960	Low coupling	0.1896	Severe disorder
Bijie	0.3470	Moderate coupling	0.2932	Moderate disorders
Copper	0.2914	Low coupling	0.2664	Moderate disorders
qianxinan	0.2766	Low coupling	0.2588	Moderate disorders
Qiandongnan	0.3132	Moderate coupling	0.2964	Moderate disorders
qiannan	0.3111	Moderate coupling	0.2889	Moderate disorders

As can be seen from the coupling degree, the coupling degree evaluation index of big data industry and ecological civilization construction in 9 prefectures and municipalities in Guizhou

province in 2015 presented different values, with the average level of 0.3213, indicating that the big data industry and ecological civilization in Guizhou province are gradually linked and integrated for development. Most of the coupling degree values are between 0.3 and 0.5, that is, in the moderate coupling, in the development stage; Very few regions are in the coupling degree between 0 and 0.3, that is, in a low degree of coupling, in the beginning period.

From the perspective of coordination degree, the big data industry and ecological civilization construction of 9 prefectures and municipalities in Guizhou province in 2015 were within the range of 0.1-0.5, that is, between serious imbalance, moderate imbalance and near imbalance. There was a certain difference between the comprehensive evaluation value of big data and the comprehensive evaluation value of ecological civilization, and there was no lag between the profit and loss type. The provinces with a high degree of coordination are mostly economically developed regions, while the provinces with a low degree are mostly underdeveloped regions in the east and west of Guizhou, showing an obvious unbalanced distribution law, indicating that there is a high dependence between the two subsystems.

4. Conclusion

This article selects 9 in Guizhou province as the main research object, using the intuitionistic fuzzy analytic hierarchy process (ahp), respectively, for large data of Guizhou province industrial development level, a comprehensive evaluation of ecological civilization construction using the coupling model, further explore the big data in Guizhou synergies between industry and ecological civilization, so as to clear the relationship between them, finally the following research conclusions:

On the whole, the coupling degree between big data industry and ecological civilization construction in 9 prefectures and cities of Guizhou province is in the moderate and low degree. The evaluation grade of coupling coordination degree is serious imbalance, moderate imbalance and close to imbalance. There is no optimal coupling degree or the worst coupling degree. However, generally speaking, the degree of coupling coordination degree is still low, and the big data industry and ecological civilization construction of each city and city need to be improved.From the perspective of space, the coupling degree reflects the gap between the big data industry and the construction of ecological civilization. At the same time, there are obvious spatial heterogeneity fluctuations in the coupling degree of cities and towns in Guizhou. Guiyang and Zunyi have high degree of coupling coordination, while other areas have low degree of coupling coordination, indicating that the degree of coupling coordination in economically developed areas is higher than that in economically underdeveloped areas.

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References

[1] Delia. Research on the development of big data industry in China [J]. Scientific and technological progress and countermeasures, 2014,31(04):56-60.

[2] Cha hongwang, zheng tingting. Research on the development of big data industry in China [J]. Zhongzhou academic journal, 2018(04):19-25.

[3] E.H.Haeckel. Characterizing and measuring sustainable development [J]. Review of Environment and Resources, 2003,8(1):559-586.

[4] Tansley A G. THE PROBLEMS OF ECOLOGY [J].New Phytologist, 2010,3(8)191-200.

[5] Gu shuzhong, hu yongjun, zhou hong. Scientific connotation and basic path of ecological

civilization construction [J]. Resource science, 2013, 35(01):2-13.

[6] Wen xianqing. Big data technology and its application in the construction of ecological civilization [J]. Journal of nanjing forestry university (humanities and social sciences edition), 2015,15(01):9-19.

[7] Wang luxiao, liu xiao, luo qingjun. Exploration of a new mode of using big data to promote the construction of ecological civilization [J]. Environmental protection, 2017,45(14):72-73.

[8] Lin zhen, shuang zhimin. Comparative study on evaluation index system of ecological civilization construction in provincial capital cities -- a case study of guiyang city, hangzhou city and nanjing city [J]. Journal of Beijing university of aeronautics and astronautics (social science edition), 2014,27(05):22-28.

[9] Bai caiquan, huang yabao, song weixuan, he yiqing. Research on the coupling and coordinated development of financial agglomeration and ecological efficiency in the province [J]. Resources and environment in arid areas, 2014,28(09):1-7.