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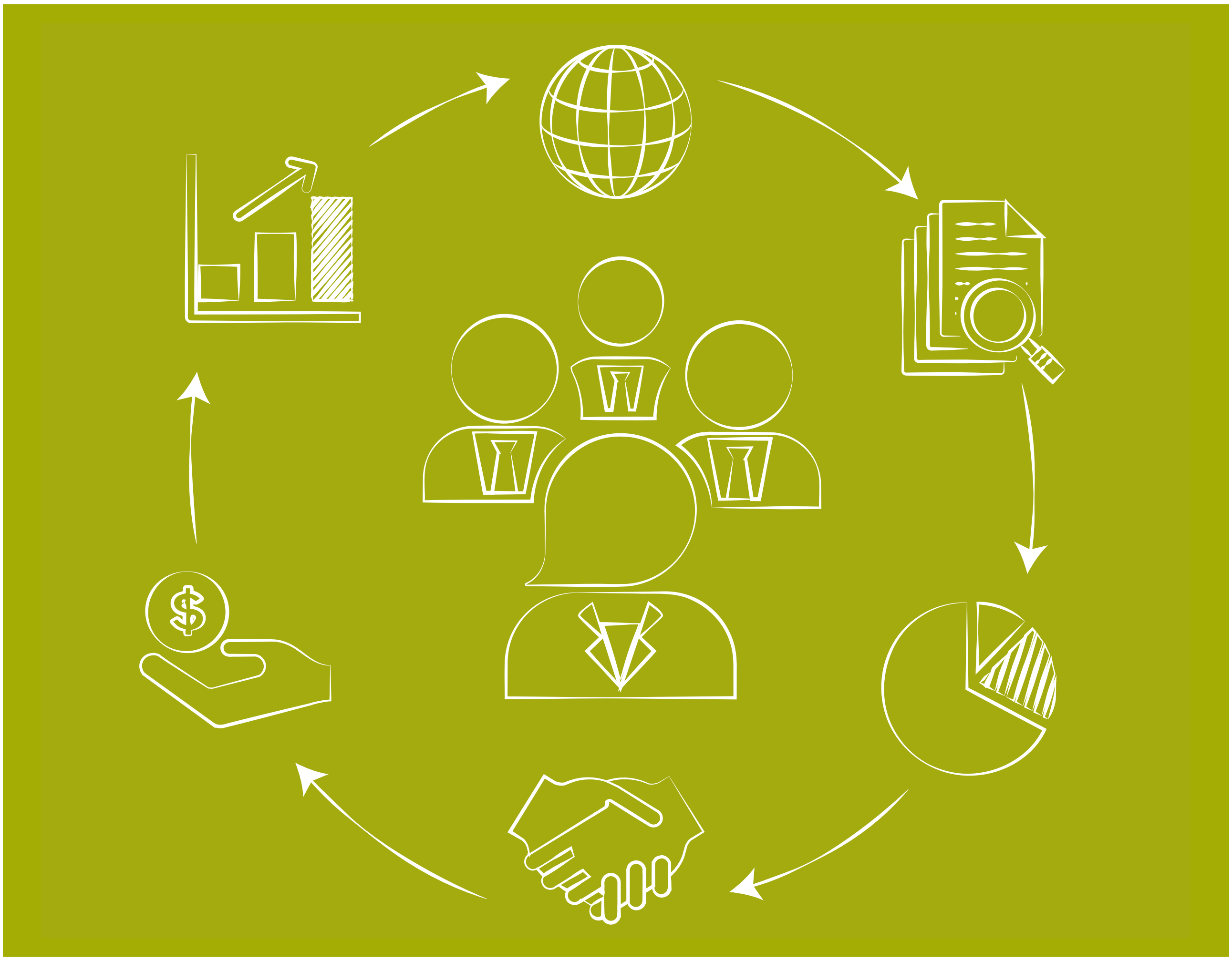

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FROM CLOSURE TO GRADUAL RELEASE OF EGS INDUSTRY: EMPIRICAL EVIDENCE FROM THE SPATIAL EVOLUTION AND CAUSAL MECHANISM IN THE MAIN TOWN AREA OF WUHAN, CHINA

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ABSTRACT

With the economic impact and increasing popularity of the electronic gaming industry, EGS (Electronic Gaming Sports) had become an important topic of debate in sports academia regarding its conceptual delineation and attribute characteristics. This paper jumped out of the hotspot academic perspective of the concept, characteristics, and impacts of EGS. In response to the gaps in the spatial development of the EGS industry and the lack of empirical research findings, an interpretive empirical research method was adopted, focusing on Wuhan as the study area to gain insight into the situation where the spatial development of the EGS industry was unclear. The spatial evolution of the EGS industry in the main town area of Wuhan was interpreted through a quantitative approach and based on the spatial data of EGS companies from 2006 to 2022 using Average Nearest Neighbor (ANN), Kernel Density Estimation (KDE), and Ordinary Kriging (OK) of geospatial analysis. The results indicated closure to the gradual release of the EGS industry, with specific findings as follows. (1) The EGS industry in the main town area of Wuhan from 2006 to 2022 developed rapidly, and the overall spatial distribution showed a process from discrete to cluster, accompanied by an apparent deepening of aggregation in recent years. The local aggregation of the EGS industry transformed from dual to multiple cores, and the multiple cores formed stronger groups of aggregation as the cluster spread and merged. (2) The spatial interpolation of the registered capital of companies predicted the hot spot of high-capital distribution of EGS companies in the Optics Valley vice town area of Hongshan to the southeast, indicating that more competitive EGS companies and larger EGS industry groups might emerge in Optics Valley in the future. (3) The spatial evolution of the EGS industry in the main town area of Wuhan could be divided into an early start phase from 2006-2010, a rapid development phase from 2010-2014, an aggregate explosion phase from 2014-2018, and a cluster integration phase from 2018-2022. (4) The spatial evolution of the EGS industry was influenced not only by the main factors of industrial economic agglomeration, industrial chain derivation, and industrial policy environment but also by the other factors of land and talent market, adjacent infrastructure support, city industrial promotion, and globalization dissemination. The future development of the EGS industry could be guided by the government's industrial policies, supported by high-quality talent teams, and driven by local promotion and international communication to provide an essential impetus for the optimal EGS industry.

KEYWORDS

Electronic Gaming Sports (EGS); Spatial Evolution Pattern; Capital Weighted Forecast; Causal Mechanism; Wuhan, China.

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1. INTRODUCTION

With the economic impact and increasing popularity of electronic gaming industries, EGS (Electronic Gaming Sports) had become an important topic of debate in the academic debate on sport, and how the future direction of EGS would evolve was the issue's main focus [1]. In recent years, EGS had been one of the fastest-growing and most convenient forms of entertainment, driven by new media technologies to become mainstream [2]. EGS was a sport in which electronic gaming competitions reached the organized competition level. A sports model combined athleticism, technology, spectacle, and entertainment by using modern technology to organically integrate electronic games with the rules of traditional sports competitions. EGS connected the Internet, traditional media, and new mass-consumption industries with low pollution, strong driving effects, and sustainable development, and was conducive to promoting the city's image. However, due to the younger demographic of the EGS industry, there was a general perception that the development of the EGS industry had a negative impact on young people [3]. The negative effects include health, psychological, consumer, social, and ethical issues for young people [4, 5, 6, 7].

As an emerging topic of interest to scholars from various disciplines, there was a debate among academics as to whether EGS qualifies as a sport. Some scholars suggested that EGS was different from other traditional sports because it could be considered both recreational and physical, and as a cultural industry practice was bound to accelerate the development of society [8]. Conversely, some scholars claimed that EGS was not a sport, regardless of its similarity to sports [9, 10]. Some scholars proposed that EGS as a form of sportification, whether it fell within the definition of sport or not, needed to be examed for its positive or negative impact on the industry through sports management [11]. Furthermore, EGS was not just about playing electronic games but also being used to satisfy team relationships and a sense of social belonging [12]. After EGS players face social isolation due to excessive gaming, social capital was fostered by constructing communication mechanisms between online gaming and offline social interaction, transforming EGS into real-life social support with positive potential [6,13]. Some scholars studied the potential of EGS as a sporting category from the perspective of professional recognition in the school, suggesting a relationship between EGS and education in academia [14]. The findings showed that EGS penetrated the daily life of Chinese college students, so it was crucial for students to plan a rational schedule and consumption of EGS to promote a better life and mental health [15]. This paper found that some scholars believed that EGS was similar to playing computer games in the traditional sense, which was a misunderstanding between the concepts of computer games and EGS. As an emerging industry evolved after the development of computer games and internet technology, the organization and standardization of EGS were essential features that distinguished it from traditional computer games. Compared with traditional computer games, EGS events with organizational management could exercise and improve participants' thinking and reaction, limb coordination, willpower, and team cohesion. As the commercial value and social influence of EGS increased, a

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mainstream EGS cultural complex was formed based on the core elements of EGS events and EGS communities. Some scholars found that for EGS players, a small proportion of players experienced gaming addiction, with a larger proportion exhibiting issues of self-esteem, performance, family conflict, sleep, and physical health [16].

In summary, a comprehensive literature review of EGS found that existing research on EGS was distributed in the fields of sport, business, health, technology, and media, but the disciplinary results showed a certain fragmentation [17]. Most scholars only focused on the traditional related fields of EGS, lacking consideration for combining EGS with other disciplines [18]. There was a considerable research gap in the direction of the spatial development of the EGS industry. The only existing studies were the progression of EGS diffusion in the center to the surrounding urban network, the factors that need to be considered in urban EGS organization, and the business opportunities created by EGS facilities organization, indicating that there were almost no studies on the spatial development of EGS industry [19,20]. Therefore, this paper discerned the unclear status of the spatial development of EGS industries through an interpretive empirical research approach. The main town area of Wuhan in Hubei Province, China, was used as the case study area. The period from 2006 to 2022 was used as the time interval for this study. The study focused on the regional development of the EGS industry and explored the spatial evolution, causation, and suggestion of the EGS industry. The study results were important for grasping the spatial pattern and evolutionary trend of the EGS industry in the main town area of Wuhan, which was conducive to optimizing the future spatial development of Wuhan's EGS industry as a representative city in central China.

2. METHODOLOGY

2.1. DESCRIPTION OF THE STUDY AREA

Wuhan, Hubei Province, China, had 13 administrative districts, with a permanent resident population of 12,326,500 at the end of 2020, according to the 7th National Census of China. The main town area of Wuhan included the seven administrative districts of Jianghan, Jiangan, Qiaokou, Qingshan, Hanyang, Wuchang, and Hongshan (Figure 1). As a mega-city in China, a central city in the central region of China, and the center of the EGS industry in central China, Wuhan had a particular influence on the world.

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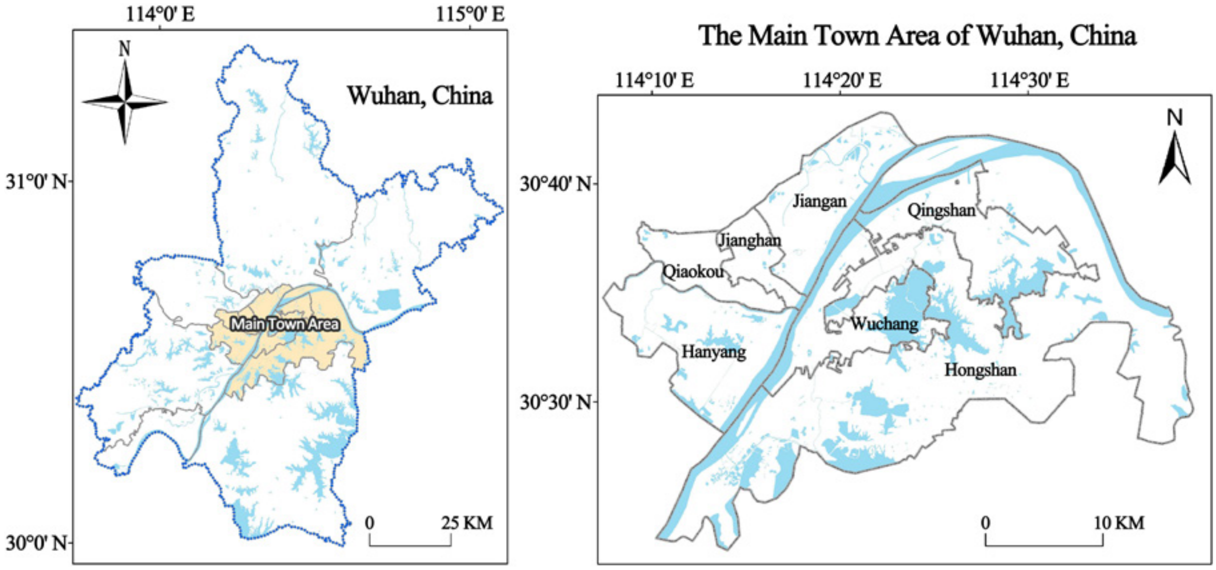

Figure 1. Wuhan Main Town Area Location Map, China

To a certain extent, spatial clustering of industry tended to occur in regions where the division of labor and specialization was more sophisticated. The EGS industry relied on the foundations of the cultural, sports, digital information, and technology industries. By linking its production factors and demand conditions, new industrial chains could be formed to promote the region's economic development. As the core city in central China, Wuhan was a cluster of EGS developing companies upstream, EGS operation companies midstream, and EGS organization companies downstream of the industry chain. Examples included Wuhan eStar Gaming and Wuhan Douyu Network Technology Co. Ltd. (listed on the NASDAQ exchange under the ticker symbol "DOUYU"). Due to the urban development structure of Wuhan, the main town area of Wuhan was much smaller than the other distant town areas, but it was more representative of Wuhan's main characteristics in terms of population density, economic activity, infrastructure, and so on. Therefore, as a city in central China with the most comprehensive industry chain, using the main town area of Wuhan as the case study area to discuss the spatial development of the EGS industry was representative and typical for exploring the trend of the EGS industry in China.

2.2. DATA COLLECTION

As the Chinese officially recorded a company credit agency, the Tianyancha system was one of China's leading business inquiry platforms (www.tianyancha.com). On 10 May 2019, Tianyancha was awarded Enterprise Credit Business Operation Qualification License by the People's Bank of China (PBC). Tianyancha system included information on hundreds of millions in social entity companies (including companies, institutions, foundations, schools, law firms, etc.) in China, with more than 300 dimensions of information automatically updated, such as listing information, corporate background, corporate development, judicial risk, operational risk, business status, intellectual property rights, etc. This paper used the data of EGS business companies as representative data of the development of the EGS industry and carried

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out a query based on the Tianyancha system to quantify and classify the collation of EGS companies. The specific search procedure was as follows.

The search engine based on the Tianyancha query platform was searched for all aspects of the following keywords relating to the business of EGS companies. As of 2022, these included eSports, electronic games, eSports tournaments, eSports clubs, eSports media, eSports news, eSports production, eSports host, eSports community, eSports live stream, eSports training, eSports broker, eSports internet cafes, eSports startup, eSports matchmaking, eSports platform, eSports equipment, eSports player, eSports service and other related Keywords.

Tianyancha's data search engine was comprehensive, but some of the information included may be inaccurate, which resulted in some screened companies not belonging to the EGS industry. Therefore, the selected EGS companies were reviewed through manual screening. Through the National Enterprise Credit Information Publicity System (https://www.gsxt.gov.cn/), data on the registered address, date of registration, registered capital, type of company, scope of business, and registration status of the above-mentioned EGS companies were collected. For the authenticity and validity of the data source, anomalous companies with unclear registered addresses, current business status showing cancellation, and revoked business licenses were removed. The resulting EGS industry data for the main town area of Wuhan showed that there were 4 EGS companies as of 2006, 12 EGS companies as of 2010, 27 EGS companies as of 2014, 63 EGS companies as of 2018, and 114 EGS companies as of 2022.

2.3. DESIGN OF THE STUDY

Through an overview of important historical events in the development of EGS, this paper sorted out the important historical progressions affecting the development of EGS in China (Table 1). It concluded that EGS as a controversial emerging industry was developing in a positive direction through continuous regulation and refinement by various sectors [21]. Based on a comprehensive analysis of EGS events, this paper considered that the longitudinal period from 2006 to 2022 was an essential guideline and reference value for evaluating the development status of the Chinese EGS industry. Therefore, this paper took the year 2006 as the beginning of the study ("General Administration of Sports of China first issued series of normative documents for the EGS industry") and established the period from 2006 to 2022 as the study's time interval. Based on the key historical events affecting EGS in China during the period, four-time intervals were delineated: 2006-2010, 2010-2014, 2014-2018, and 2018-2022. The spatial distribution characteristic, spatial evolution trends, and spatial forecasts of the high-capital areas in Wuhan's main town area were analyzed according to the four historical development stages of the Chinese EGS industry. The research objective was to explore the causation of spatial evolution and make recommendations for the development of the EGS industry in the main town area of Wuhan.

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Table 1. Key Events Affecting the Development of EGS in China (2003-2022)

Year	Key Events on the Development of EGS in China
2003	For the first time, EGS officially became the 99th sport recognised by the General Administration of Sports of China (GASC).
2004	The National Radio and Television Administration of China (NRTAC) issued notices prohibiting the broadcasting of EGS programs.
2006	The General Administration of Sports of China (GASC) issued a series of policies for the first time, such as "National E-Sports Competition Management Measures", to gradually establish an effective EGS management regulation system.
2008	The General Administration of Sports of China (GASC) redefined EGS as the 78th sport for the first time.
2009	The World Cyber Games (WCG) Final was held in Chengdu, China.
2011	China Central Television (CCTV) sports channel broadcasted the EGS specials program for the first time, and the World Cyber Games (WCG) had officially held in Kunshan, China.
2012	EGS had been nominated for the Tokyo 2020 Olympic Games.
2013	For the first time, the General Administration of Sports of China (GASC) set up a 17-member national team of EGS to compete in the 4th Asian Indoor and Budo Games.
2014	The "Sports on Earth" program of China Central Television (CCTV) broadcasted a documentary on the League of Legends project of EGS.
2016	For the first time, the Ministry of Education of China (MEC) added "E-Sports and Management" to the "Catalogue of Specialisation in Higher Vocational Education of General Higher Education Schools".
2017	The Olympic Council of Asia announced the inclusion of EGS as an official competition. In addition, the International Olympic Committee announced at its sixth summit in Switzerland that the EGS competition would be considered a sporting event.
2018	The 2018 Asian Games in Jakarta included EGS as a performance event. The same year, the Chinese government issued the "Measures for the Registration of E-Sports Athletes in Sichuan Province" to officially implement the EGS athletes' registration system.
2019	For the first time, the Ministry of Human Resources and Social Security of China (MHRSSC) issued a public notice for new occupations, including EGS athletes and EGS operators. In the same year, EGS was officially listed as a sporting competition after the fourth executive meeting of the National Bureau of Statistics of China (NBSC).
2020	For the first time, the Olympic Council of Asia announced the EGS program as an official event of the Asian Games.
2022	For the first time, EGS was an official event at the 19th Asian Games in Hangzhou, China, and was recorded in the national medal table.

Note: Compiled by the author from a variety of open-source information.

The spatial distribution characteristic was used to determine EGS companies based on temporal cross-sectional data for the main town area of Wuhan in 2006, 2010, 2014, 2018, and 2022. The study used Average Nearest Neighbour (ANN) analysis, which emphasized closer spatial connectivity of near objects than distant objects. The spatial distribution of point elements of EGS companies in the main town area of Wuhan was used to measure the mutual proximity and distribution characteristics in geographic areas. The Average Nearest Neighbour (ANN) ratio was calculated as the observed average distance divided by the expected average distance, which was used to measure the distribution of point elements in geographic

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areas. The ratio of ANN less than 1 indicated that the distribution was a cluster, greater than 1 indicated that the distribution was discrete, and equal to 1 indicated that the distribution was random [22].

The spatial evolution trend was simulated using Kernel Density Estimation (KDE) analysis based on data from four-time intervals, 2006-2010, 2010-2014, 2014-2018, and 2018-2022. Kernel Density Estimation (KDE) assumed that within a certain spatial range, a certain object could occur at any geographical location, but the probability of occurrence differed at each spatial location [23]. The object was considered to happen more frequently if it occurred more often in the spatial range and less frequently if not. The simulation results provided a graph that showed the spatial density change of the EGS company number. Based on the crest and trough in the spatial density graph of EGS companies, the spatial degree of clustering and the evolution trend of EGS companies were recognized from 2006 to 2022.

The spatial forecast was based on the location and number of spatially distributed EGS companies in 2022 and discriminated the high-capital areas of EGS using the registered capital of EGS companies as a weighted variable. The method used to discriminate high-capital areas of EGS companies was the Ordinary Kriging (OK) with spatial interpolation, which was an approach to optimally estimate unknown points based on variable data related to known point elements within the study area by the semivariogram model [24]. The aim was to forecast the high-capital distribution in the main town area of Wuhan and to make recommendations for the future spatial development of the EGS industry.

3. RESULTS AND DISCUSSIONS

3.1. SPATIAL EVOLUTION OF THE EGS INDUSTRY

3.1.1. SPATIAL DISTRIBUTION CHARACTERISTICS OF THE EGS INDUSTRY

The geographical location of EGS companies was abstracted as spatial point element data, and the results of its spatial distribution characteristics were discriminated by the Average Nearest Neighbor Ratio (R). R was calculated through the observed average distance (the actual EGS company distribution) divided by the expected average distance (the assumed random EGS company distribution) [25]. The calculation formulas were as follows.

$$R = \frac{\bar{D}_o}{\bar{D}_e} \quad (1)$$

$$\bar{D}_o = \frac{\sum_{i=1}^{n} d_i}{n} \quad (2)$$

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$$\bar{D}_e = \frac{1}{2\sqrt{\frac{n}{s}}} \quad (3)$$

In the above formula (1), the observed average distance was the average distance between the EGS company's point and the centroid of its nearest neighbor point, defined as $\bar{D}_o$. The expected average distance was the average distance in the random distribution of each EGS company's point, defined as $\bar{D}_e$. Average Nearest Neighbor Ratio was defined as R. In the above formula (2), d_i was the distance between EGS company's point i and each other EGS company's point. n was the number of EGS company's points i within the study area (the main town area of Wuhan in China). $\bar{D}_o$ was the observed average distance of the EGS company's point. In the above formula (3), n was the number of EGS company's point i within the study area (the main town area of Wuhan in China). S was the size of the study area (the main town area of Wuhan in China). $\bar{D}_e$ was the expected average distance of EGS company's point.

The distribution of EGS companies for five-time sections in 2006, 2010, 2014, 2018, and 2022 were measured by performing Average Nearest Neighbor (ANN) analysis in the ArcGIS software platform's Spatial Statistics tool (Table 2). The distribution of EGS companies in 2006 showed a very significant discrete trend, with R=2.440>1. The large R might be because the number of EGS companies was too less and caused the difference between the observed average distance and the expected average distance being too strong. The distribution of EGS companies in 2010 had observed an average distance of 2464.319m and an expected average distance of 2286.432m with R=1.078. However, P=0.606>0.05 indicated that the null hypothesis was rejected and the distribution pattern lacked evidence of statistical significance (the null hypothesis specified that the spatial elements were randomly distributed states). The number of EGS companies increased to twenty-seven in 2014, with R=0.789<1, indicating that the distribution of EGS companies in the main town area of Wuhan had gradually varied from discrete to cluster distribution. Until 2018 and 2022, R kept decreasing to 0.666 and 0.661, indicating a more obvious clustering of EGS companies. Moreover, the expected average distance of 114 EGS companies in 2022 was 1174.579m, and the actual observed average distance was only 776.757m. This indicated that the distance between the closest elements had been relatively small, and the aggregation dynamic of EGS industries was high. Therefore, the results indicated that the EGS industry distribution in the main town area of Wuhan as a whole exhibited a process from discrete to cluster distribution between 2006 to 2022, and the degree of aggregation continued to deepen in recent years.

Table 2. Average Nearest Neighbor (ANN) Results for the Main Town Area of Wuhan (2006-2022)

Year	Number of companies /individual	Z-Score	P-Value	Observed Average Distance/m	Expected Average Distance/m	Average Nearest Neighbor Ratio (R)	Distribution Characteristic
2006	4	5,508	0,000	7814,481	3203,248	2,440	Discrete Distribution
2010	12	0,516	0,606	2464,319	2286,432	1,078	Insignificant Distribution
2014	27	-2,097	0,036	1761,916	2232,881	0,789	Cluster Distribution
2018	63	-5,069	0,000	1028,692	1544,212	0,666	Cluster Distribution
2022	114	-6,918	0,000	776,757	1174,579	0,661	Cluster Distribution

3.1.2. SPATIAL EVOLUTION TRENDS OF THE EGS INDUSTRY

Kernel Density Estimation (KDE) estimated probability density values based on the distance between the element to be estimated and the sample element. Using the spatial property of the data sample to explore its spatial evolution trend, helped reveal the spatial concentration of the EGS industry [26]. The calculation formulas were as follows.

$$F(x) = \frac{1}{Nh}\sum_{i=1}^{n} K_n\left(\frac{x - x_i}{h}\right) \tag{4}$$

In the above formula (4), $F(x)$ was the estimated density function at spatial location x. N was the number of EGS companies in the main town area of Wuhan. h was the bandwidth that controlled the degree of smoothing and the range of effect for the kernel function. K was the kernel function for the spatial weights. $x - x_i$ was the distance between data sites x and x_i.

Kernel Density Estimation (KDE) analysis was performed in the ArcGIS software platform's Spatial Analyst tool to reveal the spatial concentration and trend among EGS companies within the main town area of Wuhan for 2006, 2010, 2014, 2018, and 2022. In addition, based on the variation of the EGS company numbers from 2006 to 2022, this paper found that the number of EGS industries in the main town area of Wuhan had been growing in a developmental trend, but there were discrepancies in the growth rate of the number in different periods. There was a 200% increase from 2006 to 2010 (8 additional EGS companies), a 125% increase from 2010 to 2014 (15 additional EGS companies), a 133% increase from 2014 to 2018 (36 additional EGS companies) and an 81% increase from 2018 to 2022 (51 additional EGS companies).

In terms of the spatial evolution of the EGS industry from 2006 to 2010, the number of EGS companies in the main town area of Wuhan was not significantly increased

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but initially formed a spatial distribution kernel (Figure 2). The maximum kernel density value increased from 449.99 to 1545.92. This indicated that the double core density areas of Hongshan and Jiangan had already taken shape and showed a certain aggregation trend phenomenon.

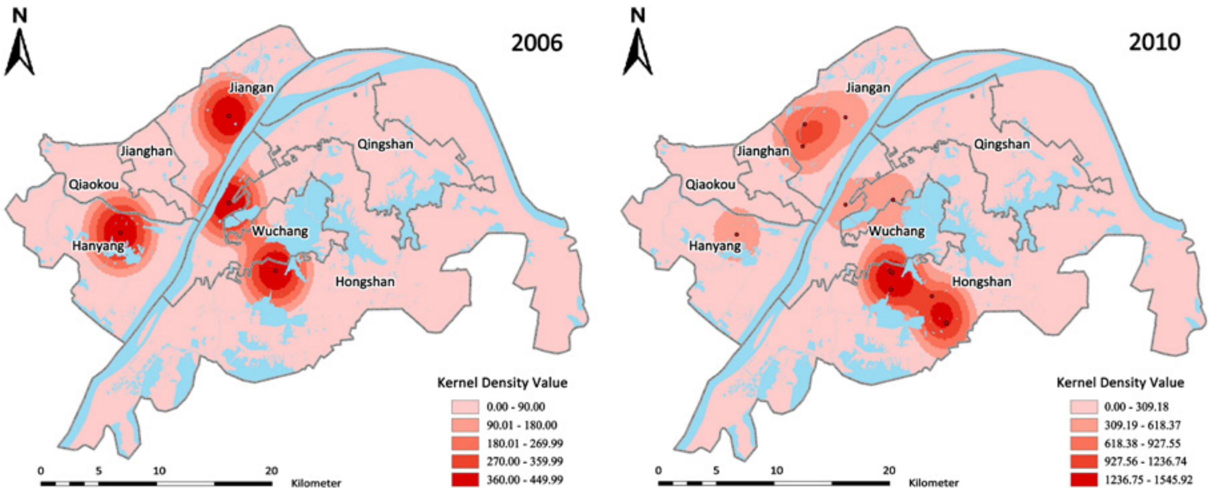

Figure 2. Kernel Density Estimation (KDE) Results for the Main Town Area of Wuhan (2006-2010)

In terms of the spatial evolution of the EGS industry from 2010 to 2014, the growing number of EGS companies led to an increasing spatial aggregation phenomenon, with EGS companies covering the main town area of Wuhan's seven administrative districts (Figure 3). The maximum kernel density value increased from 1545.92 to 1910.94, a small increase compared to 2006-2010, reflecting the growing core concentration in the cluster area but with a slower development rate. The initial dual-core aggregation of Hongshan and Jiangan gradually evolved into the multi-core aggregation of Jiangan, Jianghan, Hanyang, and Hongshan.

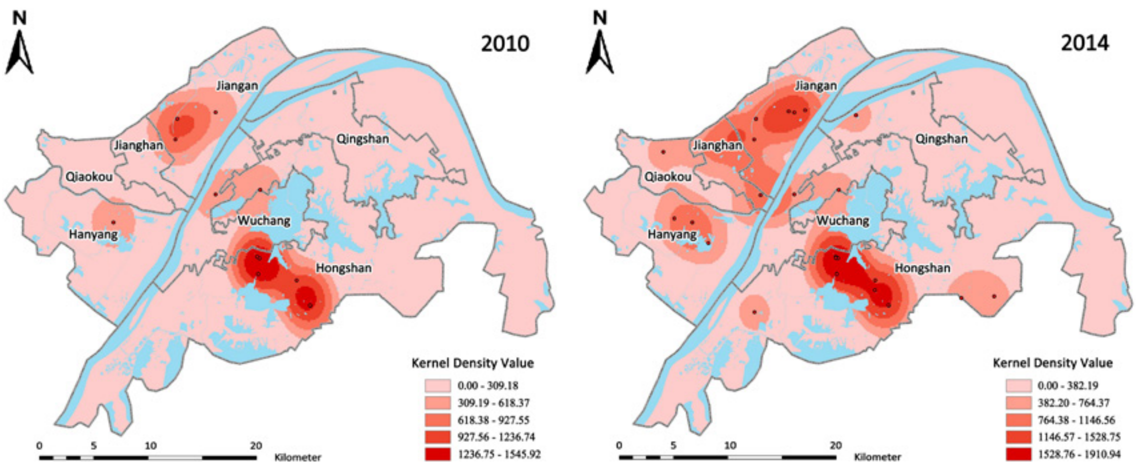

Figure 3. Kernel Density Estimation (KDE) Results for the Main Town Area of Wuhan (2010-2014)

In terms of the spatial evolution of the EGS industry from 2014 to 2018, the number of EGS companies in the main town area of Wuhan showed a faster growth and the distribution of EGS companies increased, especially the number of EGS companies in the southwestern region of Hongshan which grew very significantly (Figure 4). The maximum kernel density value increased from 1910.94 to 9175.94, which in turn led to a sharp strengthening of the core clustering trend for the EGS industry in southwestern Hongshan, with the degree of concentration already surpassing the cluster area in Jiangan. The trend of EGS industry evolution broke with the multi-core aggregation of the EGS industry in 2014 and emerged the trend of unipolar grouping in the Hongshan region.

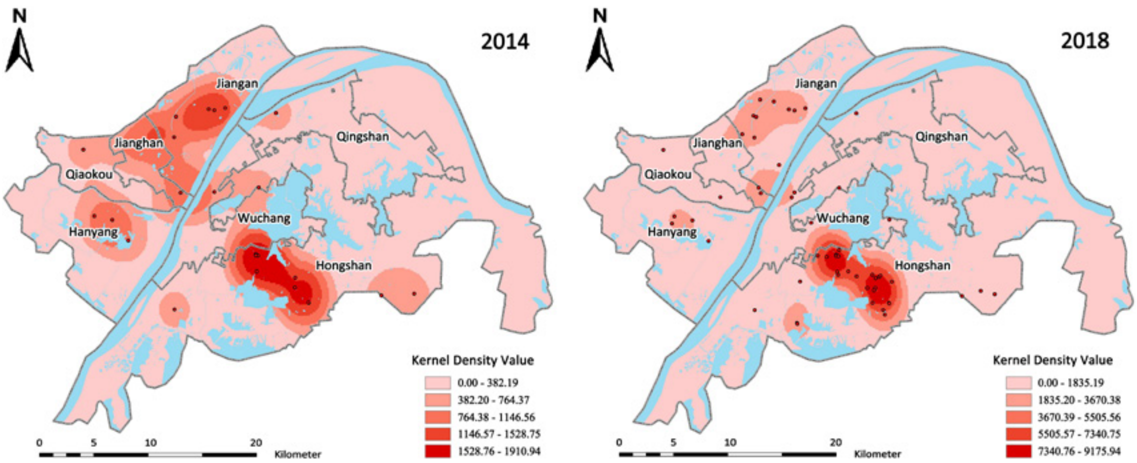

Figure 4. Kernel Density Estimation (KDE) Results for the Main Town Area of Wuhan (2014-2018)

In terms of the spatial evolution trend of EGS industries from 2018 to 2022, the aggregation trend of EGS companies in the main town area of Wuhan spread further, and not only the trend of unipolar grouping in the Hongshan area continued to strengthen, but also the trend of group consolidation in Jianghan (Figure 5). The maximum kernel density value increased from 9175.94 in 2018 to 15921.97, and the spatial aggregation trend of EGS industries steadily increased. The spatial pattern of the EGS industry presented the core grouping of Hongshan and the ribbon grouping of Jiangan and Jianghan.

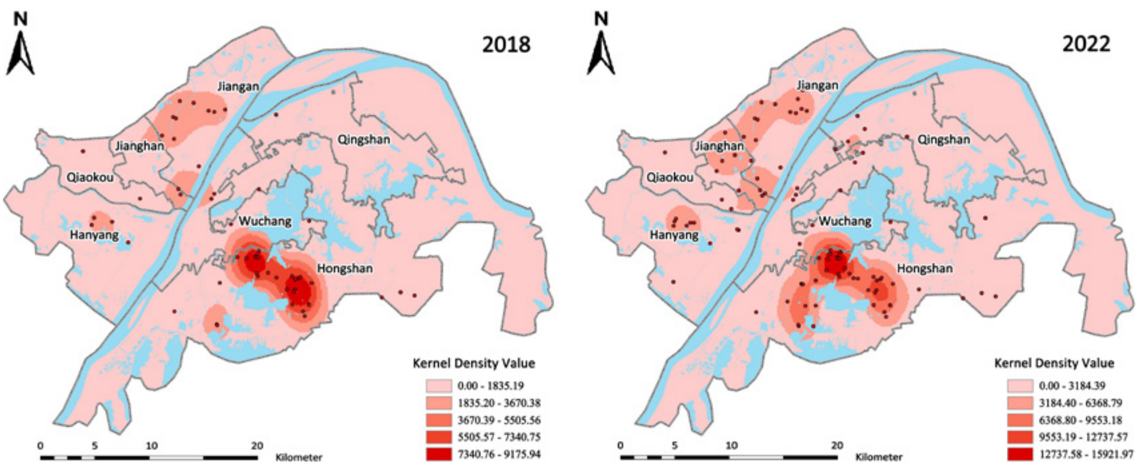

Figure 5. Kernel Density Estimation (KDE) Results for the Main Town Area of Wuhan (2014-2018)

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Therefore, as the number of EGS companies in the main town area of Wuhan continued to increase, the degree of spatial core aggregation of the EGS industry grew year by year, and the core aggregation areas transformed from the dual-core cluster to the multi-core cluster. The multi-core cluster of the EGS industry kept spreading to the surrounding areas based on the aggregation of each center, which in turn led to the formation of larger-scale monopole grouping and ribbon grouping in the adjacent core aggregation areas as the cluster spread. By exploring the growth and spatial evolution of EGS companies in each period, this paper suggested that the main town area of Wuhan's EGS industry experienced the early start phase (2006-2010), the rapid development phase (2010-2014), the aggregate explosion phase (2014-2018) and the cluster integration phase (2018-2022) between 2006 to 2022.

3.1.3. SPATIAL FORECAST OF THE HIGH-CAPITAL EGS INDUSTRY

Kriging interpolation was known as the spatially local interpolation technique, which enabled linear optimal unbiased estimation of data at unknown sampling sites in the area [27]. Ordinary Kriging (OK) was a univariate model with relatively simple operation compared to Regression Kriging (RK) and Universal Kriging (UK), as well as low error and good spatial prediction results [28]. Therefore, this paper adopted the Ordinary Kriging (OK) for spatial interpolation in predicting the spatial dynamic of the high-capital EGS industry. The calculation formulas were as follows.

$$Z'\left(x_0\right) = \sum_{i=1}^{n} \lambda_i \cdot Z\left(x_i\right) \tag{5}$$

In the above formula (5), $Z'\left(x_0\right)$ was the estimated value of the attribute at the unknown EGS company's location x_0. λ_i was the weight, which was used to weight the attribute value of the known EGS company's points. $Z(x_i)$ was the attribute value of the x_i point in the set Z of known EGS company points.

The main town area of Wuhan's EGS industry had been improving recently in terms of the supporting chain of industries, which to a certain extent demonstrated the unique development opportunities of the EGS industry in the future. Therefore, this paper predicted the capital hotspots for the main town area of Wuhan's EGS industry in the future by weighing the capital elements of companies. Ordinary Kriging (OK) analysis was performed in the ArcGIS software platform's Spatial Analyst tool based on the point data of EGS companies in 2022, the spatial forecast for the high-capital areas of the EGS industry in the main town area of Wuhan was carried out by weighting the registered capital of companies (Figure 6). Parent companies within the spatial distribution hotspots might spin off its industries chain to continuously increase their competitiveness and asset value [29]. Therefore, the aggregation of high-capital EGS companies in the hotspots signified the opportunity for more competitive EGS companies to emerge in the future. The spatial prediction results showed that high-capital EGS companies in the main town area of Wuhan were distributed around the Optics Valley vice town area in the southeast of Hongshan. This indicated that the Optics Valley vice town area in the southeast of Hongshan had the opportunity for more competitive EGS companies to emerge in the future and formed a larger EGS industry group with other EGS companies clustering in the region.

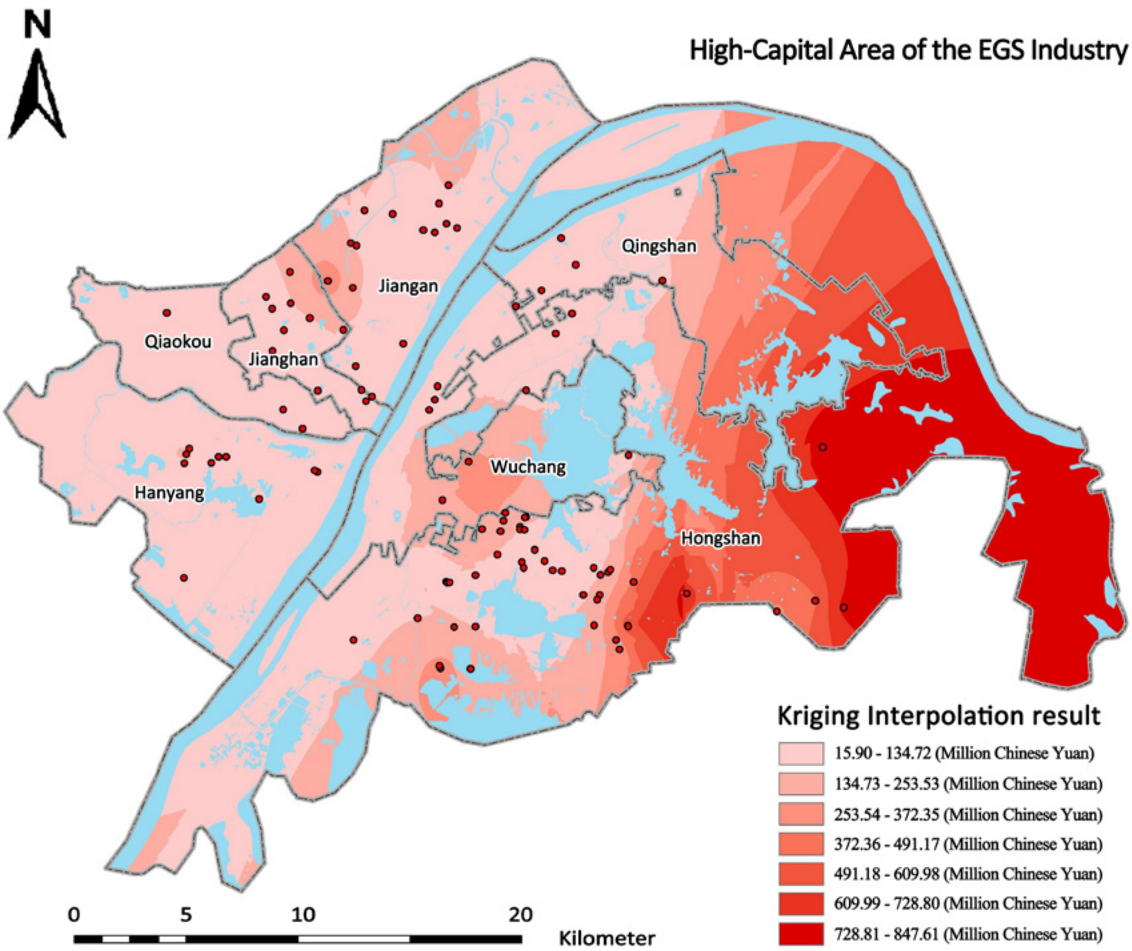

Figure 6. Capital-Weighted Kriging Interpolation Results for the Main Town Area of Wuhan in 2022

3.2. CAUSATION AND SUGGESTIONS FOR THE EGS INDUSTRY

3.2.1. CAUSATION FOR SPATIAL EVOLUTION OF THE EGS INDUSTRY

Based on the analysis of the spatial evolution trend of EGS companies in the main town area of Wuhan, this paper found that the aggregation characteristics of the EGS industry were significantly strengthened over time from 2006 to 2022. Moreover, there was the possibility of further polarisation in the Optics Valley vice town area in the southern part of Wuhan Hongshan in the future. The spatial evolution of the EGS industry in the main town area of Wuhan was considered to be influenced by three main factors: industrial economic agglomeration, industrial chain derivation, and industrial policy environment.

As a concentration of economic activities in geographical and spatial distribution, industrial economic agglomeration was mainly manifested by the agglomeration of similar or complementary industries in adjacent geographical locations. Further, it formed industrial economic groups and interdependent regional networks. Agglomeration economies played a guiding and centripetal role in the formation of the EGS industry group. As new companies were attracted to the city's existing industrial resources, they might congregate in industrial economic agglomerations nearby potential customers or potential suppliers, and draw resources from neighboring companies [30]. In addition, excellent agglomerations could better incubate and nurture synergies between each EGS company. The Average Nearest Neighbour (ANN) ratio of EGS companies decreased from 2.440 to 0.661, and the maximum kernel density value of EGS companies increased from 449.99 to 15921.97 between 2006 to 2022. Therefore, whether as a whole or locally, the trend of aggregation in the distribution of EGS companies in Wuhan strengthened over time, contributing to the development of the EGS industry in the direction of agglomeration and cooperation.

Inherited spin-offs in industry chain derivation arose from the spillover of new companies from the parent company’s business. In the process of inherited spin-offs, the parent company facilitated the transfer of its resources to the new company in a tolerant manner for the transfer of assets, which was more competitive and had a higher survival rate than other inexperienced start-ups [31]. Cooperative spin-offs in the industry chain derivation were achieved through cooperation between companies in the upstream, midstream, and downstream of the industries chain, bringing into play the absolute capabilities of each company in its respective strengths and achieving win-win cooperation in the industries chain further. The main town area of Wuhan's EGS companies might already have a well-established chain of industries in the Optics Valley vice town area of southern Hongshan. Compared to other EGS industry aggregations in Wuhan, the hierarchy of the EGS industry in Hongshan was much stronger than in other regions with polarising effects. In addition, the Optics Valley vice town area had hosted numerous international EGS events, and its "EGS city card" confirmed the perfection of the industry chain and supporting facilities. For example, it hosted the China Youth E-sports Competition (CYEC), the Global Optoelectronic Information Engineer Contest, and so on, which were major electronic information competitions.

The industrial policy environment was one of the factors directly influencing the aggregation of EGS industry, political, commercial, and social advantages had become a focus of attention for those EGS inside and outside sectors with active use of media tools to drive investment [32]. The industrial policy environment consisted of direct government policies contributing to forming and developing industries, which were effective and quick to implement. The positive business philosophy of companies and inclusive city culture values would more easily create a business environment conducive to the development of companies. Furthermore, the government proposed establishing cultural confidence in industrial development and innovating the business promotion mode of EGS industries through the combination of government policy promotion and EGS competitions [33]. This paper argued that the greater role of government industrial policy in the aggregation of the EGS industry was due to the tax breaks for micro & small companies and the technology incubation incentives enacted in the Optics Valley vice town area, which greatly supported the survival of emerging EGS companies.

3.2.2. SUGGESTION FOR FUTURE DEVELOPMENT OF THE EGS INDUSTRY

From the results of the spatial evolution of EGS, the spatial evolution trend of the EGS industry was not only influenced by the main factors of industrial economic agglomeration, industrial chain derivation, and industrial policy environment but also related to other factors such as land and talent market, adjacent infrastructure support, city industrial promotion, and globalization dissemination. Compared with the traditional sports industry, the EGS industry combined sports competition, digital information technology, and audio-visual arts into a whole, with strong information technological characteristics [34]. Therefore, by referring to the characteristics of EGS companies, which were more inclined towards emerging technology companies, this paper focused on the following three aspects to recommend the future development of the EGS industry.

1. The government's industrial policy had an important guiding role in establishing industrial chains, forming industrial aggregations, and improving cooperation in spatial groups for companies. Regional support policies, industrial cultural integration, and inter-country differences led to significant regional imbalances in the contribution of EGS industries to economic development, but economic connections between regional EGS companies had strengthened slightly in recent years [35]. Especially after the COVID-19 pandemic, government strategic plans and investments could be considered for the strategic development of EGS because of the important impact on the economy of the destination [36]. By guiding the formation of a conglomerate of EGS companies, government industrial policies could easily create a good brand appeal to attract consumers and develop high technology [37]. In addition, reasonable and favorable tax breaks for companies and a positive business environment would attract new EGS companies to locate. The location of new companies was not only influenced by the source market but also by whether the costs and benefits of operating space could be maximized under the support policies of industries.

2. High-quality talent teams played a vital role in the development of the EGS industry as carriers with corporate knowledge and skills. Typically, talent teams performed better in collaborative management than in self-management, reflecting that high-quality talent teams were better for the development of

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companies and demonstrated team pride and cohesiveness [38]. The EGS industry involved in new Internet businesses such as sports, digital information technology, and new media communications required a more versatile mix of technology professionals than traditional industries. Moreover, due to various technological and commercial dependencies, EGS was in a precarious state compared to earlier traditional sports, as the EGS industry lacked a large number of human resources to formalize and institutionalize its industrial environment [39]. In addition, whether it was upstream, midstream, or downstream of the EGS industry chain, talented teams of professionals could reduce operational costs for companies, integrate core resources, and facilitate cooperation between companies to form excellent city EGS industry cards.

3. Local promotion and international communication were critical drivers in stimulating the development of the EGS industry. As a type of sporting event, initiatives such as audience group attraction, obtaining sponsorship endorsements [40], and added value of derivative products had been important thrusts for the development of the EGS industry. In the past, the promotion and publicity of the EGS industry relied heavily on the unique enthusiasm for EGS among the youth population and the spread of various EGS events. In addition, the level of professional players in the EGS industry and the attractiveness of event broadcasts greatly impacted the promotion and dissemination of the EGS industry [41]. Many companies' brands used EGS as a medium for communication and interaction with the customer base to consolidate the space for dialogue and communication between its respective brand and the public [42]. Because the EGS industry was more commercial than other sports industries, its promotion and audience feedback were more efficient and quicker with the aid of technological communication media.

4. CONCLUSIONS

4.1. CONCLUSION

In terms of the spatial evolution trend of the EGS industry, the main town area of Wuhan had a strengthening trend of EGS industry aggregation from 2006 to 2022. The overall spatial distribution of the EGS industry showed a process from discrete to cluster distribution, and the degree of aggregation tended to deepen in recent years. The local kernel density value of the EGS industry increased year by year, and the aggregation pattern transformed from dual-core to multi-core aggregation. Moreover, as the aggregation cores spread around based on central clusters, the adjacent aggregation cores in Wuhan Hongshan formed a larger EGS industrial group as it spread and merged. The spatial interpolation results based on the weighted number of companies' registered capital predicted the future distribution of high-capital EGS companies in the main town area of Wuhan to be in the Optics Valley vice town area of southeastern Hongshan. This indicated that the Optics Valley vice town area might

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have the opportunity to emerge more competitive high-capital EGS companies in the future, which could lead to a larger scale EGS industry group.

In terms of the spatial development stages of the EGS industry, the spatial evolution of the EGS industry in the main town area of Wuhan could be divided into four phases. (1) In the early start phase from 2006 to 2010, the number of EGS companies in the main town area of Wuhan increased insignificantly, but a core concentration area was initially formed around higher education institutions and business districts. (2) In the rapid development phase from 2010 to 2014, the EGS industry aggregation core gradually developed from the dual-core aggregation of Hongshan and Jiangan to the multi-core aggregation of Jiangan, Jianghan, Hanyang, and Hongshan. (3) In the aggregate explosion phase from 2014 to 2018, along with the growth in the number of EGS companies in the southern region of Hongshan, the kernel density value of EGS companies in the main town area of Wuhan experienced explosive growth. This led to a dramatic increase in the aggregation trend of the EGS industry in Hongshan, and the intensity of aggregation surpassed that of the Jiangan agglomeration. (4) In the cluster integration phase from 2018 to 2022, the EGS industry aggregation in the main town area of Wuhan further strengthened and spread, showing the trend of the aggregation group of Hongshan, the belt group of Jiangan and Jianghan.

In terms of the causal factors of the spatial evolution for the EGS industry, the spatial distribution trend of the EGS industry in the main town area of Wuhan was not only influenced by the main factors of industrial economic agglomeration, industrial chain derivation, and industrial policy environment but also by the other factors of land and talent market, adjacent infrastructure support, city industrial promotion, and globalization dissemination. Compared to traditional industries, the EGS industry combined sports, information technology, and audio-visual arts and had the needs and characteristics of emerging technology companies. Therefore, the following three recommendations were suggested for the future spatial development of EGS companies. (1) The government's industrial policy played an important role in guiding companies to establish industrial chains, form industrial agglomeration, and improve spatial group cooperation. Reasonable and favorable tax breaks for companies and a positive business environment would be more attractive to new EGS companies. (2) High-quality talent teams, as carriers of corporate knowledge and technology, could reduce operating costs for companies, integrate core resources and promote inter-company cooperation to form excellent city cards for EGS industries. (3) Local promotion and international communication were critical drivers for the development of the EGS industry, providing an important impetus to the EGS industry development through audience attraction, sponsorship endorsement, and added value of derivative products.

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4.2. LIMITATION AND PROSPECT

This paper focused on Wuhan, the center city of Hubei Province in China. Although Wuhan was a crucial city in central China regarding study scope, there needed to be more consideration of other central Chinese cities beyond Wuhan, such as Changsha and Zhengzhou. In addition, Tianyecha, as China's largest commercial search platform, although it had the widest business coverage of commercial information, might be a little data missing covered by its search engine. It could be multi-party verification in the future by combining with other commercial search platforms such as the Aiqicha platform and the Enterprise Inspection platform. Therefore, this paper hopefully triggered more other researchers on the spatial development of the EGS industry.

5. DATA AVAILABILITY

All the data for this study is available upon request to the author.

6. CONFLICT OF INTEREST

The authors declare that the research has no financial or personal relationships with other people or organizations that can interfere with it.

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/02/

ECOLOGICAL PROTECTION AND ENVIRONMENTAL GOVERNANCE IN THE ERA OF BIG DATA CORPORATE FINANCE POLITICAL PERFORMANCE STUDIES

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ABSTRACT

The theory of sustainable development based on ecological protection and environmental governance places greater emphasis on the coordination between ecological civilization and economic construction. In response to the contradiction between economic development and ecological protection and environmental governance. We combine big data processing and big data mining techniques to conduct an in-depth study of ecological protection and environmental governance. In addition, we focus on exploring the relationship between relevant corporate financial performance and ecological protection and environmental governance. The results show that our proposed ecological conservation and environmental governance model has a maximum error of 2.37% and 1.27% in predicting ecological change and environmental governance respectively. The improvement in ecological conservation prediction is 63.72% and 65.93% respectively. In environmental governance, the improvement is 11.6% and 14.47%. The corresponding corporate earnings can be further increased by up to 37.81% and 41.36%. This shows that the adjustment of corporate finance can effectively solve the fluctuation of earnings caused by ecological protection and environmental management, and also promote the steady growth of corporate earnings.

KEYWORDS

Ecological protection; environmental governance; economic construction; big data; corporate finance

INDEX

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1. INTRODUCTION

Nowadays, China's economic development has been remarkable and it has become the second-largest economy in the world [1]. However, the rapid development of China's economy [2, 3] has come at the expense of the environment [4], with human activities, especially those of industrial enterprises, causing more damage to the environment every year [5]. Therefore, it is urgent for environmental management and ecological protection. Therefore, the task requirements should be to accelerate green and low-carbon development, continuously improve the quality of the environment, enhance the quality and stability of the ecosystem, and comprehensively improve the efficiency of resource use. At present, the construction of ecological civilization has gradually made positive progress [7, 8]. The rough and fast-growing economy needs to be transformed into a green and low-carbon sustainable development model [9, 10]. China is currently accelerating the process of environmental pollution control [11], while more stringent regulation of heavily polluting enterprises is being implemented. In the process of ecological protection and environmental management, to enable healthy, stable, and sustainable economic development [12], it is also necessary to take into account the environmental carrying capacity when society conducts economic behavior. We also need to consider the impact of environmental governance on business finances. We, therefore, need to establish a virtuous ecosystem and take a good ecological path in economic development, we must insist on putting the ecological environment before economic benefits while considering the benefits to the enterprise and dealing with the harmonious relationship between the ecology and the enterprise. We cannot let environmental management and ecological protection lead to an increase in the risk factor of enterprises and affect their development. What we should do now is to change the initial concept of economic development and use ecology and economics to combine the two concepts to explore methods and paths that can solve the problems of environmental governance, ecological protection, and economic development.

Due to the promotion of ecological protection and environmental management, various research scholars have contributed their ideas. It is hoped that ways can be found for environmental and ecological development and economic development of enterprises. New approaches to environmental governance can help to mitigate adverse socio-economic and ecological impacts. Broadbent, E.N [13] develops CoP-L on tools and strategies to improve infrastructure governance that can be used as a mechanism. Their research promotes learning and action on factors related to governance effectiveness. In addition, they used mixed methods [14, 15] to explore textual analysis and regional multi-iterative discussions with stakeholders. Zuo, L [16] argue that understanding the relationships between ecosystem services and exploring their drivers is necessary for effective ecosystem management. They quantified four factors: soil conservation, water production, net primary productivity, and habitat quality [17, 18]. Ecological priority conservation areas and ecological priority restoration areas are then identified, which facilitates targeted conservation. In terms

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of corporate ecological protection, micro-enterprises with profit-seeking characteristics have not developed sufficient motivation for environmental governance. hu, J [19] proposed that environmental protection departments carry out environmental regulation and their strength in enforcing regulations has an important impact on corporate environmental governance. wang, X [20] proposed an environmental monitoring system based on a ZigBee wireless sensor network. The system consists of a wireless monitoring network and a remote PC to achieve real-time remote monitoring of environmental information such as temperature and humidity, light intensity, rainfall, etc. Lu, S [21] looked at the legal system and established a corresponding ecological civilization system by legal norms, which has a positive effect on promoting environmental protection. They also focus on the current situation of China's ecological environment [22, 23], analyze its problems, and propose corresponding solutions in light of the problems. Guan, Y [24] combine the current requirements of China's ecological environmental protection. They introduced the macro background of the development of social organizations for environmental protection in China in terms of policies and regulations, material support, and propaganda guidance, and further analyzed the existing problems. Wu, M [25] conducted an in-depth discussion on the relationship between the economy, resources, and environment in the Greater Bay Area of China. The relationship between the green economy and the carrying capacity of resources and the environment in the Greater Bay Area is analyzed. By constructing a comprehensive economic-resource-environment index system, the entropy weighting method is used to calculate the index weights. They argue that the coordination of the economic-resource-environment system in China's Greater Bay Area is currently increasing and that economic development is moving towards high resource-carrying capacity and high environmental carrying capacity. Mazzanti, M [26] Their research questions cover everything from economic and financial performance to innovation adoption, to circular economy implementation and environmental protection. In addition in applying clustering techniques [27, 28] to better design and target policy tools for circular economy, environmental protection, and eco-innovation in areas related to ecological/ sustainability transition. Nowadays, due to the spread of information technology, computer network computing has developed [29, 30]. The processing of various complex problems through big data has also received increased attention. Fu-sheng [31] drew on the international BOT model to construct urban big data based on next-generation information technology such as artificial intelligence, cloud computing, and the Internet of Things to help the ecological construction of smart cities. Chen, F [32] used big data as a research context to construct a rural agroecological system ecological based on complex systems theory The study was based on the complex system theory to build an ecological management system for rural agricultural ecosystems. Among the many research scholars mentioned above on ecological protection and environmental quality, they have studied various aspects from the perspective of laws and regulations, ecological service system relationships, and artificial intelligence. In addition to the purely ecological influences and related governance methods, economic orientation has a great influence on ecological protection and environmental governance. In particular, with the rapid development of

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information technology, it is essential to analyze the relationship between ecological conservation, environmental governance, and related corporate finance based on big data.

The theory of sustainable development based on ecological protection and environmental governance places greater emphasis on the coordination between ecological civilization and economic construction. This research plays a guiding role in the construction and development of ecological protection and governance. The results of the research are conducive to promoting the common progress of the environment, economy, and society. Therefore, we combine big data processing and big data mining technology to conduct in-depth research on ecological protection and environmental governance. In addition, we focus on exploring the relationship between relevant corporate financial performance and ecological protection and environmental governance. It is a win-win situation for enterprises if they can maintain a healthy and stable growth of their revenue in the process of ecological protection and environmental management.

2. A FRAMEWORK FOR APPLYING BIG DATA FINANCIAL PERFORMANCE ANALYSIS TO ECOLOGICAL PROTECTION AND ENVIRONMENTAL GOVERNANCE ENTERPRISES

In the context of the big data era, the establishment of a big data analysis platform for ecological protection and environmental governance enterprises enables the collection and acquisition of financial and performance information for ecological protection and environmental governance enterprises in real time. Through the pre-set ecological protection and environmental governance logic language of the financial analysts, the report output performance end is fed back and the output data is processed to derive the important information required by the various departments and management of the ecological protection and environmental governance enterprise in real-time.

This paper uses a proposed method based on the output of financial and performance information from the ecological conservation and environmental governance state network to predict the time series generated by different environmental systems. The results conclude that the performance of the state network with ecological protection and environmental governance is reliable.

2.1. THE GENERAL FRAMEWORK OF THE MODEL

Ecological conservation and environmental management state networks are artificial recurrent neural networks that remain active even in the absence of relevant environmental data. This is shown in Figure 1.

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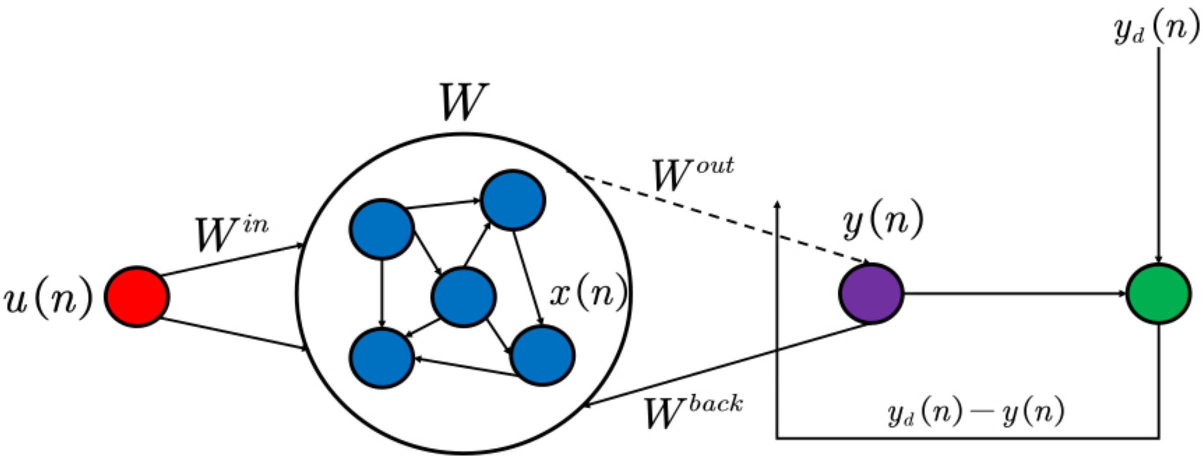

Figure 1. Model diagram of the ecological protection and environmental governance state network.

The ecological protection and environmental governance state network consists of a front-end input layer, an intermediate reserve pool, and an output layer, whose corresponding input vectors, state connection vectors, and output vectors can be expressed as follows.

$$u(n) = \left(u_1(n), u_2(n), \ldots, u_k(n)\right)^T \tag{1}$$

$$x(n) = \left(x_1(n), x_2(n), \ldots, x_r(n)\right)^T \tag{2}$$

$$y(n) = \left(y_1(n), y_2(n), \ldots, y_l(n)\right)^T \tag{3}$$

Among them, $u(n)$ is a dimensional input vector; $x(n)$ is a r dimensional state continuum vector; and $y(n)$ is a l dimensional output vector. At sampling time n, the state equation update and the financial and performance information output equation of the ecological protection and environmental governance state network are shown below.

$$x(n+1) = \tanh\left(W^{in}u(n+1) + Wx(n) + W^{\text{back}}\, y(n) + v(n)\right) \tag{4}$$

$$y(n+1) = W^{\text{out}}\, x(n+1) \tag{5}$$

Where the weight ratio W within the reserve pool is a $r \times r$ dimensional matrix, the weight ratio W^{in} at the input layer is a $r \times k$ dimensional matrix, and the W^{back} from the financial and performance information output layer and then the feedback connection is a $r \times l$ dimensional matrix of warrant ratios. $v(n)$ is the noise vector and the hyperbolic tangent is used as the activation function in this paper. In equation (5), which is the output equation of the single output network, the weight ratio W^{out} of the output financial and performance information is a $l \times r$ dimensional matrix. $y(n)$ is the financial and performance information output of the ecological protection and environmental governance state network. $u(n)$ is composed of the hyperbolic tangent activation function and the weight ratio of the output financial and performance

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information after passing the training. The network is continuously activated even in the absence of relevant environmental data.

The main component of the ecological conservation and environmental management state network is the use of a large-scale stochastic sparse reserve pool as the relevant environmental data processing medium. After processing the environmental data input signals are mapped from a low-dimensional input space to a high-dimensional state space. The network is eventually trained in the high-dimensional state space using linear regression methods for partial connection weight ratios.

2.2. ECOLOGICAL PROTECTION AND ENVIRONMENTAL GOVERNANCE STATE NETWORK INDICATORS

This subsection first gives definitions of the relevant ecological conservation and environmental management state network indicators, including definitions of prediction steps, sparsity, energy loss (energy consumption), energy efficiency (energy efficiency), and contribution.

1. The number of prediction steps is the minimum number of steps at a moment in time. This is described as follows:

$$\left| \frac{y_{predict}(n) - y_{original}(n)}{y_{original}} \right| \leqslant \Delta \tag{6}$$

where $\Delta = 0.001, y_{original}(n)$ are the values of the signal sequence at moment n and $y_{predict}(n)$ is the output value of the corresponding prediction sequence at moment n. reflects the predictive performance of the ecological conservation and environmental management state network.

2. Sparsity α is a connection probability between the neurons in the reserve pool and the financial and political performance information output neurons. This is described as follows.

$$\alpha = \frac{(N - S)}{N} \tag{7}$$

where S denotes the number of dormant synapses in the conservation and environmental governance state network and N denotes the number of all tunable synapses in the ecological conservation and environmental governance state network.

3. Energy loss E is the total energy loss of the output synapses activated in the ecological conservation and environmental management state network. This is calculated as follows.

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$$E = \sum_{i=1}^{N} \left(W_i^{out}\right)^2 \quad (8)$$

where W_i^{out} is a matrix of weights between the i connecting financial and performance information output neurons.

(4) Energy efficiency C is the energy loss per unit corresponding to the predicted number of steps in the ecological protection and environmental management state network. This is calculated as follows.

$$C = \frac{steps}{E} \quad (9)$$

2.3. ACCURACY OF ECOLOGICAL CONSERVATION AND ENVIRONMENTAL GOVERNANCE MODELS

This section discusses the comparison of the outputs derived from the ecological conservation and environmental management state network predictions with the experimental results. In Figure 2 the horizontal coordinates indicate the number of prediction steps and the vertical coordinates indicate the accuracy of the predicted values. In this paper, the number of prediction steps is set to 20, 40, 60, 80, and 100 for comparison. It can be seen that as the number of prediction steps increases, the prediction accuracy of the network model increases. When the number of prediction steps is 40, the model prediction accuracy can reach 95.61%. When the number of prediction steps reaches 100, the model prediction accuracy is 97.45%, which is only a 1.84% increase in prediction accuracy. At the same time, the network will increase the computational cost as the number of prediction steps increases. Therefore, 40 is chosen as the number of prediction steps for the network iteration in this paper.

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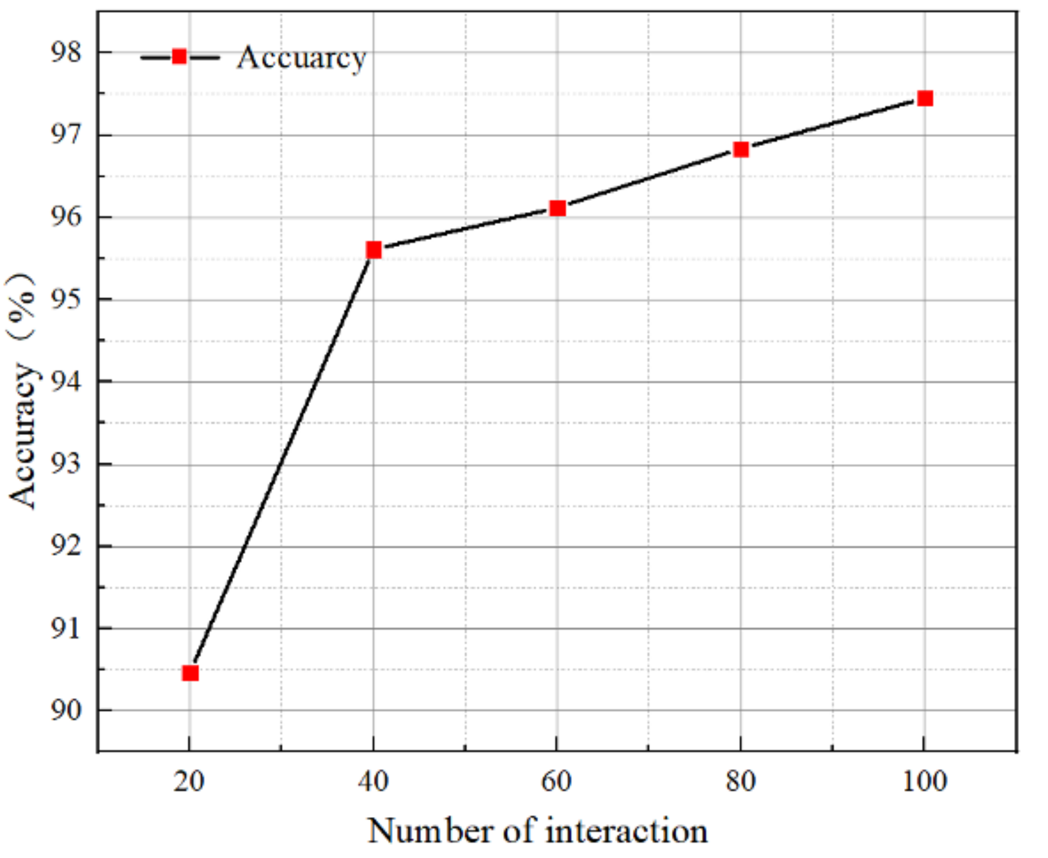

Figure 2. Plot of the number of ecological protection and environmental management state network prediction steps versus prediction accuracy.

3. RESULTS AND DISCUSSION RELATED TO ECOLOGICAL PROTECTION AND ENVIRONMENTAL GOVERNANCE

Currently, some large and medium-sized energy companies in the Chinese energy industry are facing trade-off decisions and constraints between the dilemma of ecological protection and environmental treatment and energy production. The needs in terms of energy production, ecological protection, and environmental treatment all need to be assessed through the indicators of an ecological and environmental protection enterprise. However, there are enormous tests in the area of environmental management and ecological protection, and it is, therefore, necessary to make a targeted analysis of the financial situation of ecological protection and environmental management companies and the corresponding performance results. The problems faced by companies in the field of ecological protection and environmental management are (1) a lack of awareness of ecological protection among the population and (2) insufficient investment in the ecological economy and research and development by the companies themselves. Research on environmental management, pollution treatment, and sustainable development has been relatively in-depth or at the application R&D stage in previous years and needs to be further assessed from the application environment; (3) In recent years, with the domestic

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economy, especially in some of the faster-growing regions, the development of research, development and application environment in ecological protection and environmental management has been full of vitality and vigor. However, in the rapid economic development, pollution problems in various industries have become more and more prominent. The current market environment for ecological protection and environmental management enterprises in the new era is undergoing the pressure of social opinion, means of publicity, innovation in business methods, and the combined impact of energy efficiency and environmental conditions. At the same time, the development and innovation of various big data technologies are gradually influencing the methods of financial analysis, analyzing and predicting the future development from the financial situation of the business community. The purpose of this is to serve the wider ecological and environmental management business community. In turn, it provides further policy and economic guidance to enterprises. It also guides the future of ecological protection and environmental management in China.

3.1. IMPACT OF ECOLOGICAL PROTECTION AND ENVIRONMENTAL GOVERNANCE INDICATORS

For this purpose, we collected information related to the financial performance of companies regarding ecological protection and environmental management from 2016-2020 and used an artificial recurrent neural network (ANN) to make non-linear predictions of the categorical data. One of the data sources was collected using a city in Guangdong Province, China as the base database. The input parameters include forest conservation indicators, water conservation indicators, air quality indicators, and pollutant and waste treatment indicators. For the output parameters, we used comprehensive evaluation indicators, which were set up as ecological protection indicators and environmental management indicators. In Table 1, we summarise the annual average forest protection indicators, water resource protection indicators, air quality indicators, and pollutant and waste treatment indicators for a municipality for the five years 2016-2020. It is observed that there is a huge crisis in ecological protection indicators as well as environmental governance in a city in Guangdong Province during the period 2016-2017. The figures for the area covered by forests, the total water reserves, and the overall air quality index decreased by 23.25%, 15.70%, and 26.87% respectively. This shows that the regulation of ecological protection is in great danger. The combination of massive illegal or unsustainable tree felling, water wastage, soil erosion, and pollution with the emission of harmful or greenhouse gases such as CO_2 has led to a simultaneous decline in the forest environment, water environment, and air quality. In addition, it was observed that the number of pollutant and waste treatment plants, which should be treated as pollutant emissions, did not increase significantly; the number of pollutant and waste treatment plants only increased by 5.8% between 2016 and 2017, which is far from enough to address a large number of ecological protection and environmental management issues and gaps during the period. As a result, there were huge ecological problems during this period. In the period 2017-2020, however, the significant development and promotion

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of ecological protection and environmental management enterprises and the related technological advances and developments have led to a significant improvement in all indicator parameters. The area covered by forests will increase by 5.62%, 10.88%, and 16.43% in the period 2018-2020 compared to the figures for 2017. Total water reserves have increased by 4.48%, 8.47%, and 12.26% year-on-year. The combined air quality index increased by 6.12%, 14.29% as well as 18.37% year-on-year. The number of pollutants and waste treatment plants increased by 28.125%, 55.80%, and 63.39% year-on-year.

Table 1. Annual average indicator data for a city in Guangdong Province for 2016-2020

Year	2016	2017	2018	2019	2020
Forest cover (in million hectares)	56.14	43.09	45.51	47.78	50.17
Total water reserves (in billions of cubic metres)	37.83	31.89	33.32	34.59	35.80
Air Quality Composite Index (0-1)	0.67	0.49	0.52	0.56	0.58
Pollutants and waste treatment plants	211	224	287	349	366

3.2. ASSESSMENT AND PREDICTION OF ECOLOGICAL CONSERVATION INDICATORS

In the process of ecological protection, the number of ecological protection indicators can clearly show how effective it is for ecological protection. Therefore, we have collected the ecological protection index between 2016 and 2020 and analyzed the index for these years using our proposed ecological protection and environmental governance model. As shown in Figure 3, in the actual ecological protection index, the figures for 2016 to 2022 are 0.557,0.313,0.361,0.397 and 0.431 respectively. the predicted figures in our proposed ecological protection and environmental governance model are 0.562,0.317,0.359,0.394 and 0.421 respectively. the maximum fluctuation values are below 0.01, and the maximum error is within 2.37%, which indicates that our proposed model has good accuracy. In addition, we have used the Ecological Conservation and Environmental Management model to predict the Ecological Conservation Index for subsequent years. According to our predictions, in 2024 and 2025, the relevant indices reach 0.519 and 0.526, an increase of 63.72% and 65.93% compared to 0.317 in 2017. This indicates that after 2017, China's commitment to ecological protection has become more and more powerful. China is not pursuing pure economic growth, they are building their economy while paying more and more attention to the ecological protection of the country. Strengthening ecological protection is conducive to strengthening China's green and low-carbon science and technology innovation, and sustaining the growth of green and low-carbon industries. This will be conducive to the formation of new green economic dynamics and sustainable growth poles. It will significantly improve the quality and efficiency of

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economic and social development, and provide a strong impetus for China to build a strong socialist modern state comprehensively.

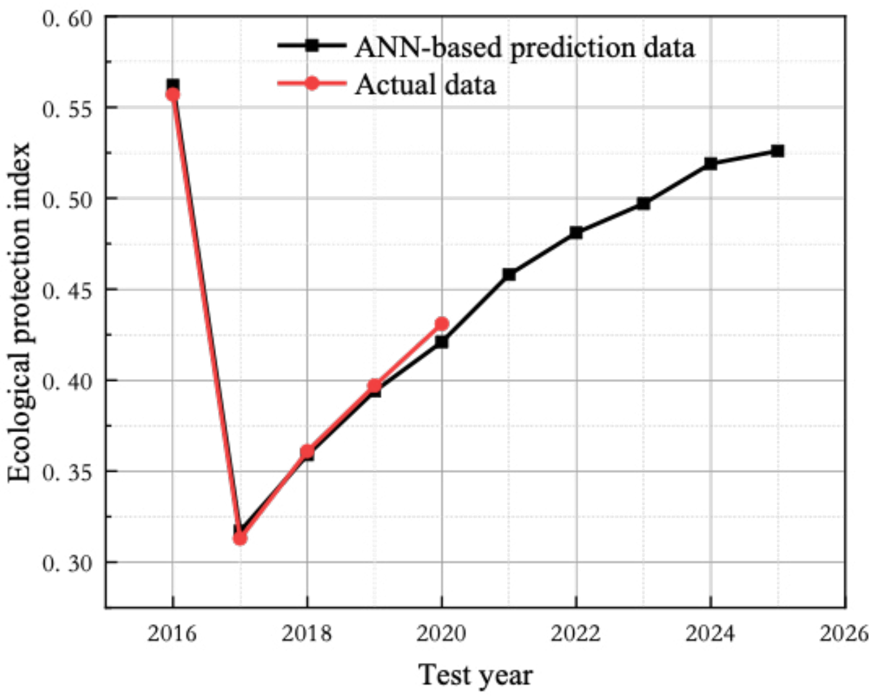

Figure 3. Assessment and prediction maps for ecological conservation indicators

3.3. ASSESSMENT AND PREDICTION OF ENVIRONMENTAL GOVERNANCE INDICATORS

China's fight against environmental pollution is of great theoretical and practical significance in achieving sustainable economic development, building a moderately prosperous society, and ultimately realizing the overall harmony of human society. It is conducive to the sustainable development of China's economy. When building an economy, there is a need to establish a way of development that meets the development needs of the present without compromising the ability of future generations to meet their needs. China is a developing country and the biggest problem it faces is developing its economy, which depends on the environment and resources to support it. The state of environmental governance is conducive to building a moderately prosperous society in all aspects. In the previous decades, China's rapid economic development had caused serious environmental pollution. Environmental pollution has become a major public hazard today. The Chinese government's efforts to manage the environment, properly manage the relationship between the economy and the environment, and manage the environment and protect the environment will provide an important foundation and prerequisite for China to build a moderately prosperous society and is a strong guarantee for China to achieve moderately prosperous for all people at an early date. Therefore, we have conducted

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an in-depth discussion on China's environmental governance, reflecting the extent of China's environmental governance through the environmental governance indicator factor. In Figure 4, we present the environmental governance factors for China between 2016 and 2020 and compare them with the results predicted by our proposed ecological conservation and environmental governance model. We can see that the actual environmental governance factors are 0.513,0.519,0.532,0.537 and 0.558 respectively, with environmental governance showing a steady and slow increase. The model predicts governance factors of 0.512, 0.518, 0.529, 0.534, and 0.551 for the period 2016 to 2020, with a maximum fluctuation of 0.007 or 1.27% compared to the actual values. This is mainly due to several factors in the environmental management process, including relevant laws and regulations, the enforcement efforts of law enforcement officers, and some local environmental influences. By forecasting the environmental governance in 2024 and 2025, the relevant factors are large 0.586 and 0.593. Compared with 2017, the steady increase of 11.6% and 14.47% indicates that environmental governance is steadily progressing.

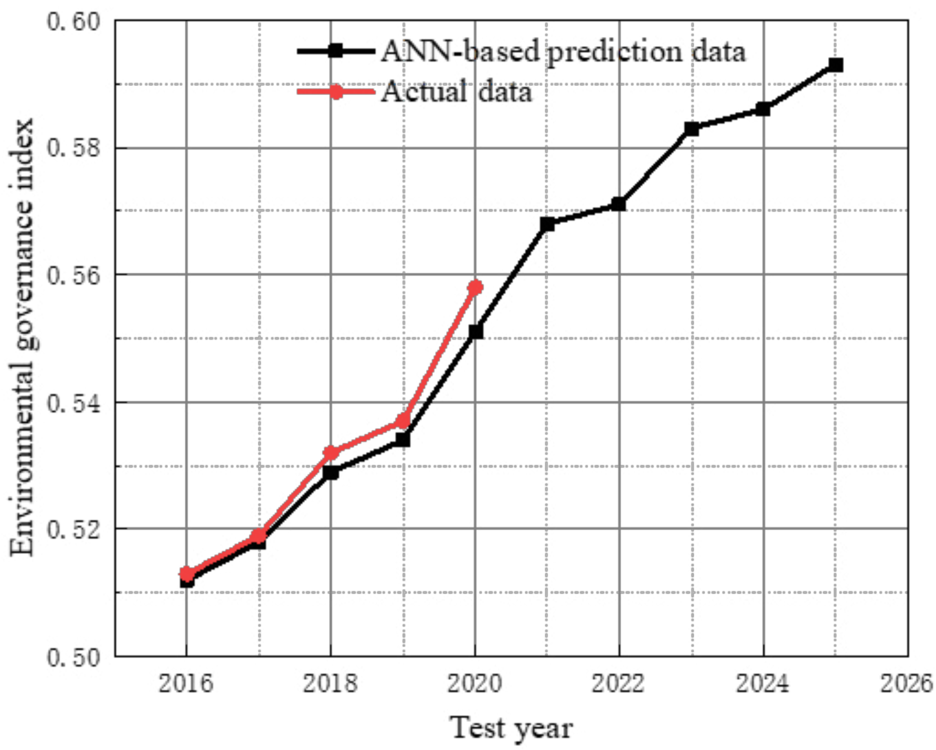

Figure 4. Assessment and prediction of environmental governance indicators

3.4. CORPORATE FINANCIAL RETURNS

Corporate finance needs to help decision-makers make the right judgment on the market based on the data provided by the finance department so that the company can grasp the right business direction in the market, develop steadily and stay in the

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invincible position. The focus of finance in an enterprise varies with the stage of development of the enterprise. To verify the impact of ecological protection and environmental management on corporate earnings, we track the earnings of a particular enterprise. As can be seen in Figure 5, between 2016 and 2020, the actual annual earnings growth of the enterprise is at 3.58%, 3.66%, 3.98%, 4.07%, and 4.14%. In our proposed model, the corresponding economic growth is 3.6%, 3.65%, 3.95%, 4.1%, and 4.12%. In addition, we forecast economic returns for the coming years, which are expected to grow by 5.03% and 5.16% in the years 2024 and 2025. This indicates that there will be no impact on the company's finances when it comes to ecological and environmental management. The corresponding increase in revenue could be as high as 37.81% and 41.36%. This shows that the adjustment of corporate finance can effectively solve the fluctuation of earnings caused by ecological protection and environmental management, and can also promote the steady growth of corporate earnings.

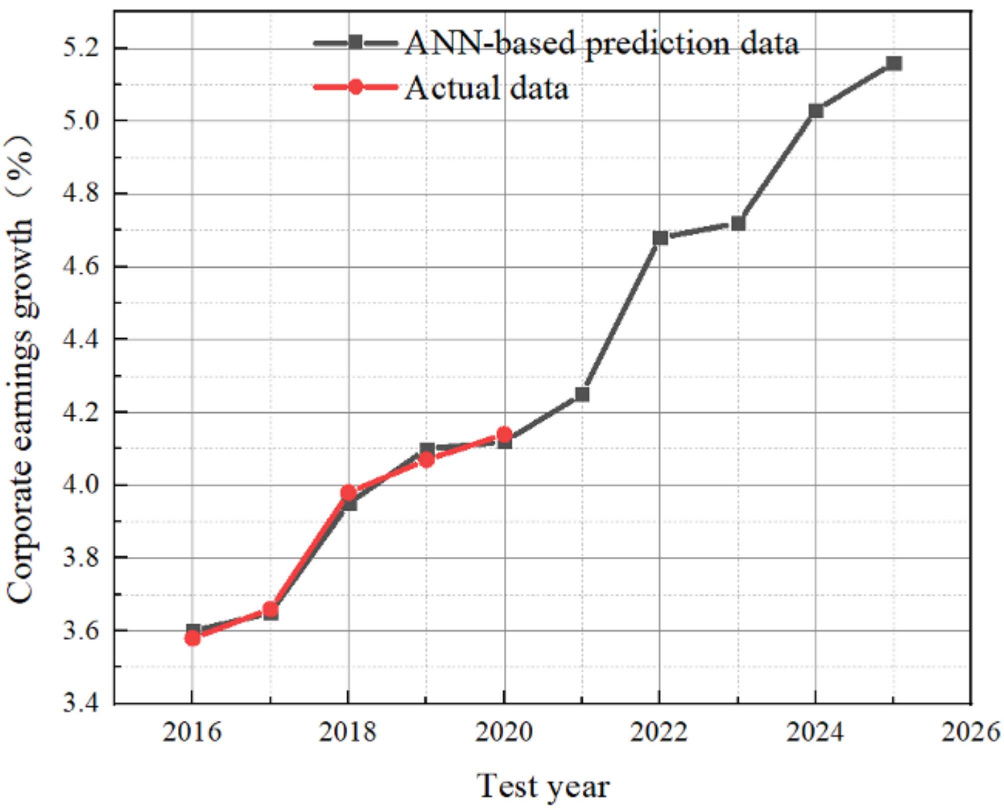

Figure 5. Graph of growth in corporate financial returns

4. CONCLUSION

Ecological protection and environmental management have a very significant and positive role to play in promoting sustainable development in China. In the process of ecological protection and environmental management, maintaining the economic growth of the enterprise according to specific circumstances is also a necessary environment for the development process. In business, finance permeates every aspect of business management, and all business management activities are ultimately reflected in financial data. These data can expose the loopholes and weaknesses in business management and provide early warning for the prevention of business risks. In the article, we combine big data technology for financial analysis to analyze and predict the future direction of development from the financial and fiscal status of the enterprise group. This is intended to provide further policy as well as economic guidance to the larger ecological conservation and environmental management business group. The findings of the study are as follows.

1. We used an artificial recurrent neural network (ANN) to make non-linear predictions of categorical data and summarised the data for a city's average annual forest conservation indicators, water conservation indicators, air quality indicators, and pollutant and waste treatment indicators for the five years 2016-2020. The results show a 23.25%, 15.70%, and 26.87% reduction in the total water reserves and air quality composite index respectively.

2. In the assessment and prediction of ecological protection and environmental management indicators, our proposed ecological protection and environmental management model has a maximum error of 2.37% and 1.27% in the prediction of ecological change and environmental management. This indicates that our model has good accuracy. It also improves 63.72% and 65.93% in ecological conservation prediction and 11.6% and 14.47% in environmental governance, respectively. It shows that our ecological protection and environmental governance are steadily progressing.

3. In carrying out ecological protection and environmental management, it is vital to ensure that companies earnings. In our forecasts, the corresponding corporate earnings can be further increased by 37.81% and 41.36%. This shows that the adjustment of corporate finance can effectively solve the fluctuation of earnings caused by ecological protection and environmental management, and also promote the steady growth of corporate earnings.

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RESEARCH ON THE IMPACT OF WASTE UTILIZATION IN HIGH-POLLUTING ENTERPRISES ON ECONOMIC ADDED VALUE EVA FROM THE PERSPECTIVE OF LOW-CARBON ECOLOGY

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ABSTRACT

At present, China's economy is developing rapidly, and the overall economic field is showing a trend of rapid growth. At the same time, the utilization of polluting wastes involves a trade-off between environmental pollution and the economy. This paper selects the method of economic value-added evaluation to analyze and predict the relationship between the two. The average single-share earnings of the group of companies that do not carry out recycling and utilization of polluting wastes are observed during 2019-2021. The results show that the net income per share and total income decreased by 32.43%, 10.28% and 32.73% respectively. During the period from 2019 to 2020, the number of EVA and the annual rate of change in income of companies that did not recycle polluting wastes decreased by 58.25% and 68.56%, respectively. On the contrary, the declines of enterprises that have been recycled are only 37.43% and 32.28%. Therefore, in recent years, enterprises that emit a large amount of pollutants should take the recycling and reuse of polluting waste as the main method.

KEYWORDS

Ecological environment; waste utilization; economic evaluation; energy enterprises; EVA evaluation.

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1. INTRODUCTION

Low carbon is an environmental responsibility for sustainable development [1, 2]. Low-carbon ecology requires people to establish a new outlook on life and consumption and also puts forward requirements for high-polluting enterprises to reuse corporate waste, thereby reducing carbon emissions and promoting the harmonious development of man and nature [3]. Low carbon will be an important way to coordinate economic and social development and protect the environment [4, 5].

Under the low-carbon economic model, people's life can gradually get away from the negative effects caused by the unreasonable use of energy, and enjoy a new life with the theme of economic energy and green energy [6]. Under the low-carbon ecology, reducing environmental pollution and ensuring low emissions is conducive to ecological environmental protection; in addition, it can also reduce the waste of resources, which is conducive to slowing down the speed of global warming and environmental degradation [7, 8]; improving corporate profits. In the production and development of an enterprise, there must be some waste of raw materials and products. For some waste materials in high-polluting enterprises, it usually takes nearly ten years to stabilize. The hazardous substances such as heavy metal ions and organic acids produced in the whole process cause pollution to the water, soil, and air in the surrounding living areas [9, 10]. At the same time, for the waste materials produced by high-polluting enterprises, there are also some resources that can be used such as metal materials. Therefore, the reuse of waste materials has a positive effect on alleviating environmental pressure and reducing carbon emissions [11, 12].

However, for enterprises, how to maximize corporate profits is the focus of enterprises. In the process of recycling waste materials, the enterprise can obtain its income and enhance the market competitiveness of the enterprise. Therefore, in the process of waste recycling in high-polluting enterprises, the company will consider the impact of waste material recycling on enterprise value assessment, and conduct a comprehensive assessment of its overall value. Through enterprise value assessment, it can further help investors make investments. Decision-making and business managers improve business decisions.

In the context of low-carbon ecology, a low-carbon economy is based on the theory of sustainable development. Through innovative ways such as industry and system, the development of energy towards an economic model with low consumption, low pollution and high utilization rate is realized. In the process of high-polluting enterprise waste recycling, how its impact on the economic added value of enterprises has attracted a lot of attention. Yang, Y. [13] argues that corporate waste poses new challenges to reducing environmental impact and enhancing resource sustainability for additive manufacturing. In the development of circular ecological economy, Aldieri, L. [14] analyzed the main characteristics of circular business models from the perspective of public interest, emphasizing how sharing economy business models can be well integrated and complementary with certain characteristics of circular economy, which is a powerful Pull factor [15, 16], other cycles of circular economy

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require a clear push factor. Braun, A.T. [17] believes that the transformation of a circular ecological economy requires a new value creation structure, thereby changing the business model. In the development of enterprises, they need to comprehensively consider after-tax net operating profit, weighted average cost of capital and total assets [18, 19], so that they can guide the development of enterprises. Gotts, I. [20] research shows that at the local level, the waste trade has become a monopoly. Their research proves that very good income can be generated in the transaction of waste and waste. Nawaz, M. [21] takes a holistic approach and examines the formal and informal aspects of the recycling value chain, assessing possible integration in waste management approaches through the use of recycling as a tool for achieving sustainability [22, 23]. To curb the trend of the massive increase in waste and reduce the adverse impact on the environment, Namkung, H. [24] proposed to promote several waste recycling policies, including waste-to-energy, which can effectively relieve pressure and respond to the production of polluting plastic waste. Alternative chemicals and fuel oils can play a key role in a country's sustainable development, generating huge benefits. Lassou, P. [25] proposed that accounting is an important component when evaluating economic growth. Gao, Y. [26] used the Global Productivity Index to estimate provincial TFP levels considering carbon emissions when conducting economic accounting [27, 28], comparing different assumed returns to scale and considering the ranking inversion problem. Nassani, A. A. [29] argues that in assessing sustainable development, accounting plays an important role in achieving national economic development through energy efficiency, economic insurance prices and sound financial development. Evidence provided by Bakre, O. M. [30] shows that accounting is an important foundation for economic development, and the selection of appropriate accounting is crucial to the valuation of assets. Fuentes-Saguar [31] analyzed the economic linkages between the bioeconomy sector and other economic sectors, and it is important to determine their aggregate and disaggregated effects on economic growth. Their study showed that in complex databases, based on accounting matrix analysis. Content evaluation of wealth creation plays a key role.

Abhayawansa, S. [32] reviewed existing research on national policy-making on value creation, sustainability and SDGs, identified gaps in national accountability and methodologies in national governance processes, and for the accounting component, organizations. The concept of value creation makes a lot of sense. Based on our analysis of the work of previous research scholars, we can find that there is still great commercial value in corporate waste. It is profitable for businesses to recycle and reuse waste materials. Therefore, based on promoting a low-carbon ecology, it is feasible for high-polluting enterprises to recycle and reuse waste materials. In assessing the benefits of waste materials, accounting can accurately analyze them, which can help to provide managers with useful information for decision-making and promote their confidence in the recycling of waste materials.

An important guarantee for the improvement of low-carbon ecological capacity is the multiple utilization and recycling of system resources, products and wastes. In carrying out the low-carbon ecological sustainable development model, the low-carbon ecological city should consider the goal of maximizing human social welfare, and must also ensure the income of enterprises in the recycling and reuse of waste materials. Therefore, in the recycling and reuse of waste materials from high-polluting enterprises, we comprehensively consider the nature, scale, development stage and organizational form of the enterprise to select relevant accounting items for adjustment, which truly reflects the ability of the enterprise to create value. According to the quality of the waste to be treated and the challenges of the substances to be treated, corresponding accounting adjustments are made to the R&D expenses, financial expenses, accounting preparations, and credit adjustment of the enterprise, to increase the economic benefits of the enterprise in the utilization of waste.

2. EVA CALCULATION AND MODEL STRUCTURE INTRODUCTION

According to research, the stakeholders involved in the utilization of waste resources in high-polluting enterprises include environmental protection units, business units, waste treatment stations, and the transportation industry. If there is effective cooperation among these participants to convert high-polluting corporate waste into secondary products, it will be beneficial to the improvement of China's high-polluting corporate waste resource utilization and the implementation of the dual-carbon strategy. To assess the impact of waste utilization in high-polluting enterprises on economic added value, we use algorithms to predict it, promote policies related to waste recycling in high-pollution enterprises, and formulate effective measures such as reasonable subsidies and penalties.

The essence of EVA is the input cost of corporate shareholders for waste utilization of high-polluting enterprises. When EVA is positive, the project can truly create value for corporate shareholders when the income from high-polluting corporate waste is greater than the input cost of corporate shareholders. EVA comprehensively considers the impact of the input cost of corporate shareholders on the utilization of waste in high-pollution enterprises, and can better reflect the value created by the utilization of waste in high-pollution enterprises for corporate shareholders.

2.1. CALCULATION OF EVA

The economic value added EVA is defined as the difference between the net operating profit after tax and the total cost of capital. The specific calculation process is as follows:

$$EVA = NOPAT - WACC \times TC \tag{1}$$

Among them, NOPAT is the adjusted net operating profit after tax of the enterprise; WACC is the weighted average cost of capital of the enterprise; TC is the adjusted total assets of the enterprise. When the adjusted net profit after tax of the enterprise is

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greater than the cost of capital, that is, when EVA > 0, the enterprise creates corporate shareholder value; and when the cost of capital is greater than the adjusted net profit after tax of the enterprise, that is, when EVA < 0, even if the enterprise accounting. If the profit is greater than zero, in fact, the enterprise is still depleting enterprise capital and does not create value for the shareholders of the enterprise.

2.2. INTRODUCTION OF EVA MODEL

To easily evaluate the impact of waste utilization in high-polluting enterprises on economic added value, the internal and external environments of enterprises tend to be stable in the short term, so EVA is divided into two different stage models. The details are as follows:

1.2.1 Single-stage model

1. Zero growth model

The utilization of waste resources in high-polluting enterprises has entered a mature period, and the EVA value remains stable and unchanged. The growth value of EVA in each cycle is 0, as shown in Figure 1:

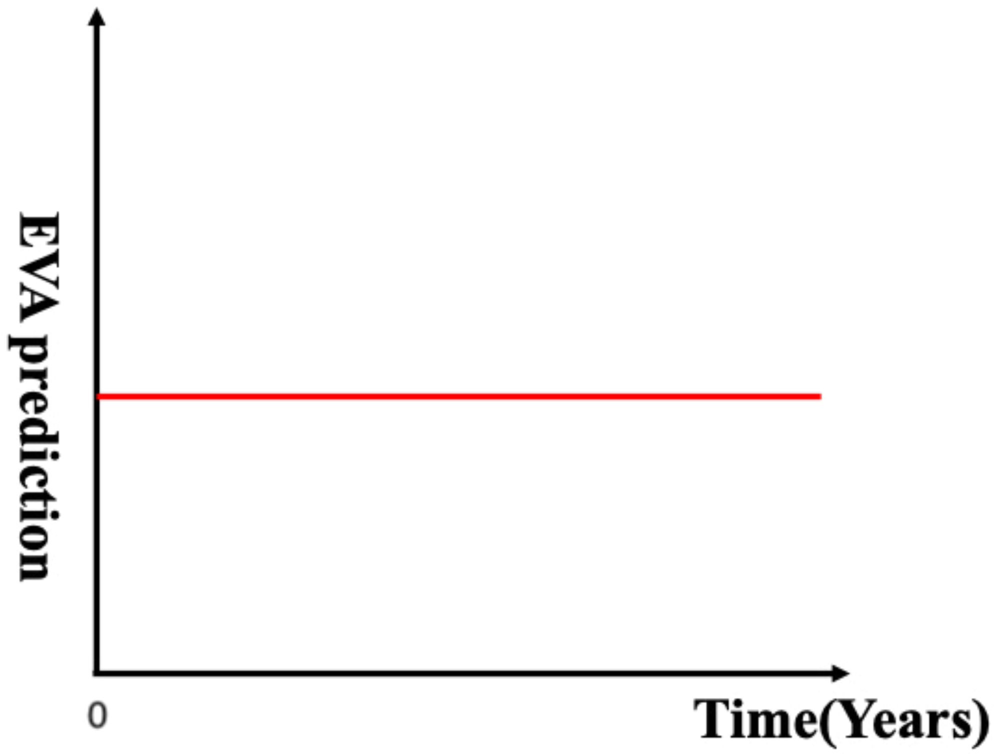

Figure 1. EVA zero growth model

$$EVA_1 = EVA_2 = EVA_3 \ldots EVA_n \tag{2}$$

$$enterprise\ value = I + \sum_{i=1}^{n} \frac{EVA_i}{(1+r)^i} + EVA \sum_{i=1}^{n} \frac{1}{(1+r)^i} \tag{3}$$

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Among them, I am the investment cost; r is the discount rate. Enterprise value is the sum of the invested capital and the present value of the expected EVA.

2. Fixed growth model

The enterprise's EVA grows at a fixed growth rate g, as shown in picture 2.

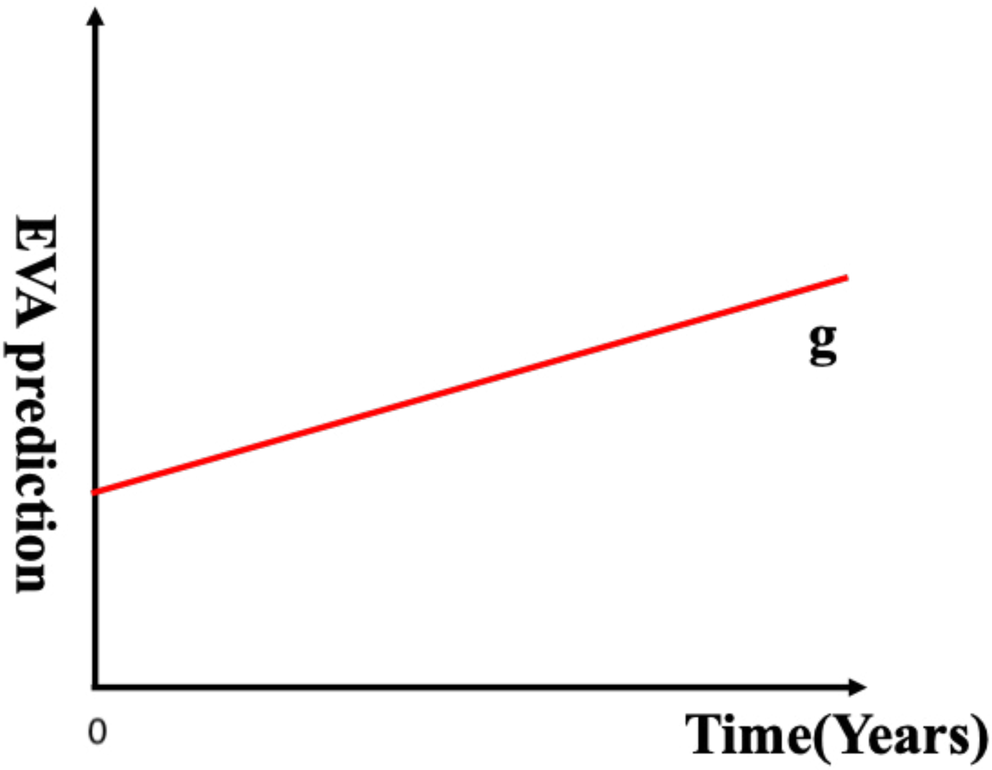

Figure 2 EVA fixed growth model

$$EVA_i = (1+g)^{n-1} EVA_1 \tag{4}$$

$$enterprise\ value = I + \sum_{i=1}^{n} \frac{EVA_i}{(1+r)^i} \tag{5}$$

Among them, g is a fixed growth rate.

2.2.1. TWO-STAGE GROWTH MODEL

The two-stage growth model includes the stage of rapid increase of enterprise value in the early stage and the stage of gradual stability in the later stage. According to the long-term competition equilibrium theory of the market, the company's enterprise value cannot maintain the trend of rapid growth in the early stage because its peers will enter the market one after another. Until the average value of EVA gets closer and closer to 0. The enterprise value is the sum of the capital sum and the present value of EVA during the period of continuous n-year extraordinary growth and the present value of EVA during the later period of continuous annual extraordinary growth. The specific calculation process is as follows:

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$$\text{enterprise value } = I + \sum_{i=1}^{n} \frac{EVA_i}{(1+r)^i} + \frac{EVA_i(1+g)^n}{r(1+r)^n} \tag{6}$$

This paper introduces the theoretical system of EVA enterprise value evaluation, clarifies the essence of economic value-added EVA, the calculation of the EVA model, the adjustment principle of relevant accounting items and the premise of its application. Enterprises are different from other resources. First of all, the recycling of waste in high-polluting enterprises must be a profitable behavior established within the scope of certain laws and regulations, and it is an organic combination of various elements that constitute the utilization of high-polluting waste. At the same time, according to the changes in the environment in the reuse of resources, the measures for waste disposal should be adjusted appropriately, to continue to make profits and bring benefits to the shareholders of the company. The evaluation of enterprise value through EVA is not only to consider the total value of enterprise assets, but also to analyze and evaluate all its assets and profitability from the perspective of the enterprise as a whole, and to evaluate the value of the enterprise as a whole.

Therefore, the accurate evaluation of enterprise value can provide investors with efficient investment decisions, and can also help enterprise managers to clarify the current value of enterprise nation and the impact of various investment, financing, operation and distribution decisions on enterprise nation value, and then formulate corresponding enterprises. Strategic planning to enhance corporate value creation capabilities.

3. ANALYSIS AND DISCUSSION OF EVA MODEL RESULTS

3.1. EVA TRENDS

At present, China's economy is developing rapidly, and the overall economic field is showing a trend of rapid growth. However, while the national economy has achieved greater improvement, the pollution of the ecological environment has gradually emerged. Therefore, in conjunction with economic development, the protection of the ecological environment has been put on the agenda. With the destruction of the ecological environment and natural disasters all over the world, countries have gradually realized the seriousness of the situation and have introduced relevant governance and protection measures. To balance the contradictory relationship between economic development and environmental protection, China has put forward the development concept of "prioritizing ecological protection and developing circular economy". Among them, the viewpoints of green ecological development and sustainable development are considered to be the main directions and goals for the simultaneous development of China's economy and environment in the future.

In the effective implementation measures, we gradually distribute the research focus to all aspects and details of the economy and the environment. However, the utilization of waste in high-polluting enterprises involves the relationship and trade-off between the two, so it is feasible and meaningful to analyze it based on the ecological environment and economy. Therefore, this section aims at the management and assumption of rational utilization of wastes produced by a large number of highly polluting enterprises. And focus on the research on the economic impact of rational utilization of waste.

In addition, to link the utilization of waste produced by high-polluting enterprises and the changes in economic values, we selected the method of Economic Value Added Evaluation (EVA). The data results obtained by the EVA evaluation method can provide a comprehensive and sufficient basis for the complex relationship between shareholders and enterprises, such as constraints, cooperation, and games. Since shareholders' investment in polluting companies requires comprehensive investment factors such as comprehensive costs, short-term returns, and long-term development. In the case of simplified analysis, considering that the EVA evaluation value is positive, the investment income produced by the target enterprise invested by shareholders will be greater than the cost. And when the cost of equity and debt are taken into account, the income for shareholders can be obtained from the profits other than investment costs.

First, we select some enterprises as experimental companies to conduct a comprehensive analysis of EVA based on input and expenditure. Starting from the changes and fluctuations of corporate financial indicators, we compare and analyze the historical financial indicators of randomly selected enterprises with pollution characteristics and the financial indicators of the industry to which they belong. The reasons for the difference and the influencing factors are analyzed, and these factors are summarized and analyzed to obtain the EVA evaluation value level of the enterprise in the industry and the directional development trend and direction of the difference. When the amount of data is large enough, a regression model can be obtained to achieve predictions based on past data. Analyze and evaluate the profitability, debt repayment, operation and development capabilities of enterprises with pollution characteristics, so that the management and investors can have a deeper understanding of the financial status and operating results of the enterprise, which is more conducive to accurate and reasonable judgment of the evaluation results more objective and true reflection of corporate value. In Table 1, we summarize the financial indicators of basic operating items for some enterprises with pollution characteristics. It was observed that the group of enterprises that did not carry out the recycling and utilization of polluting waste had a good financial trend in the period from 2017 to 2019. The average income per share, net income per share, and total income growth rate of each enterprise in this group were as follows: 76.19%, 15.05% and 9.35%. There are slight fluctuations in net income, which is within the normal income range. During the period from 2019 to 2021, it was observed that the average income per share, net income per share, and total income of each company

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in this group decreased by 32.43%, 10.28% and 32.73% respectively. This is partly due to energy conservation and emission reduction. A series of policies and indicators such as pollution emissions limit the effect. However, the lack of polluting waste recycling processes and design is also one of the reasons for the declining economic benefits of various enterprises.

Table 1. Financial indicators of basic operation projects of high-polluting enterprises

Evaluation indicators	2017	2018	2019	2020	2021
Income per share (yuan/ share)	0.21	0.35	0.37	0.32	0.25
Net income per share (yuan/share)	3.72	4.21	4.28	4.02	3.84
Total income (ten thousand yuan)	27015.83	24382.09	29542.17	21530.04	19872.88
Net income (ten thousand yuan)	2964.3	-257.6	-643.1	-1282.2	-1352.4

Subsequently, we conducted supervised learning on the process of comprehensive evaluation of EVA based on some selected enterprises as training data. The trained model is used to further correct the EVA number of existing enterprises that do not recycle polluted waste, and it is also used to predict the EVA number of enterprises that recycle polluted waste. In this section, we will compare the comprehensive evaluation results of EVA brought about by these two different development methods, and use the difference between the two results to evaluate the necessity and prospect of establishing a polluting waste recycling system. Among them, the comparison results of EVA numbers from 2017 to 2021 between companies that did and did not recycle polluted waste are shown in Figure 3. It was observed that from 2017 to 2019, all companies in the industry had a certain degree of sag trend. , but from the numerical analysis, the change rate of the EVA evaluation value is maintained between 5% and 7%. Therefore, it can be regarded as normal industry or market fluctuations. During the period from 2019 to 2020, it was observed that the EVA number of enterprises that did not recycle polluted wastes decreased by 58.25%, and the value of the EVA change rate during 2021 even reached -2.65%. On the contrary, the EVA number of enterprises that have carried out a certain degree and frequency of polluting waste recycling will only decrease by 37.43% from 2019 to 2020. During 2021, the change rate of EVA will reach 4.27%, an increase of 6.92% year-on-year for companies that do not recycle polluting waste. Therefore, through the development trend of the rate of change of the EVA evaluation value over time, companies involved in the large-scale discharge of polluting waste in recent years should update their technology promptly, and take the recycling and reuse of polluted waste as another main way of enterprise development, which can make Chemical and energy companies with traditional pollution emissions will get more stable economic benefits in 2022 when the economy is depressed.

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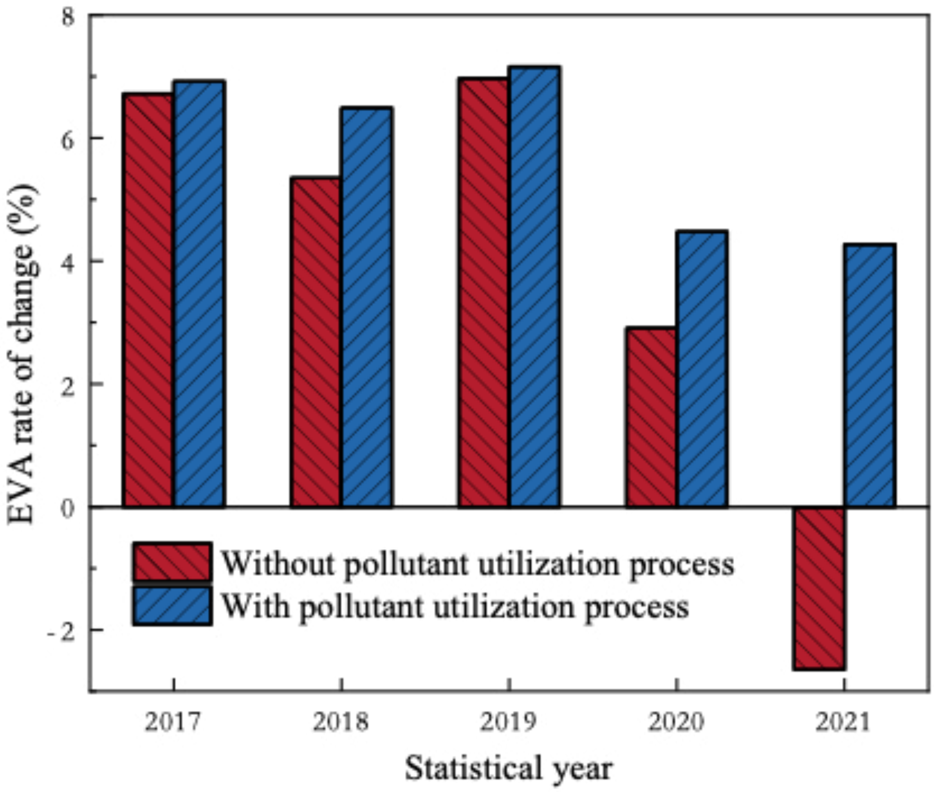

Figure 3. Changes in EVA change rate over time for companies with and without polluting waste recycling

3.2. TRENDS IN ANNUAL CORPORATE EARNINGS

Finally, we will compare the annual net income results of these two different development methods, which can evaluate the economics and profitability of establishing a polluting waste recycling system. The comparison results of the average annual income change rate from 2017 to 2021 for companies that did and did not recycle polluted waste are shown in Figure 4. It is observed that the change rate of the EVA assessment value during the period from 2017 to 2019 is similar to that in Figure 3. Consider normal industry or market volatility. During the period from 2019 to 2020, the annual income change rate of companies that did not recycle polluting wastes showed a huge drop, reaching 68.56%. However, the annual rate of change in earnings of enterprises that have already carried out polluting waste recycling decreased by only 32.28%. Therefore, the results show that the technology of recycling and reusing polluting wastes can enable enterprises involved in the large-scale discharge of polluting wastes in recent years to gain the upper hand in green ecology and sustainable development and obtain more stability in economic fluctuations means to reduce the volatility of its returns.

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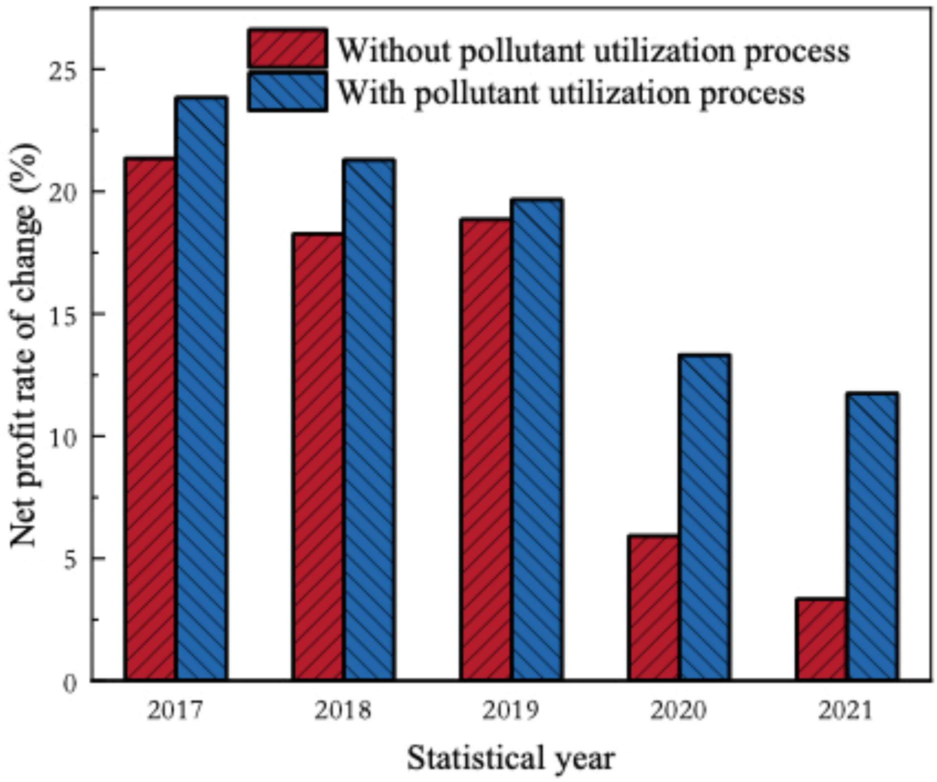

Figure 4. Changes in the annual income change rate of enterprises with and without polluting waste recycling over time

4. CONCLUSION

At present, China's economy is developing rapidly, and the overall economic field is showing a trend of rapid growth. But at the same time, the pollution of the ecological environment began to appear gradually. The utilization of polluting wastes involves a trade-off between the two, so we choose the Economic Value Added Evaluation (EVA) method to analyze and predict the relationship between the two. The first conclusion is as follows:

1. It was observed that during the period from 2019 to 2021, in the group of enterprises that did not carry out the recycling and utilization of polluted waste, it was observed that the average income per share, net income per share, and total income of each enterprise in this group decreased by 32.43%, respectively 10.28% and 32.73%, which to a certain extent are limited by a series of policies and indicators such as energy conservation, emission reduction, and pollution discharge. However, the lack of polluting waste recycling processes and design is also one of the reasons for the continuous decline of the economic benefits of various enterprises;

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2. During the period from 2019 to 2020, it was observed that the EVA number of enterprises that did not recycle polluted wastes decreased by 58.25%, and the value of the EVA change rate during 2021 even reached -2.65%. On the contrary, the EVA number of enterprises that have carried out a certain degree and frequency of polluting waste recycling will only decrease by 37.43% from 2019 to 2020. During 2021, the change rate of EVA will reach 4.27%, which is a year-on-year increase of 6.92% for companies that do not recycle polluting waste;

3. From 2019 to 2020, the annual income change rate of enterprises that did not recycle polluting wastes showed a huge drop, reaching 68.56%. However, the annual rate of change in earnings of enterprises that have already carried out polluting waste recycling decreased by only 32.28%. Therefore, the results show that the technology of recycling and reusing polluting wastes can enable enterprises involved in the large-scale discharge of polluting wastes in recent years to gain the upper hand in green ecology and sustainable development and obtain more stability in economic fluctuations means to reduce the volatility of its returns.

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ANALYSIS ON THE COUPLING CHARACTERISTICS OF URBAN ECOLOGICAL STRUCTURE AND LOCAL ECONOMY IN THE YELLOW RIVER BASIN

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ABSTRACT

The Yellow River Basin is an important part of China's ecological protection areas, but the stable development of the Yellow River Basin cannot be guaranteed due to the unreasonable setting of the local ecological structure and the slow pace of economic development. Many scholars at home and abroad have researched the ecological structure and urbanization level of the Yellow River Basin, but there is still a lack of work to analyze the coupling characteristics of the two. In this paper, the entropy weight method is used to study the coupling characteristics of economic development and ecological structure in the Yellow River Basin. The ecological environment, urbanization evaluation system and the ecological environment and urbanization coupling coordination characteristic evaluation system are constructed. The results show that the comprehensive evaluation coefficient of urbanization has increased by 276.2% from 2011 to 2020. The annual average increase of the comprehensive evaluation index of the ecological environment is over 35%. The degree of matching between the level of urban modernization and the ecological environment is basically above 95%.

KEYWORDS

Yellow River Basin; ecological architecture; urbanization; economic development; coupled and coordinated characteristics

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1. INTRODUCTION

China's economic development has accelerated the process of urbanization, which is the most important way to achieve industrialization and modernization and is given great attention by governments everywhere. From the birth of New China in 1949 to the period of reform and opening up in 1978, the level of urbanization in China has increased by about 50% [1-3]. After entering the 21st century, China's urbanization rate ranks relatively high in the world. Among them, the Yellow River Basin, as an ecological reserve in China, plays an important role in ensuring national ecological security and promoting economic development [4-6]. Before 1949, due to the conflict between natural resource development and economic development, the ecological structure of the Yellow River Basin could not be kept in balance. After that, the state intensified efforts to control the ecological environment in the Yellow River region, and the ecological structure was improved to a certain extent. Despite the obvious effect, the stable and sustainable economic development of the Yellow River Basin is still constrained by the ecological structure and economic scale. [7-11]. Therefore, it is necessary to adjust the ecological structure of the Yellow River Basin to promote the economic development of the Yellow River Basin.

In 2020, China proposed the key task of integrating new urbanization construction and urban and rural development, which clearly proposed to promote a high-quality new urbanization development strategy. As an important ecological sphere in China, improving the level of urbanization in the Yellow River Basin is an important means to ensure high-quality economic development [12-14]. One of the important factors affecting the economic development of cities in the Yellow River Basin cities is the ecological architecture of urbanization. The destruction of natural resources and their unbalanced use has led to the ecological structure of urbanization in an unstable state. The instability of the ecological structure of urbanization will in turn lead to an uncoordinated rate of economic development, which will result in lagging development. There are many advanced technologies available for surveying the distribution and exploitation of natural resources in the Yellow River Basin, which can help workers to obtain timely information data and take political measures [15-22]. The relationship between the level of urbanization and the regional economy is closely related, and there are many studies on the relationship between the two at home and abroad. The main focus is on the following three aspects. The first is the study of basic theory. The theoretical research mainly focuses on the complex model of urban ecological structure and economic development from the perspective of the "human-land" relationship. The second is the evolution pattern of the ecological structure of urbanization, exploring the dynamic pattern between the level of economic development and the ecological structure of urbanization. The third is to construct a coupled coordination model between urbanization ecological structure and economic development and analyze the influence of urbanization ecological factors on the speed and scale of economic development. The third type of these studies is a more intuitive way to grasp the coordinated development relationship between the two, and a number of scholars have conducted related studies [23-25].

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Li et al [26] evaluated the coupled coordination degree (CCD) of PLES using temporal and spatial models and found that elevation, temperature, economy, and population were the main factors affecting CCD. By regulating these factors, land use can be effectively optimized and further ecological deterioration can be mitigated. Ma et al [27] constructed a long-term and short-term memory neural network model to explore the relationship between economic development and development intensity affecting the upper, middle and lower reaches of the Yellow River basin. The results showed that a 6.5% economic growth rate is more conducive to environmental protection compared to 7% and 6% economic growth rate development patterns, then the balance between ecological structure and economic development reaches the ideal state. Shi et al [28] used Graphab software to construct a holistic landscape heterogeneity analysis ecological network to analyze the ecological situation of the Yellow River basin, in which morphological spatial pattern analysis (MSPA) and structural equation modeling (SEM)) were used to identify ecological source areas and determine the resistance surface. The results indicate that the rational use of highly heterogeneous areas is an effective way to maintain the long-term stable development of the ecological structure of the Yellow River basin. Shi et al. [29] constructed a dynamic panel and a systematic generalized method of moments to predict the influencing factors of the urbanization level in the Yellow River Basin. The results show that while the urbanization of the Yellow River Basin is improving, the unreasonable economic development and urban scale layout still have an impact on the further development of urbanization. Wei et al [30] used an efficient data envelope method to determine the relationship between water use efficiency and urbanization level in the Yangtze River basin over a decade. The results showed that the level of economic development and the proportion of water resources can enhance water use efficiency. Chai [31] et al. used social network analysis to analyze the structure of the Yellow River basin based on a two-way "time distance" modified gravity model between cities. The results show that the relative strength of the linkages between cities in the Yellow River basin constrains economic development to some extent. It is possible to build a chain of urban centers by strengthening the linkages between subgroups to enhance economic exchange. Gong [32] constructed a spatial lag model and an error model with the objective of promoting high-quality development in the Yellow River basin. The relationship between economic growth, industrial structure and urbanization level and ecological structure layout of the Yellow River basin was analyzed. The results show that carbon emissions and economic growth rate in the Yellow River Basin show a "U" shaped KFC curve, and carbon emissions affect economic growth. Rong et al [33] investigated the relationship between economic index (EC) and environmental carbon emissions by analyzing the ecological structure and using the (STIRPAT) model. The results suggest that the ecological structure between Zhengzhou, Jinan, Zhoukou and Shangqiu is not reasonably coordinated, thus affecting the further development of the ecological economy.Solarin, SA [34] applied a new type of dynamic regression distribution lag model was used to predict, in which carbon dioxide emissions were selected as the research variable. The results show that the relationship between economic development and ecological structure is relatively complex. Economic growth will lead to environmental deterioration in a short

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period, but the development of urbanization will be less affected. From the perspective of development, promoting economic development can improve environmental quality after a certain period. As a whole the current research on economic development and ecological structure of towns by domestic and foreign scholars is multi-faceted. The content is relatively rich, but there is a lack of more systematic research. Moreover, most of the previous research work focused on the relationship between the economic development of the Yellow River Basin and various environmental factors and did not give the specific characteristics of the coupling between the economy and the environment. Moreover, the previous studies were relatively simple and did not discuss the relationship between the environment and the economy from multiple perspectives. The economic and environmental factors are interrelated and affect each other. Economic regression will lead to the decline of all aspects of the ecological environment, and eventually imbalance. The destruction of the ecological balance and the fragmentation of these ecological factors will lead to poor connections between various links of economic development and ultimately affect economic development. The analysis of the coupling characteristics helps to understand the development law between the two and has theoretical guidance for further economic improvement.

To sum up, this paper aims to promote the economic development of the Yellow River region and balance the ecological environment. Taking the evaluation of the relationship between the urbanization level and the ecological structure as the starting point, three evaluation indicators are constructed, which are the evaluation index of the ecological environment of the Yellow River Basin, the evaluation index of the local economy, and the evaluation index of the urbanization level and the coupling coordination characteristics of the regional economy. The coupled coordination relationship between urbanization and ecological environment subsystems in the Yellow River Basin is compared from two dimensions of time and space, and the economic development level of the Yellow River Basin is measured.

2. RESEARCH METHODOLOGY

2.1. ENTROPY METHOD

This paper chooses 2011-2020 as the time point to enumerate the ecological structure of urbanization in the Yellow River Basin as well as the economic development. The comprehensive ecological and environmental index, the urbanization index of the Yellow River basin and the analysis of the coupling and coordination characteristics of urbanization and environment are analyzed. Firstly, population, economic and urbanization indexes are selected to constitute a comprehensive evaluation system. Several indicators are selected to measure the interaction between the economy and the environment and the current situation of the ecological environment, and the weight of the indicators is determined by the entropy value method.

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The entropy method used in this paper is relatively scientific and reasonable compared with the hierarchical analysis method and subjective assignment method, and it has been applied more often in academic research, especially in research related to regional economic development strategies. The entropy method was constructed in this paper to assign weights to the indicators of the factors influencing the level of urbanization development in the Yellow River Basin. In the analysis of the entropy method, it is necessary to have a clear understanding of the research object. How many indicators are in the urbanization index system constructed in this paper, how many of them are positive indicators and how many are negative indicators? Then the data needed for the study are dimensionless using the normalization method commonly used in mathematics. It is worth noting that zero values may appear in the process of dimensionless processing. At this point, the zero values are to be processed by shifting all the data to the right by one unit. The treatment of negative indicators is simply a matter of changing the sign in the numerator. The specific equation is shown below:

$$x_i = \frac{x_i - \min\left\{x_1, \ldots, x_n\right\}}{\max\left\{x_1, \ldots, x_n\right\} - \min\left\{x_1, \ldots, x_n\right\}} \tag{1}$$

where denotes the dimensionless parameter, $x_1, \ldots, x_n$ denotes the $1st, \ldots, n$ indicator.

$$p_i = \frac{x_i'}{\sum x_i'} \tag{2}$$

P_i represents the weight of the i data in the index. The entropy value of the i indicator is expressed as follows, where n denotes the number of samples.

$$e_j = -\frac{1}{\ln(n)} \sum P_i \times \ln\left(P_i\right) \tag{3}$$

The weights of each indicator are calculated as shown below, where G denotes the weight of each indicator.

$$W_j = \frac{G_j}{\sum G_j}, j = 1,2,\ldots\ldots, \mathrm{m} \tag{4}$$

Then a comprehensive evaluation index was constructed, and the expression of the evaluation index is shown below.

$$U_1 = \sum_{i=1}^{n} w_i y_{ij} \tag{5}$$

$$U_2 = \sum_{i=1}^{n} w_j y_{ij} \tag{6}$$

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Where W_{ij} denotes the weight of the index, and y_{ij} denotes the standardized index. U_1 denotes the comprehensive evaluation index of urbanization, and U_2 denotes the index of ecological environment structure.

2.2. PHYSICAL MODEL OF COHERENCE

Then a physical model of the degree of coordination between urbanization and ecological coupling is constructed. Coupling represents the phenomenon of interaction or interrelationship within a large system and between the system and the outside. The concept is often used in describing the relationship between variables. The Acuity Coordination Degree describes the degree of coupling between the level of urbanization in the Yellow River Basin and the relationship between local economic development. The formula for the degree of coupling is shown below.

$$C = 2 \times \left(\frac{U_1 \times U_2}{(U_1 + U_2)^2} \right)^{0.5} \tag{7}$$

$$D = \sqrt{C \times T}, T = \alpha U_1 + \beta U_2 \tag{8}$$

C is a dimensionless number representing the degree of interaction between the level of urbanization and the level of economic development in the Yellow River Basin and takes a value between 0 and 1. The larger the value of C, the more obvious the interaction between the two. T indicates the comprehensive evaluation index of urbanization level and economic development. α, β denotes the uncertainty coefficient. According to the index system constructed above, the results shown in Table 1 and Table 2 can be obtained. U_1 denotes the comprehensive evaluation index of urbanization, and U_2 denotes the index of ecological environment structure.

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Table 1. Evaluation index system of urbanization in the Yellow River Basin

Target layer	Criterion layer	Indicator layer	Attributes	Weights
Urbanization level	Population	Population density	+	56
		Population urbanization rate	+	75
		Population growth rate	+	183
		Unemployment rate	-	39
	Economy	GDP per capita	+	68
		Proportion of output value	+	44
		Total social consumption per capita	+	81
		GDP growth	+	72
	Society	Occupancy rate	+	46
		Urban per capita disposable income	+	75
		social security spending ratio	+	62
		Urban traffic level	+	78
	Integration	Ratio of urban and rural per capita disposable income	-	77
		Urban and rural per capita consumption expenditure ratio	-	65

Table 2. Ecological environment evaluation index system of the Yellow River basin

Target layer	Criterion layer	Indicator layer	Attributes	Weights
Ecosystem	Pressure	GDP energy consumption growth rate	-	105
		Industrial wastewater discharge per capita	-	146
		per capita sulfur dioxide emissions	-	179
		Tobacco powder emissions per capita	-	112
	State	Green coverage	+	58
		Per capita water resources	+	142
		Green area per capita	+	69
	Response	Sewage treatment rate	+	44
		Pollution-free treatment rate of garbage	+	57
		Green planting area	+	69
		Industrial waste utilization	+	55

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In the constructed index evaluation system, ecological environment and urbanization are viewed as having consistent importance. Therefore, the values of the uncertainty parameter α, β uncertainty parameter in this paper are taken as 0.5. According to the relationship between urbanization and economic development level, the paper classifies the coupled coordination degree of urbanization level and ecological environment in the Yellow River Basin into four categories, as shown in Table 3.

Table 3. Classification of types of coordinated development of ecological environment and town modernization in the Yellow River Basin

Development stage	Degree of coordination	Subclass	Comparison between U_1 and U_2	Basic type
Coordinated development	[0.6,1.0]	Coordinated development（IV)	$U_1-U_2>0.1$	Coordinated development - ecological environment lagging type（IV-1）
			$\|U_1-U_2\|\geq0.1$	Coordinated Development – Synchronized（IV-2）
			$U_2-U_1>0.1$	Coordinated Development - Lagging Type of Urban Modernization（IV-3）
Transitional phase	[0.5,0.6)	Barely coordinated development（III）	$U_1-U_2>0.1$	Barely coordinated - ecological environment lagging type（III-1）
			$\|U_1-U_2\|\geq0.1$	Barely coordinated-synchronized（III-2）
			$U_2-U_1>0.1$	Barely coordinated - lagging urban modernization（III-3）
	[0.4,0.5)	On the verge of deficient decline（II）	$U_1-U_2>0.1$	On the verge of disorder - ecological environment lagging type（II-1）
			$\|U_1-U_2\|\geq0.1$	Near-disorder-synchronized（II-2）
			$U_2-U_1>0.1$	On the verge of dissonance - lagging type of urban modernization（II-3）
Dissonance stage	[0.0.4)	Dissonance Decline（I)	$U_1-U_2>0.1$	Dissonance Decline - Ecological Lag Type（I-1）
			$\|U_1-U_2\|\geq0.1$	Detuned decay-synchronized（I-2）
			$U_2-U_1>0.1$	Unbalanced Decline-Lagging Type of Urban Modernization（I-3）

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3. ANALYSIS OF RESULTS

The Yellow River Basin covers nine provinces and regions of Qinghai, Sichuan, Gansu, Ningxia, Inner Mongolia, Shaanxi, Shanxi, Henan, and Shandong, and is an important economic belt in central and western China. This puts forward higher requirements for the protection and management of the ecological environment, so it is necessary to do a good job of ecological protection in the Yellow River Basin. While promoting high-quality economic development, we must also take into account the balance between the economy and the environment. To this end, this section evaluates the ecological construction and economic construction of the Yellow River Basin and proposes the comprehensive evaluation indicators of the two and the coupling characteristics of comprehensive analysis.

3.1. COMPREHENSIVE EVALUATION INDEX ANALYSIS OF TOWN ECOLOGICAL ENVIRONMENT AND LOCAL ECONOMY

Urban ecological environment and local economic development are closely related, and it is necessary to study the combined index of both. On this basis, the coupling and coordination characteristics between the two can be better described. The following will be a specific analysis of the town's ecological environment and the degree of regional urbanization construction respectively.

3.1.1. COMPREHENSIVE INDEX ANALYSIS OF THE URBAN ECOLOGICAL ENVIRONMENT

From 2011 to 2020, with the promulgation of national policies and the vigorous propaganda of local governments, the concept of "green water and green mountains are the silver mountain of gold" has become more and more popular. The overall ecological environment level of the Yellow River Basin towns shows a fluctuating upward trend, as shown in Figure 1. It can be broken down into the following three trends.

2011-2014, the stable development phase. In these four years, the development rate was the fastest in 2011, while the development leveled off in the following two years. the development rate between 2013 and 2014 was the same as that in 2012. The main reason is that the provinces, cities and towns in the Yellow River Basin have caused greater damage to the ecological environment in the past due to their transitional dependence on the exploitation of local natural resources. Take Shanxi Province as an example, as a typical resource-based province and city. The long-standing reliance on coal and other non-renewable energy sources and a single industrial production method has led to serious ecological and environmental problems. Since the government's intervention during the 11th Five-Year Plan, many provinces and cities in the Yellow River Basin have been implementing pollution

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reduction and building "blue sky and blue water projects", and ecological environmental protection work has begun to change.

From 2015 to 2017, the fluctuating development stage. This phase shows a specific trend of rising and then declining, with the ecological environment construction efficiency rising in 2015-2016. 2016 was the year with the highest level of regional ecological environment construction in this period. In this period, all regions of the Yellow River Basin took active and effective measures for ecological management, however, pure ecological prevention and control cannot solve the fundamental problems. The ecological environment is a protracted war, purely under prevention and control due to the lack of effective treatment measures, no publicity on the importance of anti-pollution and there is situation of pollution while treatment. There was even a time when the degree of pollution was higher than the degree of ecological environment treatment, exposing the contradictory relationship between ecological environment construction and economic and social development. Thus, there was a decline in the degree of ecological environment in 2016-2017.

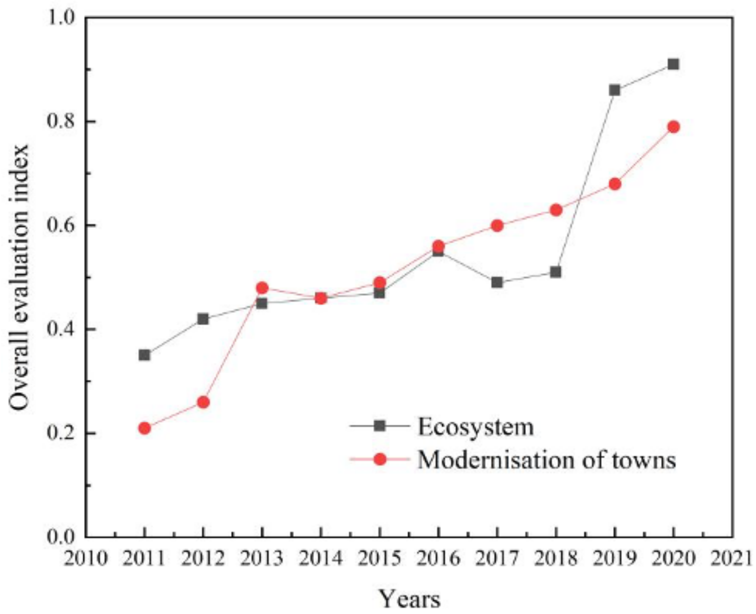

Figure 1. Evaluation of the comprehensive index of modernization and ecological environment of towns in the Yellow River Basin

2018-2020, the rapid development phase. During these three years, the comprehensive evaluation index of ecological and environmental management in each region of the Yellow River Basin shows a historical spike. This is mainly because the regions actively explore industrial transformation and development within this phase, and set clear standards for the pollution emissions of factory enterprises. In particular, in 2019, Secretary Xi Jinping said at the Symposium on Ecological Protection and High-Quality Development in the Yellow River Basin, "The Yellow River Basin is an important ecological reserve in China and plays a very important role in my country's economic and social development". This has placed higher demands on ecological management in the Yellow River Basin regions and has yielded immediate results. In 2019, the negative indicators of industrial wastewater, dioxide, and

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industrial waste gas smoke particles all showed significant reductions compared to 2017. Emissions of industrial wastewater decreased by 39.6%, emissions of SO_2 decreased by 62. 7% and emissions of industrial exhaust smoke particles decreased by 73.5%.

3.1.2. COMPREHENSIVE URBANIZATION INDEX ANALYSIS

During the nearly ten years from 2011 to 2020, the level of urbanization in the Yellow River Basin regions is generally on an upward trend, with slower development in the first two years. The main reason for this is that since the impact of the global financial crisis in 2008, the prices of abundant coal resources and other resources in the Yellow River Basin have dropped significantly. Therefore, there is a serious overcapacity, which has impacted the development of coal companies. Especially for the central and western regions, such as Gansu Province, where most of the youths with low education have become more difficult to be employed. In addition, in the Sichuan basin, due to the Wenchuan earthquake in 2008, the modernization of towns in the local region was slow in the post-earthquake home reconstruction and recovery phase. After rebuilding homes, reshaping industrial chains and local governments stepping up investment and paying attention to education development, there was a period of growth between 2012 and 2013.

During 2013-2014, the growth rate development was leveled off. During this period, the government began to increase its efforts to build local infrastructure, provide more convenient and efficient transportation, establish stronger healthcare measures, and continuously improve the level of social and public services. At the same time, the government began to gradually reduce the level of capacity intervention, focusing on cultivating the local people's self-development ability, training employment knowledge, increasing employment opportunities, and providing strong support for people to escape from poverty and become well-off. The year 2014 was also the year when the degree of ecological environment construction and the degree of urban modernization were the closest, indicating that the governments in the Yellow River Basin paid attention to the protection and construction of the ecological environment along with economic construction during the year.

Table 4. Comparison of government economic interventions in the Yellow River Basin, 2011-2014

Indicator name	Estimated year			
	2011	2012	2013	2014
The level of economic development	842	875	926	917
Percentage of infrastructure	367	384	413	457
Government intervention	865	914	907	896

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The year 2020 is the decisive year in the battle against poverty and the year when the whole country will achieve prosperity. It can be seen that this year, the modernization of towns in the Yellow River Basin reaches its peak. This is mainly due to the effective implementation of a series of anti-poverty policies introduced by the central government and the strong support provided by local governments in terms of resources, education and employment. The development of each region has entered a reasonable range since 2014, and the primary, secondary and tertiary industries have achieved good results in a smooth transition. The economic structure shows positive changes, with the output value ratio of primary, secondary and tertiary industries at 5.2:49.4:58.5. New production capacities such as tourism and the Internet economy have played a significant role in leading innovation, resulting in a significant increase in the overall evaluation index of the modernization of towns.

The higher the coincidence of the two curves shown in Figure 1, the closer the environmental and economic development rates are, but it is not that this is better, for example, the higher the overlap of the two, the development of both may be relatively slow, 2011-2012 The deviation is significantly due to the slower economic development than the construction of the ecological environment, 2017-2018 The deviation between the years is significantly due to the government's economic policies to stimulate the process of urban modernization so that economic development began to catch up with the construction of the ecological environment.

3.2. ANALYSIS OF THE COUPLING AND COORDINATION CHARACTERISTICS OF TOWN MODERNIZATION AND ECOLOGICAL ENVIRONMENT

The general situation of each region in the Yellow River Basin is analyzed. The coupling degree and coupling coordination degree of urbanization and ecological environment is calculated through the comprehensive evaluation index of the two. The result is shown in Figure 2. It can be seen from the figure that the coupling degree between urban modernization and the ecological environment of the whole Yellow River Basin region is above 0.95 in the decade of 2011-2020, except for 2012. The high level of coupling between urban modernization and the ecological environment indicates that the interaction between economic and ecological systems in the Yellow River Basin is high, and the low coupling degree in 2012 is mainly due to the economic downturn and slow development in that year. This led to the degree of modernization of towns and cities lagging behind the construction of the ecological environment, while the comprehensive ecological environment evaluation index increased steadily during the year.

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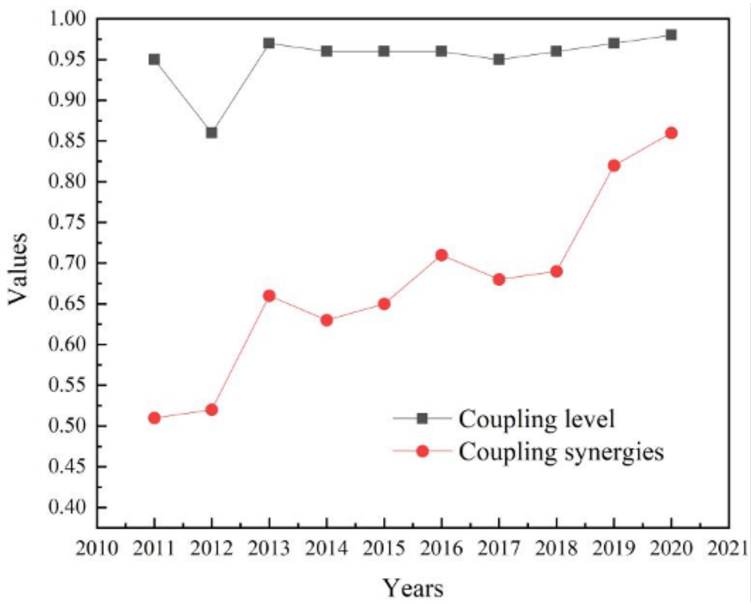

Figure 2. Coupling degree and coupling coordination degree of urban modernization and ecological environment in the Yellow River Basin

Although the coupling degree can reflect a certain extent the degree of interaction between the modernization of towns and the construction of an ecological environment, it does not reflect whether they promote each other at a high level or constrain each other at a low level. For this reason, this paper calculates the coupling coordination degree according to the relative situation of different development levels between the two systems. The categories of mutual influence between urban modernization and the ecological environment are identified, and the results are shown in Table 5.

Table 5. Basic types of coupling and coordination between urban modernization and ecological environment

Year	2011-2012	2013-2016	2017-2018	2019-2020
Type	Barely coordinated - backward type of urban modernization（II-3)	Coordinated development - synchronous type（IV-2)	Coordinated development - ecological environment lagging type（IV-1)	Coordinated Development - Lagging Type of Urban Modernization

It can be seen that the situation of coordination between urban modernization and the ecological environment in the Yellow River Basin has been improving in the last decade. From 2011 to 2012, it is a barely coordinated and lagging type of urban modernization, and from 2013 to 2020, it is a coordinated development type. In 2013, as the economy recovered, the ecological protection of the environment also progressed steadily. Thus a period of synchronous development between the two systems was ushered in, but synchronous development only means that the gap between the two became smaller. This does not mean that the pace of development will be the same, for example, in the period 2013-2014 the modernization of towns will

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be slightly faster than the ecological construction. It also does not mean that a higher level of growth is ushered in, but rather that it is in constant development. After 2017, there was a small slowdown in ecological construction in the Yellow River Basin, mainly due to a decrease in precipitation across several provinces and cities in the Yellow River Basin during this period. the total average precipitation decreased by 9.4% and 11.5%, respectively, between 2017 and 2018, and also the recycling rate of industrial solid discharges, etc., decreased by about 6.8%. In 2019, ecological protection also reached a new climax as General Secretary Xi introduced the concept of the Yellow River Basin as an important ecological barrier and an important economic zone for China. The year 2020 is a decisive year for poverty alleviation and economic development, and the construction of the ecological barrier will be further improved to ensure that poverty is not returned. The construction of urban modernization will be slightly behind the construction of an ecological environment.

4. DISCUSSION

This paper takes each region of the Yellow River Basin as the research object and considers a variety of situations. A comprehensive index evaluation is made from the total degree of urbanization and the degree of ecological environment construction. The development level is also measured by comparing the coupling degree and coordination between the two subsystems of urban modernization and the ecological environment by integrating time and space differences. The main conclusions are shown below.

1. From 2011 to 2020, the development level of urban modernization in the Yellow River Basin regions generally shows an upward trend. It develops rapidly after 2018. the comprehensive evaluation index of urban modernization in 2011 is only 0.21 and grows to 0.63 in 2018. and keeps increasing to 0.79 in 2020, with an average annual growth rate of 12.6% in the latter two years, and a total increase of 276.2% in ten years.

2. During the decade, the ecological construction situation rose in fluctuation. It has gone through three stages of steady development - fluctuating stage - rapid development. In the latter two years of the rapid development phase, the comprehensive evaluation index of the ecological environment increased by an average of 35% per year.

3. In terms of coupling degree, the coupling degree of urban modernization and ecological environment is basically above 0.95 in the ten years studied in this paper. Thus, it can be seen that the correlation between the two is very large. In terms of the degree of coupling and coordination, excluding the two years of development in 2011-2012 when the economic development was relatively flat, the rest of the period of ecological environment and town modernization are all coordinated. From 2018 onwards, coordinated development enters the lagging

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period of town modernization, and the next stage is focused on improving the quality of town modernization development and promoting economic growth.

Nan Qiao and Xiaochuan Xu came up with the idea. Nan Qiao and Xiaochuan Xu designed the experiment. Nan Qiao performed an analysis of the results. Nan Qiao and Xiaochuan Xu finished the paper. All authors read and approved the final manuscript.

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/05/

ANALYSIS OF DIGITAL INFORMATION MANAGEMENT OF GREEN ECOLOGICAL AGRICULTURE IN THE NORTHEAST OF MY COUNTRY UNDER THE ENVIRONMENT OF AGRICULTURAL PRODUCTS E-COMMERCE

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ABSTRACT

With the rapid development of China's regional agriculture, its consumption of energy, the squeezing and encroachment of the environment and the pollution of the ecological environment have been put on the agenda, which stems from the unreasonable management and regulation of the rapidly developing agricultural infrastructure. Aiming at the evaluation index cluster of agricultural management in Northeast China, the main structure of the digital information management platform of green ecological agriculture we built is divided into the variable layer, middle layer and evaluation index layer, which is a superimposed and progressive layer structure design. The results show that compared with 2018, the use index of electronic agricultural products, per capita greening index, soil organic matter content index and per capita water content index increased by 30.34%, 6.14%, 25.34% and 30.26% respectively in 2019. The index of per capita desert land area decreased by 10.97%. The Sustainability Index experienced an unusual decrease in 2017-2018, with a drop of 0.08. Compared with 2018, the green ecological index from 2019 to 2021 increased by 5.94%, 8.58% and 12.87% respectively. This guides the structure and design of China's future agricultural development.

KEYWORDS

Agricultural ecology, green environmental protection, sustainable development, information management, data platform

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1. INTRODUCTION

The development of green ecological agriculture can protect and improve the ecological environment, prevent pollution, maintain ecological balance [1, 2], improve the safety of agricultural products [3], take the road of sustainable ecological development [4], and closely integrate environmental construction with economic development. Combined [5, 6], it can improve the income of agricultural workers while developing agriculture. Green ecological agriculture, in simple terms, is to use the principles of ecology, ecological economics and systematic scientific methods to organically combine the achievements of modern science and technology with the essence of traditional agricultural technology [7, 8], and integrate agricultural production, rural economic development and ecological. It is a new comprehensive agricultural system with ecological rationality and a virtuous cycle of functions that integrates environmental governance and protection, resource cultivation and efficient utilization [9, 10]. There are three main models of green ecological agriculture, mainly including space-time structure type, food chain type and space-time food chain comprehensive type, as shown in Table 1. Ecological agriculture is an agroecological economic complex system. According to the principle of "whole, coordinated circulation and regeneration", the agricultural ecological system and the agricultural economic system are comprehensively integrated to realize the multi-level utilization of natural resources and energy, to achieve the maximum ecological economy overall benefit [11, 12]. At the same time, it can integrate agriculture, forestry, animal husbandry, sideline and fishery industries[13, 14] to form a comprehensive development model of large-scale agricultural production, processing and sales, adapting to the development of the socialist market economy[15]. However, with the rapid rise of China's e-commerce and the rapid development of informatization, the application of various digital high-tech information technology and the analysis and management of modern green ecological agriculture are the inevitable trends in the development of agricultural modernization.

Table 1. Main modes of green ecological agriculture

agricultural model	Features
space-time structure	According to the biological, ecological characteristics and a rationally formed ecosystem of mutually beneficial symbiotic
food chain	A virtuous cycle agro-ecosystem designed according to the energy flow and material cycle laws of the agro-ecosystem
Integrated spatiotemporal food chain	The organic combination of space-time structure type and food chain type is a mode type with moderate input, high output, less

Green ecological agriculture is an inevitable way to realize modern agriculture and efficient and reasonable organization and management are the foundation and guarantee for the development of ecological agriculture. Scientific management concepts, tools and methods are the basic means to achieve green agriculture [16, 17]. Green ecological management reflects the choice of ecological agriculture development model and the innovation of green technology management. Select and manage agricultural production models from the perspective of agricultural product

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production and ecological economics, and research can best reflect ecological benefits and economy. Nowadays, in the field of analysis and management of green ecological agriculture, many experts and scholars have made a lot of discussions. For example, for agriculture and ecological management under uncertain conditions, Chen, J [18] proposed a reliability-based interval multi-objective crop area planning model. The integration, developed considering the economic and ecological benefits of the research system [19, 20], was developed to deal with interval and ambiguous uncertainties. It focuses on crop area optimization, and the interval objective function is to maximize system benefits, maximize watershed area, and maximize system benefits per unit area. Rural agroecosystems have an important impact on the development of China's economy, society and ecological environment at any time. Chen, F [21] took big data as the research background and based on the complex system theory to construct an indicator system for the ecological management system of rural agroecosystems. The fertilizer was used in the experiment, and the consumption, water pollution degree, pest and disease degree, carbon and nitrogen absorption and agricultural economic benefit of the rural agricultural ecosystem in a certain area were taken as the systematic indicators of the ecological management system. Using data mining technology in big data [22, 23], collecting and processing relevant data in the network, analyzing and understanding agricultural ecosystems through complex systems, and finally calculating and analyzing data of various indicators, their research shows that agro-ecological management Institutions have a positive effect on rural agro-ecosystems. In the development of green ecological agriculture, the optimal water distribution model is an effective tool to provide a reasonable water distribution scheme [24], Pan, Q. [25] proposed an interval multi-objective fuzzy interval credible constraint nonlinear programming model, combined with the estimation of ecological vegetation space water demand, to solve the problem of agricultural and ecological water allocation in irrigated areas under uncertain conditions. Excessive fertilization can cause land pollution [26, 27], which is not conducive to the development of ecological agriculture. Li, X. [28] established a linear regression equation to predict the runoff in the study area, and then determine the pollution in the area. Zhu, Z. [29] built a 5G IoT-based agricultural product circulation information system to realize real-time positioning, information sharing and security assurance of supply chain circulation. Liu, X. [30]'s research shows that in agricultural product e-commerce, product quality, brand image, e-commerce platform and logistics distribution have a significant positive impact on customer satisfaction, and have an important impact on the sales of agricultural products. Based on the research of many scholars, we found that in e-commerce, the quality and safety of agricultural products are decisive factors for the sales of products. Through digital information management, we can achieve coordinated development and the environment, and form two virtuous circles in ecology and economy, the unity of the three major benefits of economy, ecology and society. By studying the data in the development of green ecological agriculture, and constructing a green ecological management system model by analyzing these data, data mining, etc., the economic benefits of ecological agriculture can be improved.

The research on green ecological agriculture management is of great significance to the development of ecological agriculture and the solution to various drawbacks and crises brought by modern agriculture. However, in the current e-commerce sales, the safety and quality of agricultural products cannot be presented to customers. Based on this, in our research, we build an information-based digital management platform, which includes developed languages, frameworks and databases. In the digital information management platform, we track and monitor the agricultural product information of green ecological agriculture in Northeast China throughout the whole process, to ensure the safety and quality of the agricultural products during the sale of the agricultural products on the e-commerce platform. In addition, we also discussed the economic benefits of this digital information platform for green ecological agriculture.

2. CONSTRUCTION OF AN INFORMATION DIGITAL MANAGEMENT PLATFORM

To better understand the situation of green ecological agriculture in Northeast China, this chapter mainly introduces the development languages, development frameworks and tools used in the electronic platform of agricultural products, and gives a brief introduction to them according to the situation of green ecological agriculture in Northeast China. The advantages and reasons for selection are analyzed one by one. These theories or tools include: languages, frameworks and databases.

2.1. JAVA LANGUAGES INTRODUCTION

1. There are not many Java language features, and there is no need to consider issues such as multiple inheritance, operator overloading, automatic forced conversion, etc.;

2. Abstract the real green ecological agriculture by Java in Northeast China through classes, represent agricultural products through objects, and extract common attributes and behaviors between things through inheritance;

3. Java can detect type errors in time in the process of compiling the electronic platform for agricultural products, and can automatically recycle garbage so that the memory of the electronic platform for agricultural products does not occupy much space;

4. Java can perform language conversion in the virtual machines corresponding to different agricultural product electronic platforms, and parse and run on different agricultural product electronic platforms;

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5. Java can support the multi-threaded agricultural product electronic platform model to ensure the synchronization between the agricultural product electronic platform threads.

This system uses Java7 to develop the electronic platform for green ecological agricultural agricultural products in Northeast China. As of Java7, the information features of the electronic platform for agricultural products have been reflected, annotated, generic, $J.U.C.$ and concurrency.

2.2. FRAMEWORK CONSTRUCTION PRINCIPLE

The $Spring$ framework in the agricultural product electronic platform adopts a layered structure, which consists of five well-designed electronic $Spring$ framework sub-modules, as shown in Figure 1.

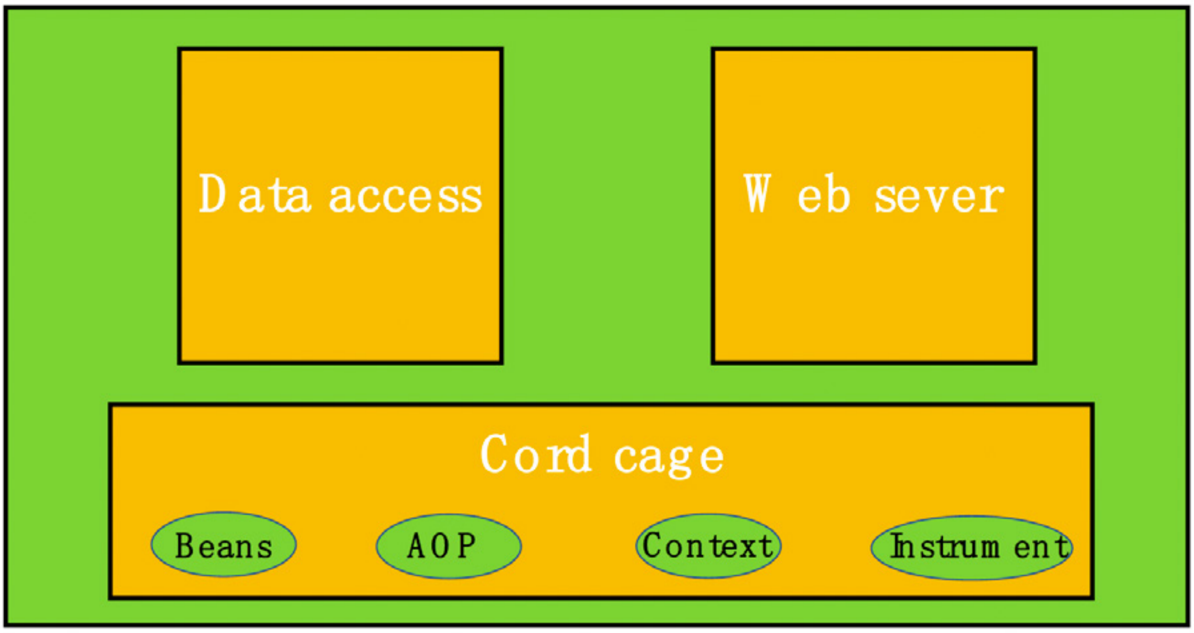

Figure 1. The Framework of the Agricultural Products Electronic Platform

Any module in the agricultural product electronic platform can be used independently, and can also be used in parallel with some modules of other agricultural product electronic platforms. The five electron spring framework submodules are as follows:

1. Bean container. The Bean container is the basis for the electronic Spring framework to realize the IOC layered structure. By reading the XML file or by parsing the language of the agricultural product electronic platform, it generates the agricultural product electronic platform information of green ecological agriculture in Northeast China defined by Bean, and fills it into the core in a container;

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2. Spring AOP module. This module extracts the agricultural product information from the aspects of the business process of the agricultural product electronic platform and encapsulates those behaviors that are not related to the business logic of the agricultural product electronic platform but are required to be called by many functional modules in the agricultural product electronic platform. Duplicate codes in the platform reduce the coupling degree of the electronic platform of agricultural products;

3. Spring DAO module. This module is not related to the specific situation of green ecological agriculture in Northeast China. Through this module system, abnormal semantics in the platform system can be identified;

4. Spring Web module. Common development basic functions such as file uploading and downloading in the agricultural product electronic platform, binding request parameters to objects, etc. are included in this module.

5. Spring MVC framework. This module is used to configure view parsing related to green ecological agricultural products in Northeast China and to define the priority of processing.

2.3. *MYSQL* DATABASE

The database supports the storage engine settings of various electronic platforms, and there are different data types of storage methods within the electronic platforms so the access speeds to the electronic platforms are different. In addition, the creation of a monitoring electronic platform big data will only be used for queries, and will not be added, deleted, or modified. Since the addition of the database supports setting the storage engine at the table level of the electronic platform, combined with the characteristics of green ecological agriculture in Northeast China, different storage engines can be selected for different electronic platforms in a more targeted manner to optimize their performance.

3. MODEL VALIDATION

With the popularization of various smart mobile devices, the promotion of agricultural information and the promotion and sale of agricultural products can solve the problems of difficulty in obtaining rural information, low commercialization, and unsalable commodities. The functional test of this system is mainly based on black boxes. Testing is the main means. Therefore, iterative training is very necessary for the underlying data of the agricultural product electronic platform, and the model operation accuracy can be tested through iterative training. The details are as follows:

1. Accuracy. Precision is the proportion of positive classes that resolve to samples identified as positive classes. The specific calculation process is as follows:

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$$Precision = \frac{TP}{TP + FP} \tag{1}$$

Among them, TP is a true example, and FP is a false positive example.

2. Recall rate. Used to solve for the proportion of all positive class samples that are correctly identified as positive classes. The specific calculation process is as follows:

$$\mathrm{Re}\,call = \frac{TP}{TP + FN} \tag{2}$$

Among them, FN is a false negative example.

3. Accuracy is a metric used to evaluate classification models. Simply put, it is the proportion of the total number of correct predictions by the model. The calculation process is as follows:

$$Accuracy = \frac{TP + TN}{TP + TN + FP + FN} \tag{3}$$

Among them, TN is a true negative example.

We compared the different accuracy comparison models, took into account the background of the agricultural product electronic platform and other backgrounds, adopted appropriate algorithms for evaluation, and finally considered the accuracy rate. In Figure 2, as the number of iterations increases, the training accuracy in the input agricultural product information is also increasing. When the number of iterations is 50, the accuracy of 97.33% is reached, and then the accuracy tends to stabilize; the number of iterations is 25. The second time, the test set accuracy reached 95.34%. As the number of iterations increases to 50, the accuracy rises to 97.52%, which shows that our agricultural product electronic platform has high prediction accuracy for the underlying data. The description of the data set parameters is shown in Table 1.

Table 1. The relationship between iteration accuracy and the number of interactions

Number of interactions	Iteration accuracy
12.5	90.55
25	95.34
37.5	96.59
50	97.33
62.5	97.35
75	97.41
87.5	97.48
100	97.52

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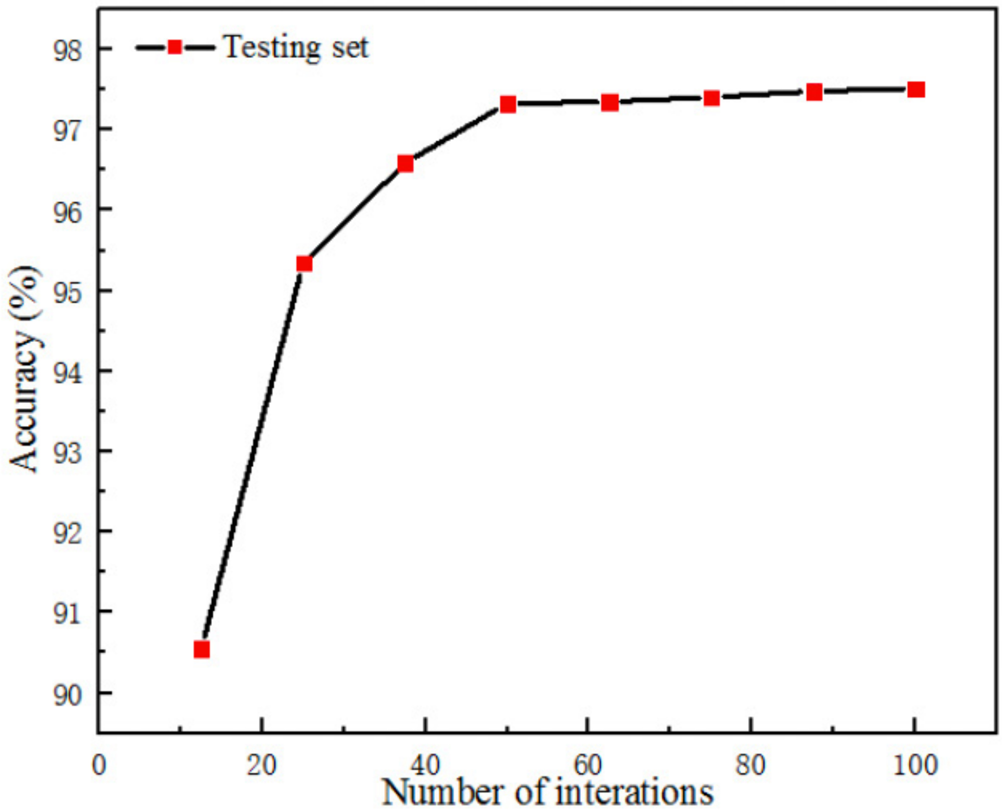

Figure 2. Iterative Accuracy Graph

4. RESULTS AND ANALYSIS

For the development of green ecological agriculture in China, the rural revitalization strategy has greatly improved the level of regional agriculture. This improvement is related to economic benefits and the structure of agricultural allocation. However, the substantial development of agriculture is still a double-edged sword. With the rapid development of China's regional agriculture, its consumption of energy, the squeezing and encroachment of the environment and the pollution of the ecological environment have been put on the agenda. This problem largely stems from the unreasonable management and regulation of the rapidly developing agricultural infrastructure. Therefore, the demand and management of green ecological agriculture in China is a top priority.

First of all, the conventional evaluation indicators of regional sustainable utilization of agricultural resources can be used as the main evaluation indicators and guiding principles for the demand and management of green ecological agriculture in China, which provides a solid foundation for us to establish an effective management system. For the evaluation index cluster of agricultural management in Northeast China, we can regard the index cluster as a series of variables that are correlated and complementary and have strong responsiveness to the sustainable utilization of agricultural natural resources and agricultural socio-economic resources. The number of elements in the variable population is large, but they are all basically continuous

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distributions, so they can form an indicator vector or indicator matrix. A series of indicators formed by various digital information outputted by the spatial database. We have built an evaluation system for the demand and management of China's green ecological agriculture before and introduced the construction principles and methods in the digital system. Among them, several index systems stored in the index library include the content of sustainable utilization of agricultural resources. In specific applications, they can be called directly through the user interface of scientific engineering, and then input into the evaluation model.

Specifically, the main structure of the digital information management platform of green ecological agriculture we built is divided into variable layer, middle layer and evaluation index layer, which is a superimposed and progressive layer structure design. The variable layer includes the utilization rate of electronic agricultural products, per capita green area, per capita desert land area, soil organic matter content and per capita water resources content. The hidden environmental variables in the middle layer are determined as natural population growth rate, desertification development rate, soil organic matter loss rate, water resource decay rate, and vegetation index. For the final evaluation index layer variables, we chose the sustainable development index and the green ecological index as the final comprehensive evaluation index.

4.1. INFLUENCE OF VARIABLE LAYER PARAMETERS OF DIGITAL INFORMATION MANAGEMENT PLATFORM

According to the collection of a large amount of relevant data in 2017, we have continuously revised and learned the forecasting module in the digital information management platform of green ecological agriculture, and used the digital information management platform to analyze various data of the variable layer during 2017-2021. Data collection and mining were carried out. This data collection and mining comes from multiple sources of information such as provincial agricultural bureaus, environmental bureaus and local regional monitoring points in the Northeast region. After processing the data, the platform retains data points that are useful for future evaluation metrics. The annual average data collected from 2017 to 2021 were normalized after screening to facilitate subsequent analysis and to build multiple regression curves. The results of the analysis are shown in Figure 3. It is observed that the use index of electronic agricultural products, the per capita greening index, the soil organic matter content index and the per capita water content index all show an upward trend over the years, while the per capita desert land area index shows a decreasing index. Among the related variables, one variable is regarded as the dependent variable, and one or more other variables are regarded as independent variables, and a statistical analysis method is used to establish a linear or nonlinear mathematical model quantitative relationship between multiple variables and use sample data for analysis. The overall trend of each variable parameter has a large change range from 2018 to 2019. It is observed that compared with 2018, the use index of electronic agricultural products, per capita greening index, soil organic matter

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content index and per capita water content index in 2019 are observed. Up 30.34%, 6.14%, 25.34% and 30.26% respectively. The index of per capita desert land area decreased by 10.97%. This shows that from 2018 to 2019, the management and control of green ecological agriculture in Northeast China achieved a more significant effect. In the following 2019-2021 years, the changes in per capita greening index, soil organic matter content index, per capita water content index and per capita desert land area index tended to be stable, which indicates that the management of green ecological agriculture in this region is in the realization of the underlying structure. After the transformation, the government began to carry out stable development, which is conducive to further evaluating the advantages and disadvantages brought about by the structural transformation and providing guidance for subsequent development.

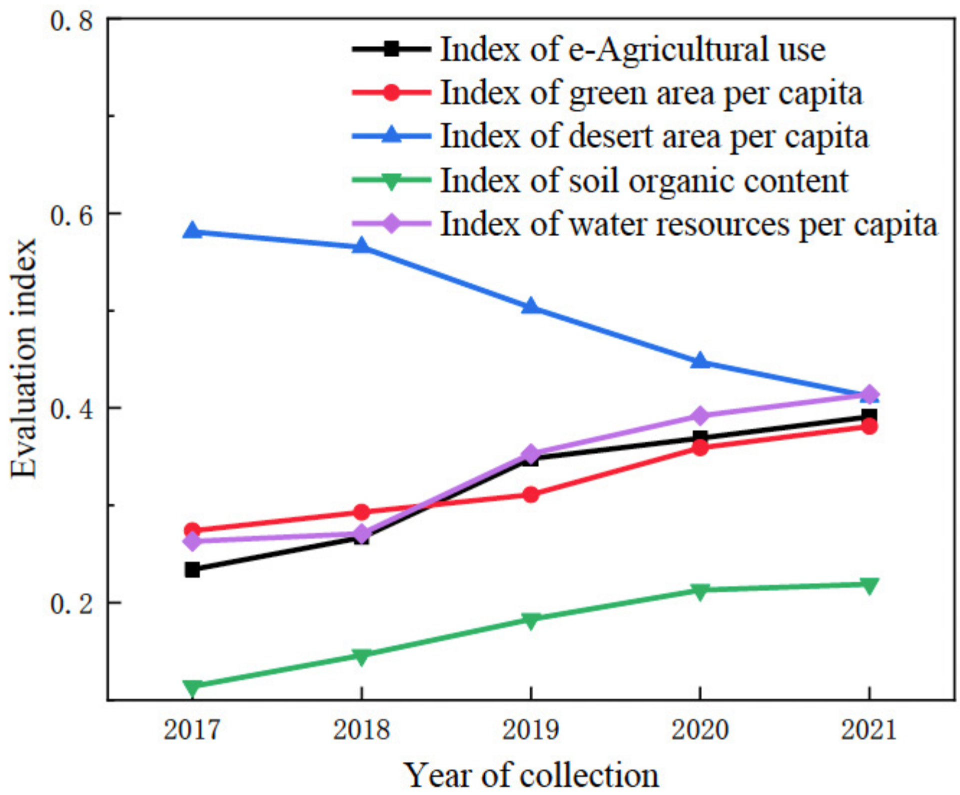

Figure 3. Changes of each index in the variable layer with years

4.2. SUSTAINABLE DEVELOPMENT ASSESSMENT OF GREEN ECOLOGICAL AGRICULTURE

Then, we forecast the variable layer data for the period 2017-2021 after using the data collected in 2017 to revise the learning of the forecasting module within the digital information management platform of green ecological agriculture. Effective analysis data has been obtained. In this section, we use the prediction module in the digital information management platform of green ecological agriculture to analyze the output layer variables we care about. Among them, the changing trend of the

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sustainable development index over the years is shown in Figure 4. An unusual decrease in the Sustainability Index was observed during 2017-2018, with a decrease of 0.08. This is inconsistent with the trend change results of the variable layer in Figure 3.

Therefore, we judged and analyzed the results according to the data changes in the middle layer. We found that the excessively large development area of farmland makes the corresponding soil and water resources environment polluted to a certain extent, which eventually leads to the reduction of the sustainable development index. And with the improved measures, in 2019, the observed sustainability index increased by 0.013, compared to the growth rate of 4.28% in 2018. This shows that the implementation of the adjustment measures of control is feasible. From 2019 to 2021, the growth of the sustainable development index also stabilized, at 0.317, 0.319 and 0.322, respectively.

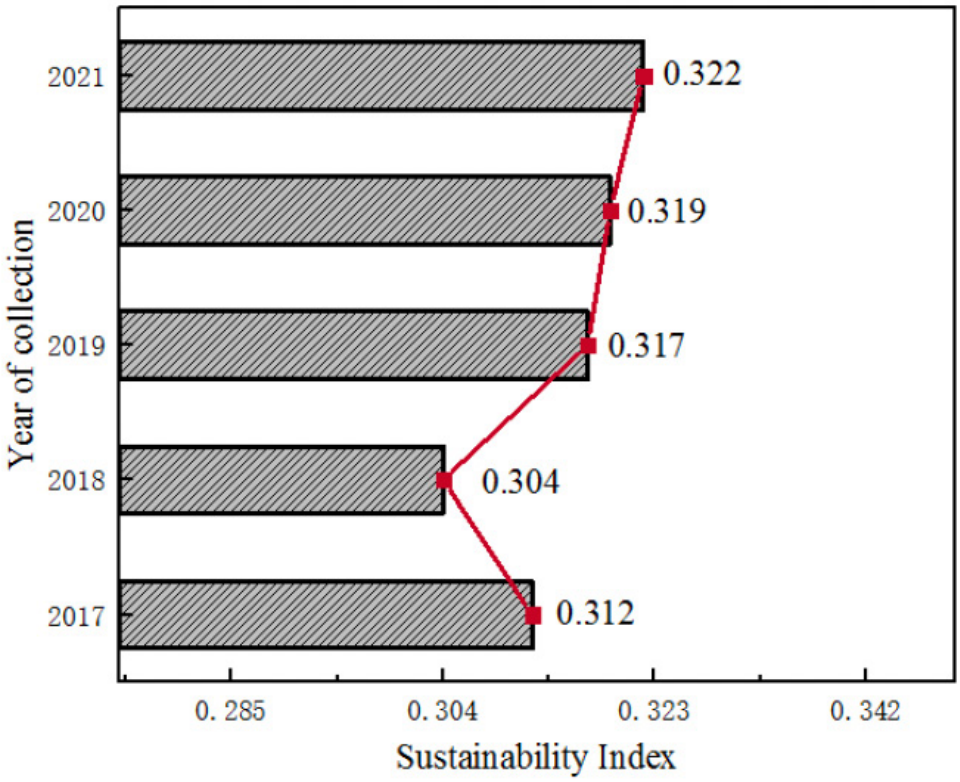

Figure 4. Changes in the sustainable development index over the years

4.3. GREEN ECOLOGICAL ASSESSMENT OF GREEN ECOLOGICAL AGRICULTURE

Finally, we use the prediction module in the digital information management platform of green ecological agriculture to analyze the changes in the green ecological index with the development year. The results are shown in Figure 5. A smaller increase in the green ecological index was observed during 2017-2018, at only 2.36%. As can be seen from Figures 3 and 4, this period is a critical stage for

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structural and policy regulation. During the period from 2018 to 2019, the green ecological index has been significantly improved, which is due to the comprehensive results of the agricultural environment, the abundance of soil nutrients and water resources in Figure 3, which are conducive to green and sustainable development. It was observed that compared with 2018, the green ecological index from 2019 to 2021 increased by 5.94%, 8.58% and 12.87% respectively.

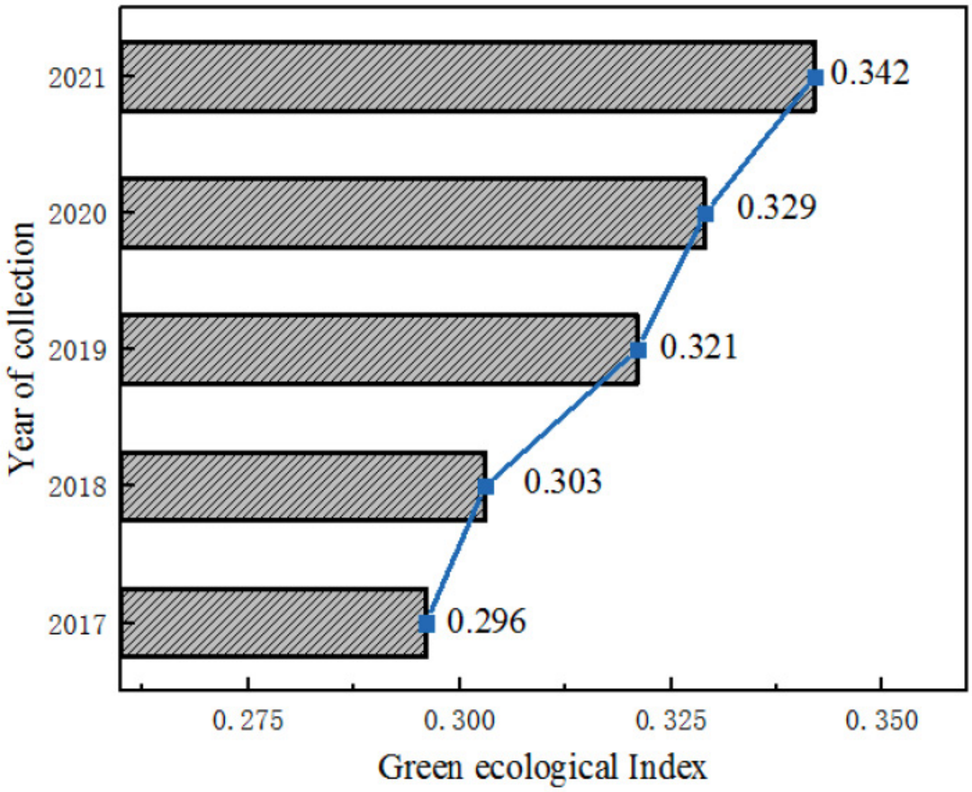

Figure 5. Changes of Green Ecological Index with Years

5. DISCUSSION

With the rapid development of China's regional agriculture, its consumption of energy, the squeezing and encroachment of the environment and the pollution of the ecological environment have been put on the agenda. This problem largely stems from the unreasonable management and regulation of the rapidly developing agricultural infrastructure. Therefore, the demand and management of green ecological agriculture in China is a top priority. This provides a solid foundation for us to establish an effective management system. Aiming at the evaluation index cluster of agricultural management in Northeast China, the main structure of the digital information management platform of green ecological agriculture we built is divided into a variable layer, middle layer and evaluation index layer, which is a superimposed and progressive layer structure design. We focus on the analysis of the variable layer and the evaluation index layer. The conclusions are as follows:

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1. The overall trend of each variable parameter has a large change range from 2018 to 2019. Compared with 2018, the use index of electronic agricultural products, per capita greening index, soil organic matter content index and per capita water content index increased respectively in 2019 by 30.34%, 6.14%, 25.34% and 30.26%. The index of per capita desert land area decreased by 10.97%. This shows that from 2018 to 2019, the management and control of green ecological agriculture in Northeast China achieved a more significant effect. In the following 2019-2021 years, the per capita greening index, soil organic matter content index, per capita water resource content index and per capita desert land area index tended to stabilize;

2. The sustainable development index dropped abnormally during 2017-2018, with a drop of 0.08. This is inconsistent with the trend change results at the variable level. This is due to the excessive development of cultivated land, which pollutes the corresponding soil and water resources to a certain extent, which ultimately leads to a decrease in the sustainable development index. And with the improved measures, in 2019, the Sustainability Index rose by 0.013, compared to 4.28% in 2018. This shows that the implementation of the adjustment measures of control is feasible. From 2019 to 2021, the growth of the sustainable development index also stabilized, at 0.317, 0.319 and 0.322 respectively;

3. from 2017 to 2018, the growth rate of the green ecological index was small, only 2.36%, because this period was a key stage of structural and policy regulation. During the period from 2018 to 2019, the green ecological index has been significantly improved, which is a comprehensive result of the improvement of the agricultural environment, soil nutrients and water resources, which is conducive to green and sustainable development. Compared with 2018, the green ecological index from 2019 to 2021 increased by 5.94%, 8.58% and 12.87% respectively.

In the process of ecological compensation, the government should coordinate and integrate ecological compensation funds, give unified leadership to ecological compensation activities, coordinate management and operation, and establish a supervision mechanism to make the process of ecological compensation open and transparent. Barriers, it is necessary to transform the ecological compensation mechanism of a single element into a comprehensive compensation mechanism centered on the entire region and make overall planning and coordinated promotion, but in the selection of compensation objects, precise compensation must be implemented, and the compensation area must be selected reasonably, taking into account the local area. To meet the needs of the development of residents and enterprises, it is necessary to innovate in the way of ecological compensation, strengthen the participation of the people, pay attention to the will of the people before compensation, and incorporate the participation of the people into the evaluation system of the implementation effect of ecological compensation, to improve the participation of the people, to better play the positive force of public participation.

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RESEARCH ON THE FACTORS INFLUENCING THE DEVELOPMENT OF GREEN FINANCE IN BEIJING, TIANJIN AND HEBEI UNDER THE PERSPECTIVE OF ECOLOGICAL ENVIRONMENTAL PROTECTION

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ABSTRACT

In today's world, the contradiction between people and the ecological environment is becoming more and more acute. Green finance is an effective method to resolve the contradiction between economic growth and ecological environment pollution, which has been widely recognized by all countries. This paper analyzes the level of green financial development in the Beijing-Tianjin-Hebei region through an analytical model of green financial development influencing factors constructed by simulation, combined with ecological environmental protection, and identifies the main influencing factors affecting the level of green financial development in this region. In addition, the realization path proposed in this paper from the perspective of government-led green financial development is, firstly, to improve green finance-related standards, assessment system and green financial legal system. The second is to implement green financial regulation and improve the driving force of green policy and market integration. The research results show that the comprehensive measurement score of green finance development level in Beijing, Tianjin and Hebei region shows a steady increase between 2016 and 2020, among which the comprehensive measurement score of green finance development level in Beijing is as high as 72.13 in 2020, an increase of 17.32%. It provides theoretical guidance for the improvement of green financial public policies in Beijing, Tianjin and Hebei regions.

KEYWORDS

Ecological civilization; environmental protection; Beijing-Tianjin-Hebei; green finance; public policy.

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1. INTRODUCTION

In the process of survival and development, human beings excessively pursue rapid economic development, overuse and deplete resources, resulting in the destruction of the living environment [1-3]. The damaged environment in turn restricts human survival and development, and ecological and environmental problems have become a major world problem. From the perspective of the requirements of the times, the report of the 19th Party Congress clearly states that we should adhere to the harmonious coexistence between human beings and nature and treat the ecological environment as life [4-6]. The deterioration of the ecological environment has posed a serious obstacle to China's high-quality development and reduced the happiness index of residents [7-11]. In this context, in recent years, countries around the world have been vigorously developing green finance and industrial transformation to reduce carbon emissions and promote the sustainable development of economic life and the ecological environment [12-15].

In recent years, the emergence of environmental pollution phenomena represented by haze and dust storms has aroused great concern in society, signaling that the previous sloppy growth model is no longer sustainable. Ecological and environmental issues are closely related to the health of the people and must be reversed with great effort. Chen et al [19] analyzed the evolution of population, economy and groundwater exploitation based on the changes in the groundwater flow field in the Luan River delta, the heart of the Bohai economic zone. They also summarized the previous studies and analyzed the groundwater flow states in different aquifers of the delta. The results showed that the groundwater level in the delta region declined gradually, and the over-exploitation of groundwater exacerbated ecological problems such as water quality deterioration and shrinking biological habitats. Ma et al [20] considered lakes and vegetation as sensitive indicators of climate change and human activities, as well as an essential part of water ecology. Therefore, they combined lake area, vegetation cover changes, and terrestrial water storage to form a comprehensive evaluation index of ecological and environmental problems in the Nengjiang River basin. They found that human activities were the main factor causing ecological problems in lakes during 2000-2019, and during these years, frequent human activities led to a decrease in river recharge and a gradual shrinkage of the lake area. Han et al [21] applied artificial intelligence to ecological environmental protection problems and used deep learning models to identify invasive alien species as a way to target alien species prevention and control. They built and trained a Bi-LSTM model and a neural network model to identify the relevant images based on the data of reports about the invasion of Asian hornets in the United States. The results show that this model can effectively identify and prevent new species and avoid the malicious destruction of the original ecology, to achieve the purpose of protecting ecological diversity. Cheng et al [22] combined the ecological environment with the tea industry and tourism to analyze the related industries in Fujian Province. They constructed a coupled coordination model by establishing a comprehensive evaluation index system related to the three. The results showed that the comprehensive development index of Fujian Province

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has been steadily increasing in recent years, and the degree of coupling and coordination of the three systems is changing to high-quality coordination. Jiang et al [23] concluded that the current Yellow River basin, as an open ecosystem, has a very fragile ecological environment and is very vulnerable to natural and human activities. They designed an ecological environment evolution simulation system using big data and information technology for the changing ecological environment of the Yellow River basin. This system integrates various data such as historical data, spatial geographic information as well as monitoring data to realize the functions of multi-source information synthesis, environmental monitoring and evolution simulation, and provides some emergency management measures for some critical situations. Dong et al [24] used remote sensing technology and a projection tracking model to detect and analyze the urban ecological environment of Shanghai. The results showed that the eco-environmental quality of all regions in Shanghai had improved. They found that the ecological environment of each region affects each other, so the management of the ecological environment should take into account the impact of surrounding areas.

To sum up, vigorously developing green finance is of great significance to China's realization of a green, healthy and sustainable development path. This paper studies the current situation of green finance development in the Beijing Tianjin Hebei region and analyzes the main factors affecting its development. According to the statistical data in recent years, the government expenditure in the field of green environmental protection in the three places in recent years is analyzed, which provides theoretical support for promoting the development of China's economy and ecological environment.

2. GREEN FINANCIAL DEVELOPMENT SYSTEM AND MEASUREMENT

Because green finance essentially combines the greening of energy and the environment and takes into account the protection of the environment while maintaining economic development, green finance is growing with the development of world industrialization. From the existing literature, green finance is also known as sustainable development finance. The development of green finance takes into account the development of the economy and natural environment and emphasizes that human development should follow the laws of nature and live in harmony with nature.

2.1. GREEN FINANCE DEVELOPMENT EVALUATION INDEX SYSTEM CONSTRUCTION

So far, there is no unified standard in academia to define and measure green finance. According to previous literature research, the empirical analysis of green finance is mostly measured by a single index such as green credit. Unable to adapt to

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today's rapid economic environment, it is necessary to propose a new evaluation index system.

2.1.1. SYSTEMATIC AND HIERARCHICAL PRINCIPLES

The construction of the indicator system needs to have sufficient coverage to determine that the constructed system is a systematic whole and can reflect the level of green finance development comprehensively, to determine that the selected indicators can fully reflect their main characteristics from different perspectives, and at the same time, the selected indicators should be representative and hierarchical and should be independent of each other and not contain each other as substitutes.

2.1.2. PRINCIPLE OF SCIENTIFICITY AND FEASIBILITY

Science is the basis in the construction of the indicator system, which should follow scientific theory, and each indicator should be consistent with the definition of green finance and show its characteristics and attributes scientifically. At the same time, the selected indicators should also be feasible, with quantifiable indicators and accessible data to guarantee accurate and reliable data and to ensure that the caliber, scope and calculation methods of each indicator data are consistent among different regions and within different periods.

2.1.3. PRINCIPLES OF RELEVANCE AND RELIABILITY

The selected indicators should satisfy the unity of relevance and reliability. Indicators that are irrelevant or unreliable to green finance cannot be selected. Irrelevant indicators are difficult to evaluate green finance, and unreliable indicators may lead to errors, so they are also not selected. It is necessary to have a standardized operation and sufficient realistic data information as support to get reliable indicators.

Based on the above principles, referring to the indicators constructed by the previous green finance level measurement research, combined with the current situation of green finance development. This paper constructs the index system shown in Table 1 from the following four aspects.

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Table 1. Evaluation indicators

Tier 1 Indicators	Secondary indicators	Tertiary indicators	Measurement Method
Green Finance Development Level	Green Credit	Percentage of loans to energy-intensive industries	Percentage of loans to energy-intensive industries / Interest expenses of industrial industries
	Green Securities	Percentage of market capitalization of environmental companies	Total output value of environmental protection enterprises / Total A-share market capitalization
	Green Investment	Percentage of Green Spending	Fiscal expenditure on energy conservation and environmental protection / Fiscal expenditure
	Green Insurance	Environmental liability insurance amount ratio	Amount of agricultural insurance / total insurance

1. Green Credit

Green credit is an important part of China's green finance policy. The academic circles often use the following four evaluation methods: (1) the green credit of 21 banks published by the CBRC; (2) China environmental statistics yearbook data (3) China environmental statistics yearbook data; (3) The interest expense ratio of high energy consuming industries used in Li and Xia Guang's report; (4) Loans from regional listed energy conservation and environmental protection enterprises to banks. Based on the feasibility and comparability of the data, and considering that green credit can not only support the development of green development in the positive direction but also inhibit the development of high consumption and high pollution industries in the negative direction, this paper mainly uses the fourth and fifth methods to measure green credit from the negative and positive directions respectively. Therefore, this paper measures green credit from the reverse and positive perspectives of the fourth and fifth methods respectively. The empirical data are from the Guotai'an database and China Financial Yearbook.

2. Green Securities

The green securities market can help enterprises finance green projects by issuing bonds or stocks. Given the late start of green bonds in China and the lack of audit data, and referring to the research results of several scholars, this paper chooses green stocks as the research object

3. Green Insurance

Green insurance helps to strengthen the supervision of environmental protection and clarify the responsibilities of relevant subjects. Environmental protection insurance can be expressed by environmental liability insurance. Environmental liability insurance can refer to green insurance, but considering that on the one hand,

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China did implement environmental pollution liability insurance at the end of 2013, which started late and lacked mandatory, on the other hand, agriculture is fragile and affected by the natural environment, agricultural insurance is most relevant to the natural environment, and has a certain public attribute. Therefore, this paper chooses agricultural insurance scale and loss rate as its proxy variables.

4. Green Investment

Green investment is an investment based on sustainable development, which can improve the financing ability of green projects and control pollution. The green investment provides comprehensive guidance and control for environmental protection. It can reflect the financing level of green industries through other ways than credit, securities and insurance, and reflect the government's support for environmental protection enterprises, which is in line with the actual situation of green investment in China. The data on green investment comes from the China Environmental Statistics Yearbook.

2.2. GREEN FINANCIAL DEVELOPMENT INDEX MEASUREMENT

In this paper, the green financial development index is measured by the entropy value method. The entropy weight method can deeply reflect the distinguishing ability of indicators and determine better weights. Empowerment is more objective, with a theoretical basis and higher credibility. In addition, the algorithm is simple and practical and does not need other software analysis. It can effectively avoid the deviation caused by subjective factors in the process of determining the weight coefficient, and eliminate the negative impact of excessive reliance on subjective feelings on the evaluation results.

The formula for calculating the weight of the indicator is as in equation (1) and equation (2).

$$P_{ij}^{t} = \frac{Y_{ij}^{t}}{\sum_{i=1}^{m} Y_{ij}} \tag{1}$$

$$\lim_{P_{ij}^{t} \to 0} P_{ij}^{t} \times \ln\left(P_{ij}^{t}\right) = 0, P_{ij}^{t} = 0 \tag{2}$$

Where, Y^{t} denotes the weight of the ith sample under the j indicator in year t for that indicator, and is the data after the extreme difference standardization process. P_{ij}^{t} is the indicator value after the original data is standardized by the extreme difference method.

The function to calculate the information entropy of the indicator is shown in Equation (3):

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$$E_j^t = -\frac{1}{\ln(m)} \sum_{i=1}^{m} \left[P_{ij}^t \times \ln \left(P_{ij}^t \right) \right] \tag{3}$$

Where, E_j^t denotes the information entropy of the j indicator in year t. Calculate the information entropy of the index, and determine the weight according to its calculated value. The greater the uncertainty of the index value, the greater the entropy, and the smaller the index weight, and vice versa, the greater the indicator weight. Calculate the indicator weights as in equation (4).

$$W_j^t = \frac{\left(1 - E_j^t\right)}{\sum_{j=1}^{n} \left(1 - E_j^t\right)} \tag{4}$$

Where, W_j^t indicates the weight of the j indicator in the comprehensive evaluation, and the larger the weight, the greater the contribution to the result.

Therefore, the green financial development index measurement calculates the comprehensive evaluation value as shown in equation (5):

$$U_i^t = \sum_{j=1}^{n} \left(W_j^t - Y_{ij}^t \right) \tag{5}$$

Where, U_i^t denotes the composite evaluation value of the i study the subject in year t.

This section composes in detail the theoretical framework for the analysis of the structure, objectives, and factors influencing the realization mechanism of green finance in Beijing, Tianjin, and Hebei Province, and the mechanism path of green finance affecting economic development is combined with the logical relationship between the two to reason out the role mechanism of green finance affecting the ecological economy of Beijing, Tianjin, and Hebei Province for role analysis. The theoretical basis is provided for the subsequent analysis.

3. ANALYSIS AND DISCUSSION

Green finance pays attention to environmental protection while developing the economy, which provides important support for promoting the construction of ecological civilization and winning the pollution war. This paper makes statistics on the data of green credit, green investment and green securities in Beijing Tianjin Hebei region in 2017. Then, it makes a statistical analysis of the pollution control and environmental protection expenditure in the Beijing Tianjin Hebei region from 2016 to 2020.

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3.1. GREEN FINANCE DEVELOPMENT FRAMEWORK

Green finance is a comprehensive concept, which contains multiple dimensions. To make an objective and reasonable measurement of green finance, a comprehensive index system should be established to contain information from multiple aspects. Specifically, by judging and analyzing the current financial development, multiple dimensions are established, such as green securities, green insurance, etc., and then appropriate indicators are selected to measure the development of each dimension to build a reasonable indicator system and calculate a comprehensive green finance score. At present, the academic community has not yet unified the construction of a green finance index system, and there are differences in the selection of indicators. However, most Chinese scholars use five key indicators such as green credit to evaluate. Through the statistical analysis of the existing published data, the development status of green credit, green investment and green securities in Beijing Tianjin Hebei region in 2017 is obtained. Specific information is as follows.

1. Green Credit

As of the end of June 2017, the balance of loans in the green credit sector of major Chinese banks in Beijing was RMB901.768 billion, an increase of 8.6% year-on-year, of which RMB 756.080 billion was for energy conservation and environmental protection, an increase of 9.0% year-on-year. At the end of 2016, green credit in the banking sector in Tianjin accounted for 9% of all loans in the city. 144,000 green credits were issued in the banking sector in Hebei Province in the first quarter of 2017, amounting to RMB 221.399 billion.

2. Green Securities

By the end of July 2017, Beijing enterprises, including state-owned enterprises, had issued 45 green bonds. In February, China Development Bank successfully issued 5 billion yuan of green financial bonds in the bond market, including three categories and nine projects of energy conservation, clean transportation and clean energy.

3. Green Investment

In terms of green funds, the scale of several green industry funds in the Beijing-Tianjin-Hebei region has reached the order of 100 billion. By the spirit of the State Council's approval and under the strong promotion of the Department of Industrial Coordination of the National Development and Reform Commission, the Beijing-Tianjin-Hebei Industrial Co-development Investment Fund was established in December 2016. Up to now, Beijing has set up several sub-funds of government investment guiding funds.

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3.2. GOVERNMENT INVESTMENT ANALYSIS

The statistical results of environmental protection expenditure in Beijing, Tianjin and Hebei Province from 2016 to 2020 are shown in Figure 1. It can be found that the proportion of environmental protection expenditure in Beijing is getting higher and higher from 2016 to 2020. From 3.25% in 2016 to 6.83%, an increase of more than 100%, indicating that the Beijing government is paying more and more attention to environmental protection. In contrast, from 2016 to 1019, the proportion of environmental protection expenditure in Tianjin remained at about 2%, but by 2020, this proportion increased to 3.23%, indicating that the Tianjin municipal government did not pay enough attention to environmental protection until 2020. On the other hand, Hebei Province pays more attention to energy conservation and environmental protection, which reached 4.28% in 2016 and increased to 6.49% by 2020. This is because the pollution situation in Hebei was relatively serious at that time. The local government attached great importance to environmental protection and took many measures to reduce the emission of pollutants.

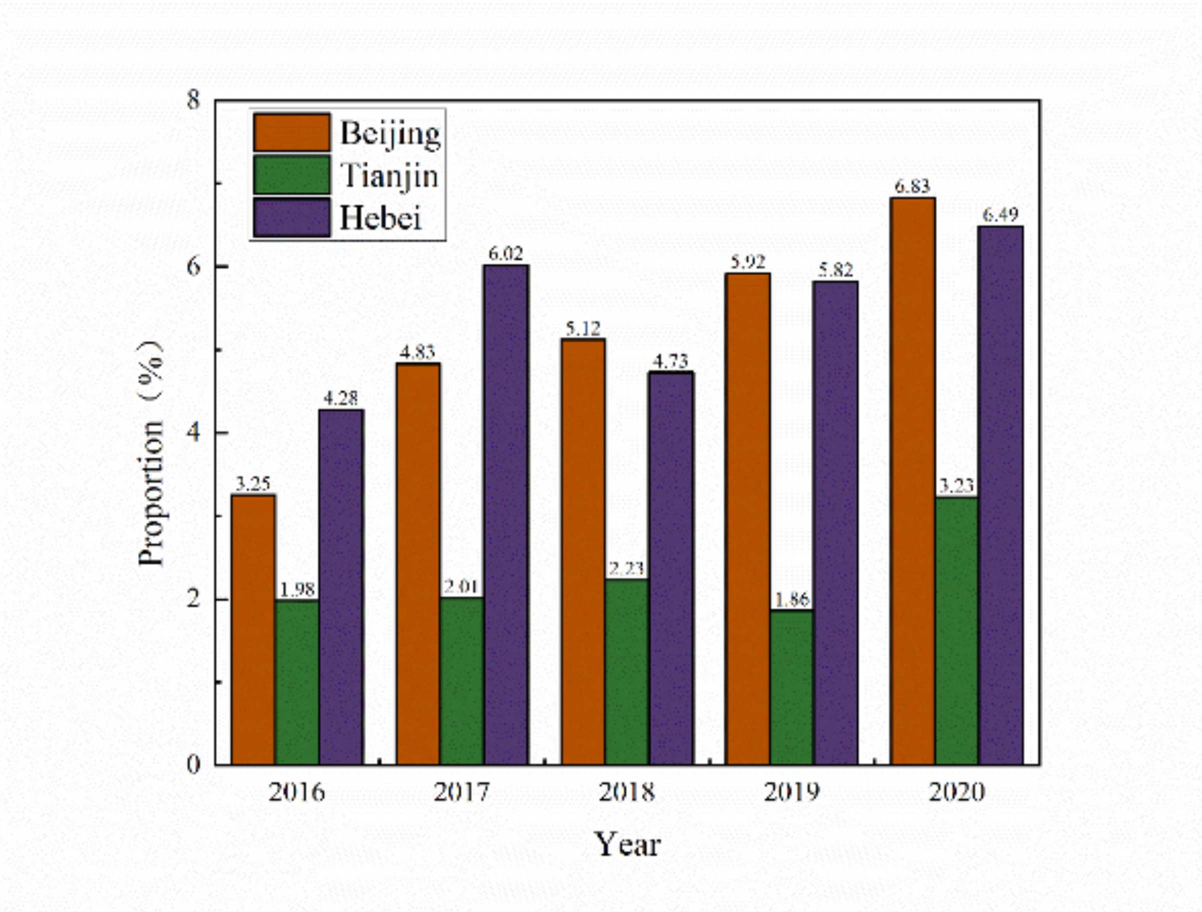

Figure 1. Proportion of fiscal expenditure on energy conservation and environmental protection in the Beijing-Tianjin-Hebei region to total fiscal expenditure, 2016-2020

Figure 2 shows the proportion of investment in environmental pollution control in Beijing, Tianjin and Hebei Province from 2016 to 2020. As can be seen from Figure 2, Tianjin's regional investment in environmental pollution control continues to take the

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lead, reaching a maximum of 10.12% in 2018, only 11.2% lower than that of Hebei Province in 2020. The proportion of investment in environmental pollution control in Hebei Province has increased steadily year by year, from 5.68% in 2016 to 11.2% in 2020, with a relative increase of 97.18%. In contrast, from 2016 to 2020, Beijing's investment in environmental pollution control accounted for a relatively low proportion, only about 2%. This is because Beijing's regional GDP base is larger than that of Tianjin and Hebei.

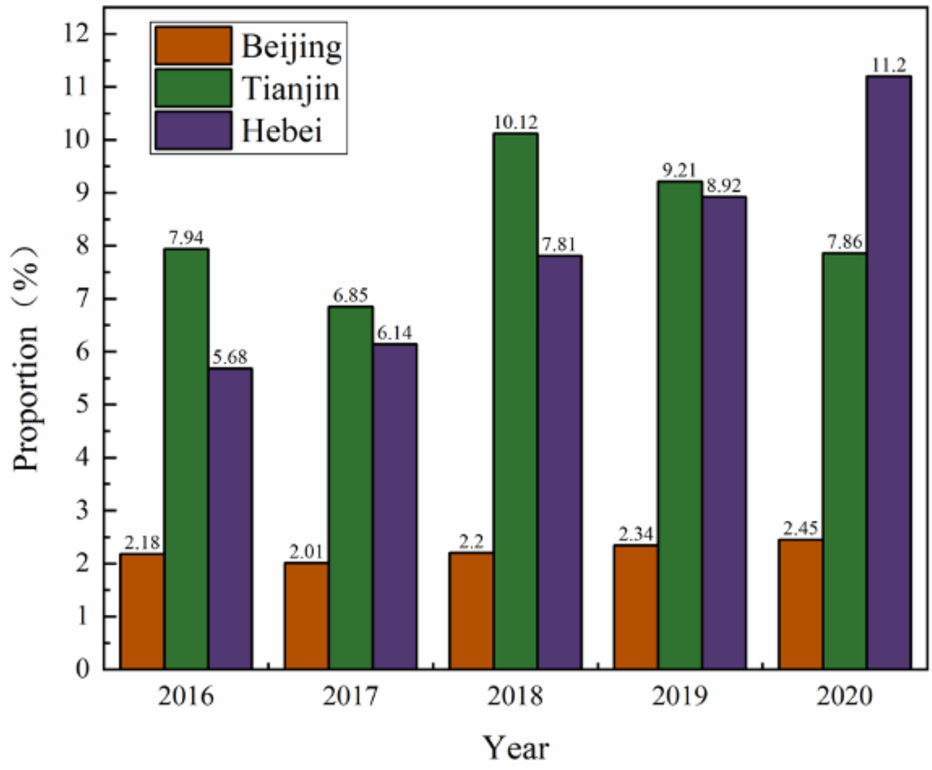

Figure 2. Investment in environmental pollution control in Beijing-Tianjin-Hebei region as a proportion of regional GDP, 2016-2020

3.3. MEASUREMENT OF GREEN FINANCIAL DEVELOPMENT LEVEL

Based on the data from 2016 to 2020, under the framework of the evaluation indexes of green financial development level in Table 1, the weights measured by the entropy weighting method (39% for green credit, 26% for green securities, 18% for green investment, 10% for green insurance, and 7% for carbon finance, all the results are retained to integers) are calculated in The results are kept to the whole number), and the strict integration from the third-tier indicators to the first-tier indicators is gradually completed by the established method under the principle of "progressive indicators", and the results are finally output. The scores of green financial

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development levels of Beijing, Tianjin and Hebei from 2016 to 2020 are shown in Table 2.

Table 2. Tianjin and Hebei Green Finance Development Level Score

City	2016	2017	2018	2019	2020	Average Development Level
Beijing	61.48	64.03	67.29	69.26	72.13	66.84
Tianjin	47.95	51.23	54.67	56.38	59.84	54.01
Hebei	42.61	44.97	48.33	51.21	54.19	48.26

According to the comprehensive measurement of the green financial development level of Beijing, Tianjin and Hebei, it can be found that the highest green financial development level of Beijing was 61.48 in 2016, and increased to 72.13 in 2020, an increase of 17.32%. The green financial development level of Tianjin has increased from 47.95 to 59.84, while that of Hebei has increased from 42.61 to 48.26. In terms of the macro pattern of synergistic development, the overall green financial development level of Beijing, Tianjin and Hebei has shown positive growth.

3.4. POLICY RECOMMENDATIONS

The development of green finance in the Beijing-Tianjin-Hebei region cannot be achieved without the support of good public policies, and the improvement of public policies mainly starts from the following aspects.

1. Increase financial investment. In the initial stage of green financial development, local governments should increase financial investment in regional economic development to promote the development of the local economy and raise the actual income level of residents. In addition, the relevant departments should introduce green financial reward and punishment policies and improve relevant laws and regulations as soon as possible.

2. Raise the awareness of environmental protection. The environment should not only be protected by the masses but also by the national government, which should introduce relevant laws and regulations to restrain people's unreasonable behavior. Through the news media to strengthen the environmental protection education concept of publicity, the residents of the community regularly organized environmental protection activities, and the relevant law enforcement departments to increase environmental protection enforcement efforts. Only when each unit has its responsibility can the whole society gradually raise awareness of environmental protection.

3. Improve the risk prevention and control mechanism, for the prevention of green financial risks, it is imperative to establish a sound green financial risk warning mechanism. The first line of defense of risk management is prevention, and it is

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essential to improve the management capacity and prevention and control of green financial risks, so green financial risk early warning should be taken as part of the systemic financial risk monitoring and warning system.

4. DISCUSSION

Green finance, as an innovative financial development model to resolve the contradiction between economic growth and ecological pollution, has been rapidly developed under the promotion of development concepts such as green, sustainable and high quality. This paper counts the green finance evaluation indicators such as green credit, green investment and green securities in Beijing Tianjin Hebei region from 2016 to 2020. During this period, the proportion of local government expenditure on energy conservation and environmental protection and the proportion of investment in environmental pollution control were analyzed. Integrate the measured scores of green finance development in various regions. The following conclusions can be drawn.

1. The indicators of green credit, green securities, and green investment in Beijing, Tianjin, and Hebei regions are steadily increasing and account for a larger share of the country. In 2017 alone, green credit in Beijing increased by 8.6% year-on-year, and the scale of green securities financing was close to 30% of the country.

2. From 2016 to 2020, the government of Beijing Tianjin Hebei region invested more and more in energy conservation, environmental protection and environmental pollution control. The proportion of environmental pollution control investment in Hebei Province increased from 5.68% in 2016 to 11.2% in 2020, with a relative increase of 97.18%.

3. Comprehensive analysis of green financial development level evaluation indexes for the comprehensive measurement of green financial development level in Beijing, Tianjin and Hebei reveals that the measurement scores of the three regions show a steadily increasing trend, with Beijing's comprehensive measurement score of green financial development level in 2020 being as high as 72.13 points.

4. According to the measurement results, it can provide theoretical guidance for the improvement of green financial public policies in Beijing, Tianjin and Hebei. Green financial public policy should increase financial investment, raise people's awareness of environmental protection, improve risk prevention and control mechanisms and increase green financial innovation.

This paper has achieved the research purpose on the whole, but there are still the following deficiencies. For example, the data sources are relatively limited, and only the Beijing Tianjin Hebei region and the lack of objective explanations of relevant

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economic theories are discussed. In the future, we can further improve the model from the Beijing Tianjin Hebei region.

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RESEARCH ON NATURAL RESOURCE ACCOUNTING ISSUES FROM THE PERSPECTIVE OF ECOLOGICAL CIVILIZATION

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ABSTRACT

The systematic thought of "mountains, rivers, forests, fields, lakes, grass ice is a community of life" requires us to set up an overall view of ecological governance. To evaluate the effectiveness of natural resource protection and management and respond to the public's concern about the shortage of resources, it is necessary to carry out the accounting work of natural resources. However, the accounting work of natural resources under the background of ecological civilization construction is still in the stage of groping forward. This paper creatively analyzes the classification of natural resources assets, the determination of natural assets value, the confirmation and measurement of resource liabilities and net assets through accounting, and explores the system and method of compiling the balance sheet of natural resources, which has certain reference value to realize the sustainable development of natural resources ecological civilization construction. This paper calculates the original ownership and use rights of land, mineral resources and water resources in a city of China. The results show that land transfer fees increased by 127,996.24 million yuan, the ending balance of natural resources taxes and land resources reserves in storage at the end of the year was 27,956 million yuan, the loss of coal resources was 300 tons, and water resources decreased by 85,062 million cubic meters.

KEYWORDS

Ecological civilization; sustainable development; natural resources; accounting; ecological governance

INDEX

1. INTRODUCTION

The construction of ecological civilization is a gradual and persistent work, and it is also something that the party and the country attach great importance to; the construction of ecological civilization is related to the well-being of the people and the rise and fall of the country [1-3]. Natural resources are the material basis for human survival, an important source of production materials and living materials for human society, and play a vital role in maintaining social and economic development. Natural resources have long been labeled as "inexhaustible and inexhaustible". The long-term excessive plundering, exploitation and utilization of human beings have caused heavy damage to the natural environment and the ecological environment has been deteriorating [4-6]. Accounting for natural resources, correct handling of the relationship between human beings and the natural environment, and the relationship between economic development and ecological civilization construction have become the top priorities.

The frequent occurrence of natural disasters and extreme weather, such as land desertification, soil pollution, sea pollution, sandstorms, acid rain, etc., indicates that human beings must pay more attention to the construction of ecological civilization and promote the harmonious coexistence between man and nature [7,8]. Zhang et al. [9] constructed a new urban resource and environmental carrying capacity (URECC) index system that includes 18 indicators. The results show that the index system fully reflects the supporting and restraining role of resources and environment on human development, which provides a reference for future research on the index system of urban carrying capacity, and also has important practical significance for guiding the sustainable development of cities. Qi et al. [10] established an evaluation system for the water ecological civilization of the Yangtze River Economic Belt. The results show that the level of water ecological civilization in the Yangtze River Economic Belt is steadily improving and has reached a high level, which is inseparable from the increase in capital investment in the Yangtze River Economic Belt. Gong et al. [11] studied the water ecological civilization of Lishui Ancient City from a historical perspective. They explored the transformation law of the urban water system by studying the water conservancy projects of ancient Lishui. Li et al.[12] combined the construction of ecological civilization with the breeding industry, analyzed the problems and difficulties faced by the breeding industry in my country at present, and proposed the development path of the breeding industry under the heavy responsibility of ecological civilization construction. He pointed out that it is necessary to establish a new thinking of healthy and environmentally friendly breeding, constantly reform and innovate, carry out industrial upgrading, and adapt to the new economic development mode; at the same time, improve the information platform, promote the application of the Internet in the breeding industry, and form a new mechanism for pollution control and breeding. Zhang et al. [13] combined ecological civilization to redefine China's green urbanization, and established related conceptual frameworks and strategic ideas. He believes that China must jump out of the traditional industrial thinking mode and promote urban greening and sustainable

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development based on ecological civilization. Green urbanization based on ecological civilization should be carried out around three basic tasks and two strategies. Zhou et al. [14] pointed out that on the road of ecological civilization construction, enterprises should also realize green management. In the new era, the development of an enterprise needs to innovate and develop a green and civilized development path; at the same time, the managers of the enterprise must adapt to the development and changes of the market, actively practice the concept of green management, and bring more comprehensive benefits to the enterprise.

In the United Nations Integrated System of Environmental-Economic Accounting (SEEA), natural resources are mainly divided into seven categories [15-17], namely: mineral and energy resources [18, 19], land resources [20, 21], soil resources [22], wood resources [23], aquatic resources [24], other biological resources [25, 26], and water resources [27, 28]. Natural resource accounting is one of the important means to implement refined management of natural resources. The current utilization rate of natural resources has exceeded the standard, and the shortage of natural resources and the deterioration of the environment are serious. Yang et al. [29] took Xi'an as an example and used ecosystem accounting to analyze changes in urban natural resources and the effectiveness of management policies. The results show that the urban ecosystem in Xi'an is degraded and vulnerable. In addition, compared with the use of physical quantities, natural resource accounting better reflects the utilization level of urban natural resources, measures the degradation and depletion of natural resources, maximizes the effectiveness of accounting, and provides a better understanding of the total product of urban ecosystems. Accounting points the way. Allam et al. [30] made some observations on the recent Amazon forest fires. They stated that the current ecosystem accounting and management framework is regionally focused, with differences in resource accounting and management policies in different countries and regions, and a lack of cohesion. In the future, a global resource accounting and management framework should be established to maintain a truly sustainable and livable ecosystem. Mcgrath et al. [31] believe that natural resource accounting can incorporate natural resources into economic and political decision-making, improve natural resource management and formulate macroeconomic indicators suitable for ecological civilization construction. They point out that natural resource accounting can provide managers with a statistical framework for the relationship between the environment and the economy. Nassani et al. [32] examined the top ten economies with rich mineral resources based on the current database. The results show that the huge human demand for natural resources is further reflected in the environmental accounting system. Human activities can lead to an increase in the extraction of mineral resources, thus jeopardizing the future stock of rare earth resources. Buonocore et al. [33] show that, although habitat accounts for only 4% and 1% of the total ocean area in the two regions, it contributes as much as 28% and 7% to the total value of natural resources, data reflecting the accounting for natural resources. Necessity, highlighting the importance of taking appropriate measures and actions to protect natural resources.

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To sum up, in the context of ecological civilization construction, accounting for domestic natural resources is very necessary. This paper takes natural resources as the main body of accounting and is supported by the accounting theory of related resources such as water resources. Through the establishment of natural resource accounting methods, a natural resource balance sheet is constructed. Based on the current availability and consumption trends of natural resources, natural resource assets and the physical quantity of natural resource liabilities have been calculated, and the value of natural resource assets and natural resource liabilities has been calculated based on the shadow price model. The results show that the natural resource accounting model can effectively help the local government and the country to formulate a development route in line with ecological civilization construction and sustainable development, and strengthen the management of natural resources and rational development and utilization.

2. THE BASIC THEORETICAL BASIS OF NATURAL RESOURCE ACCOUNTING

According to the definition of accounting, natural resource accounting can be defined as natural resource accounting is based on the measurement of natural resources and takes the existing resources, resource changes, and mobile resources of natural resources as the framework. Provides information on natural year resources to governments and countries and proposes policy and management guidelines.

2.1. NATURAL RESOURCE PRICING MODEL

Natural resource pricing refers to valuing the physical quantity of natural resources based on price theory. At present, the price theory is mainly divided into two types: the labor theory of value and the utility theory of value. The Marxist labor theory of value is the basis of Marxist axiology, which holds that price is the manifestation of value, and value is the basis of price. The amount of socially necessary labor time consumed determines the amount of value. The utility value theory believes that the relationship between supply and demand in the market determines the market price, and the real market price is the price when supply and demand balance.

So far, domestic and foreign pricing of natural resources has not yet formed a complete system. Based on the main research at home and abroad, the main overview of natural resource pricing models is the shadow price model, equilibrium price model, marginal opportunity cost model, market valuation model, etc. It is often difficult to accurately calculate the value of natural resources by using a single pricing model, which can reduce the error rate of pricing and improve the accuracy of data.

Because natural resources are divided into seven categories such as mineral and energy resources, land resources, and water resources, this section takes the accounting theory of water resources as an example.

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2.2. ASSET-LIABILITY RATIO OF WATER RESOURCES

The water asset-liability ratio is the percentage of total water resources liabilities divided by total water resources assets. The asset-liability ratio of water resources reflects how much of the total water resources assets are raised through liabilities, and it can also measure the extent to which water entities protect the interests of creditors during liquidation. The calculation formula is:

$$R_l = \frac{L}{A} \times 100\,\% \tag{1}$$

Among them, R_i is the asset-liability ratio of water resources (%), L is the total amount of water resources liabilities (billion • m3), and A is the total amount of water resources assets (billion • m3).

2.3. BASIN WATER RESOURCE ASSET ACCOUNTING

Basin water resource asset accounting refers to the accounting of asset items in the river basin water resources balance sheet, including the accounting of stock water resources assets and equity water resources assets, that is, the analysis and evaluation of various water resources assets in the river basin. Water resources assessment in the basin.

The calculation formula of the physical quantity level verification method of water resources assets is as follows:

$$V = \sum_{n=1}^{i} W_n \tag{2}$$

Among them, V is the physical quantity of water resources assets (billion • m3), W_n is the unit physical quantity of water resources assets (billions • m3), and n is the type of water resources assets.

2.4. SHADOW PRICE MODEL

The shadow price is the social objective of a finite resource or product under the condition of optimal allocation and rational use of The marginal contribution or marginal benefit. In terms of market relations, it is expressed as the equilibrium price of supply and demand. In China's non-market water supply and demand system, the market equilibrium price can be evaluated by the shadow price.

The concept of shadow price originated from mathematical programming. Assuming that the economic activity process involves kinds of n activities, the level of which is represented by $X = X_1, X_2, X_3, \ldots, X_n$, the resources consumed in these activities are m, and the supply of resources is $b = b_1, b_2, b_3, \ldots, b_n$, then the n conditions for making the economic activities to be optimal are:

$$\max S = C_1X_1 + C_2X_2 + \ldots + C_nX_n \tag{3}$$

$$\begin{bmatrix} a_{11} & \cdots & a_{1n} \\ \cdots & \cdots & \cdots \\ a_{m1} & \cdots & a_{mn} \end{bmatrix} \begin{bmatrix} x_1 \\ \cdots \\ x_n \end{bmatrix} \leq \begin{bmatrix} b_1 \\ \cdots \\ b_n \end{bmatrix} \tag{4}$$

$$X_1, X_2, X_3, \ldots, X_n \geq 0 \tag{5}$$

Among them, C is the objective function coefficient, a is the coefficient of the constraint condition, and S is the total benefit.

When the above economic activities are optimal, the shadow price m of the resource vector b is the dimensional row vector:

$$Y* = C_B B^T \tag{6}$$

Among them, C_B is the X_B objective function coefficient corresponding to the base variable and B is the coefficient matrix of the constraints, as follows:

$$B = \begin{bmatrix} a_{11} & \cdots & a_{1n} \\ \cdots & \cdots & \cdots \\ a_{m1} & \cdots & a_{mn} \end{bmatrix} \tag{7}$$

In the actual calculation, the linear programming method is mainly used. The linear programming solution is mainly to infer the shadow price of resources by establishing a linear programming model and using the dual solution theory. Shadow price is the solution to the dual problem that maximizes the total benefit objective as the original problem, and its specific model is as follows:

Objective function:

$$\max Z = \sum_{j=1}^{n} a_{vi}X_j (j = 1,2,\ldots,n) \tag{8}$$

Restrictions:

$$AX + Y \leq X \tag{9}$$

$$X^1 \leq X \leq X^h \tag{10}$$

$$Y^1 \leq Y \leq X \tag{11}$$

$$\sum_{j=1}^{n} a_{wj}X_j \leq W \tag{12}$$

$$V^1 \leq V \leq X \tag{13}$$

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$$0 \leq W_j \leq W_j^h \tag{14}$$

Among them, Z is the added value or profit of each industry, a_{vi} is the j value-added coefficient or profit rate of the first industry, X_j is the j total output of the first industry, X、X^h、X^1 are the column vector of the total output and the upper and lower bound column vectors, respectively, Y is the final use column vector, Y^1 is the final use lower bound column vector, a_{wj} is the direct water use coefficient of the j first industry, V^1 is the added value lower bound column vector, A is the direct consumption coefficient matrix, which reveals the technical and economic links between various industries, and W is the available water resources amount, which W_j^h is the upper limit of water use for the j first industry.

2.5. CALCULATION OF AVAILABLE SURFACE WATER RESOURCES

$$W_k = W_\mathrm{a} - W_\mathrm{b} - W_\mathrm{c} \tag{15}$$

$$W_b = \frac{1}{n}\left(\sum_{i=1}^{n} W_i\right) \times K \tag{16}$$

$$W_c = \frac{1}{n} \times \sum W_{it} - W_m \tag{17}$$

Among them, W_k is the available amount of surface water, W_a is the amount of surface water resources, W_b is the minimum ecological environment water demand in the river channel, W_c is the flood abandoned water, W_i is the amount of surface water resources in the i year (billion·m^3), K is the selected percentage (%), n is the number of statistical years, W_{it} is the natural runoff in the flood season of the i year (billion·m^3), and W_m is the maximum storage and water consumption of the basin during the flood season (billion·m^3).

2.6. ACCOUNTING FOR THE VALUE OF LIABILITIES

The depletion value of water resources is calculated using the cost-based cost method, and the calculation formula is as follows:

$$V_{con} = D \times v \tag{18}$$

Among them, V_{con} is the value of water resources consumption (billion • yuan), D is the physical amount of water resources consumption ((billion • m^3), and v is the unit water resources value (yuan/m^3).

The water quality degradation value is calculated based on the equal standard pollution load method, and the calculation formula is as follows:

$$V_{\deg} = P_0 \times v' \tag{19}$$

$$P_0 = \left(C_{ik}/C_{0k}\right)_{\max} \bullet Q_{ik} \tag{20}$$

Among them, V_{deg} is the value of water quality degradation (100 million yuan), P_0 is the amount of dilution water required for pollutant discharge to reach the evaluation standard concentration, v' is the value of unit net water resources (yuan/ m³), (C_{ik}/C_{0k}) is the maximum standard pollution index, and Q_{ik} is the waste water of pollutants discharged k by the pollution source i. Emissions (billion • t).

The value of water resources liability is the sum of the above two, namely:

$$V_{lia} = V_{con} + V_{\deg} \tag{21}$$

In this section, based on determining the thinking and framework, theories and methods of accounting for water resources assets and water resources liabilities in the basin, the accounting methods for the three elements of water resources assets, water resources liabilities, and water resources debt ratios in the basin are studied.

3. RESULTS AND DISCUSSION

Since natural resources are publicly released except statistical data, most management data are non-public data and are difficult to obtain through open channels. From the perspective of ecological civilization, based on the statistical data published by a city in my country, combined with the management data, statistical ledger and other data obtained through repeated investigations, the corresponding data on land resources, mineral resources, and water resources are formed. Natural resource rights and interests are accounted for based on local natural resource management. According to the collected data, the original ownership rights and use rights of land, minerals and water resources were calculated respectively.

3.1. LAND RESOURCE ACCOUNTING

By reviewing public information and internal interviews, the city has transferred a total of 55 state-owned land use rights in 2019, covering an area of 1.462174 hectares. The specific conditions of urban residential land and land for public facilities are shown in Table 1, and the changes in land resources at the beginning and end of the year are shown in Figure 1.

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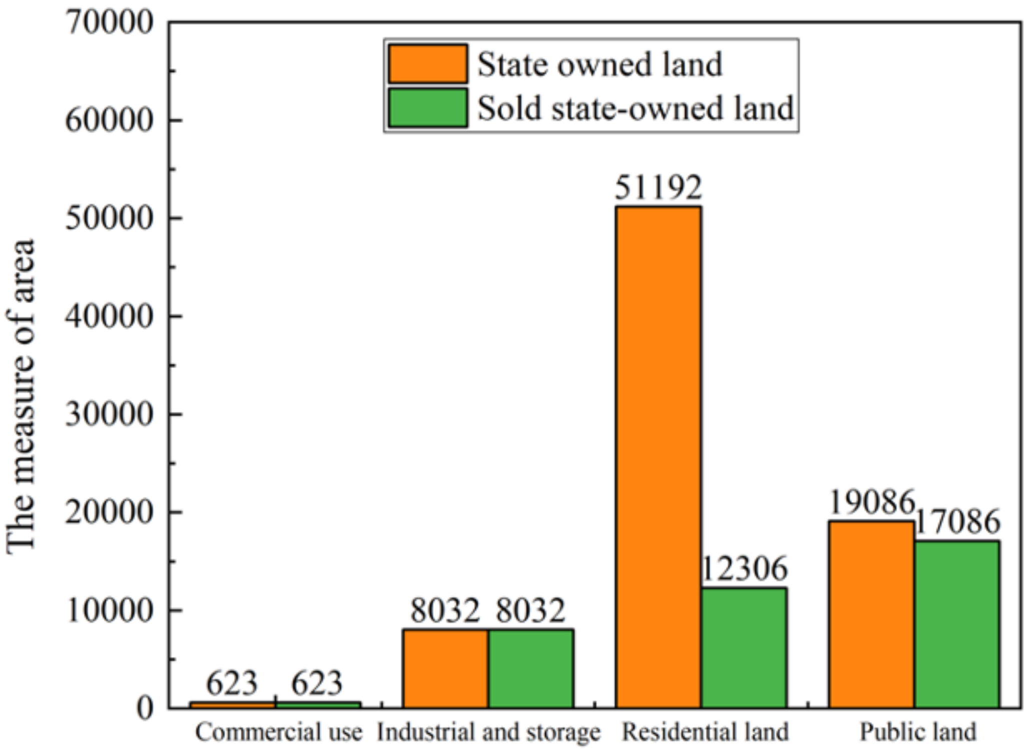

Figure 1. Changes in land resources

Table 1. Land transfer situation

type		Number of cases	Land area (hectares)	Land transfer price (ten thousand yuan)
Commercial use	retail commercial land	3	0.9894	926.34
	Wholesale commercial land	3	384	641.04
	Accommodation and dining	2	8.459	3,803.27
	Other commercial locations	8	15.274	10,533.02
Industrial and mining storage land	Industrial land	10	14.862	3,664.13
	Warehousing land	1	5.378	2,356.13
Residential land	urban residential land	21	37.246	106,072.31
public land	land for public facilities	1	10.256	0
	Parks and Green Spaces	3	47.645	0
	Scientific and educational land	2	5.328	0
	Press and publication land	1	396	0

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After calculating the impact of the transfer of land use rights on the original ownership and use rights of the land, the transfer of land use rights resulted in a decrease of 146.2174 hectares of the original ownership of the land and a corresponding increase of 146.2174 hectares of land use rights. The accounting found that the land transfer income and all rights and interests of the country in the transfer of land use rights, the newly increased land transfer fee of 1,279,962,400 yuan, on the one hand, is included in the state-owned equity account to be collected and used reserves, and on the other hand, it is included in the state-owned assets account. Receivable natural resources taxes. By calculating the impact of the land transfer income received on the equity account and the asset account. On the one hand, the state-owned use reserve is transferred from the account of the reserve to be collected to the land resource reserve that accounts for the actual received reserve accounting for 97.57 million yuan of tax declared for the current land value-added tax. Included in the equity account to be received and to be used (land value added tax) and the natural resource tax (receivable tax) in the asset account, respectively, accounting for the current land resources related taxes and fees to the national equity account and asset account impact. The declaration and payment of urban land use tax and land value-added tax in the current period are consistent with the budget at the beginning of the year, and no adjustment is required. In addition to the declaration and payment of land value-added tax in the current period, a total of 279.56 million yuan of land use rights and interests have been realized. The reserve is transferred to the land resource reserve; on the other hand, the asset account is transferred from the natural resource tax receivable to the natural resource tax and the natural resource tax and the land resource reserve balance at the end of the year is 279.56 million yuan.

3.2. MINERAL RESOURCE ACCOUNTING

According to the investigation, a new mining right was newly approved in 2019, which is that a salt-making enterprise discovered a new basic reserve of mineral salt of 5,000 thousand tons and the enterprise applied for the mining right of the discovered mineral salt resources. The copper mining company in this area found that the basic copper reserves in the mining area of the company increased by 10,000 tons compared with the previous assessment, and reported it according to the regulations. After the dynamic adjustment of the reserves in the mining area, the whole is still owned by the mining company. The above two reserves increase, involving mining taxes and fees, shall be dealt with separately. In the same year, the inspection of mineral resources found that a certain enterprise adopted destructive methods during the mining process, which resulted in the destruction of coal resources. The basic reserves of affected coal were estimated to be 300 tons, resulting in a reduction of 300 tons of coal resources in the area compared with the development plan. According to the estimated loss of coal resources of about 2 million yuan, the enterprise was fined 1.5 million yuan. At the same time, no other mining enterprises were found to be illegally exploiting mineral resources, and they all carried out production in accordance with the mining license and annual plan. Affected by market fluctuations, the final declaration and payment of resource tax was 72.56

million yuan. In that year, the income from the assignment of mining rights was RMB 1 million, and the occupation fee for mining rights was RMB 9.64 million. The mining of mineral resources in the current year was carried out as planned, as shown in Table 2, and the changes in mineral resources during the year are shown in Figure 2.

Table 2. Changes in Mineral Resources

name	Beginning Reserves (kt)	Reserves sold at the beginning of the period (kt)	Proved new reserves (kt)	Illegal reduction of reserves (kt)	New transfer reserves (kt)	Development and utilization of reserves (kt)	Ending reserves (kt)	Transferred reserves at the end of the period (kt)
coal	25332	25211	0	300	0	980	24052	23931
copper mine	274604	263.996	10000	0	0	12983	271621	261013
zinc mine	121450	95.603	0	0	0	4623	116822	90975
Nickel Ore	113212	113.212	0	0	0	583	112629	112629
mineral salt	634224	622.008	5000	0	5000	3849	635375	623159

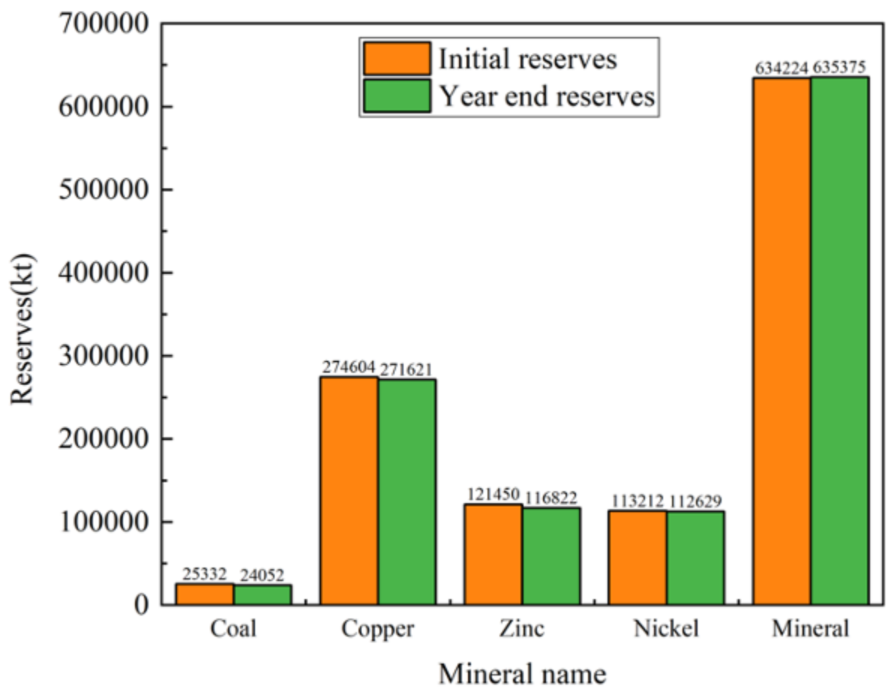

Figure 2. Changes in mineral resources

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After accounting, it was found that a certain enterprise's destructive mining of coal resources resulted in a loss of 300 tons of coal resources. The destruction of coal resources resulted in a loss of 2 million yuan, which reduced the available coal resources in the future. It is the occupation of the available resources in the future period in the current period and should be included in the natural resources liabilities of the current period to make up for the shortage of future resources. The liability of 1.5 million yuan is included in the liability compensation fund by making up for the enterprise penalty; the remaining insufficient part should be borne by the natural resource owner, that is, the state and included in the liability compensation fund. The resource tax declared and paid in the year was 72.56 million yuan, an increase of 2.49 million yuan compared with the budget of 70.07 million yuan at the beginning of the year. The natural resource tax receivable and the reserve for use should be increased. In that year, the proceeds from the assignment of mining rights amounted to RMB 1 million, and the occupation fee for mining rights amounted to RMB 9.64 million. The total amount of natural resource taxes receivable and reserves to be collected for the current year should be increased by RMB 13.29 million. When the relevant taxes and fees are received into the treasury, the equity account is transferred from the reserve for use to the paid use reserve, and the asset account is transferred from the natural resource tax receivable to the natural resource tax and charge in the treasury and the mineral resources reserve at the end of the year. The balance is $83.2 million.

3.3. WATER RESOURCE ACCOUNTING

According to the recorded data of the water conservancy department and hydrological department of the place, combined with the meteorological and hydrological conditions, the increase and decrease of water resources were sorted out as shown in Table 3. In 2019, there was 7% more rain than normal, 28 new industrial water use units were added, 1 million cubic meters of new water abstraction permits were added, and 9 million cubic meters of agricultural water abstraction permits were reduced. The annual declaration and collection of water resources fee is 69.4 million yuan. Compared with the budget data, an increase of 100,000 yuan is due to the payment of water resources fees by new water-using units, and a decrease of 40,000 yuan is caused by the reduction of water consumption by agricultural water-using units. The local water conservancy department found that the water resource of the lake was polluted by the enterprise, and the water quality was inferior to Category 5 water. The affected water resource was 2 million cubic meters, and the enterprise was punished by 1.6 million yuan according to relevant laws and regulations million. Based on this, the calculation of local water resources rights and interests is shown in Table 3, and the change in water resources during the year is shown in Figure 3.

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Table 3. Changes in water resources increase and decrease

	beginning of the year stock	precipitation	inflow	regressor	water for live	Industrial water	agricultural water	ecological water	Year-end stock
surface water	27365	13048	73792	403	98	517	489	11	28687
river	19783	12971	55491	339	72	467	356	9	20171
reservoir	541	34	8503	52	31	16	167	2	586
lake	7485	44	9798	12	8	5	3	3	7643
groundwater	5869	0	6	0	3	3	0	1	5932

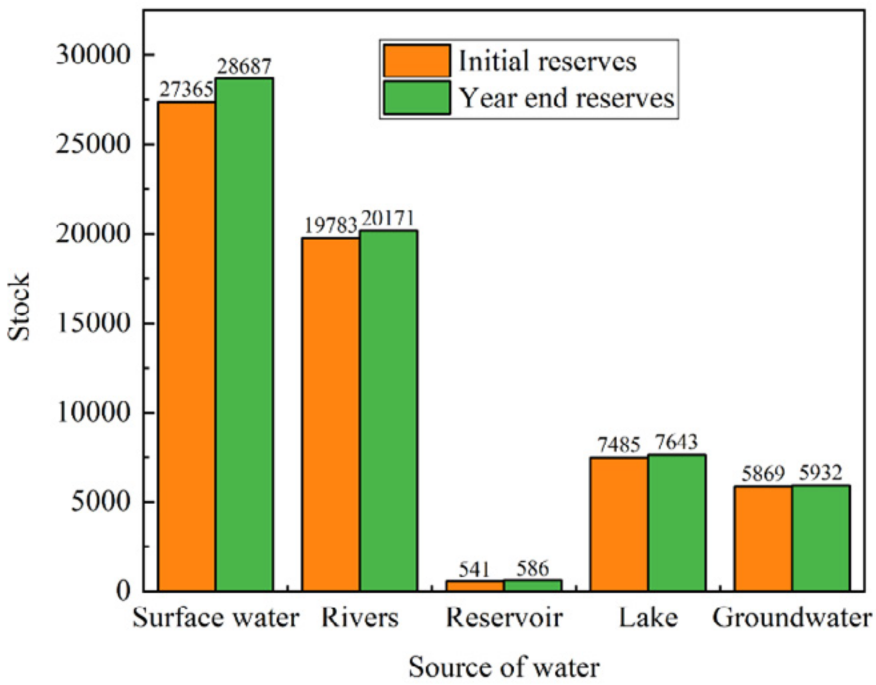

Figure 3. Changes in water resources

According to Table 3, the land increased water resources by 87,250 million cubic meters due to natural recharge such as precipitation and inflow in that year, increasing the water resources assets and the original ownership rights of water resources respectively. According to Table 3, the land reduced water resources by 85,062 million cubic meters due to natural reasons such as inflows in the current year, reducing water resources assets and original ownership rights of water resources respectively. In that year, 28 new industrial water-using units were added, the newly-added permitted water abstraction amount was 1 million cubic meters, and the agricultural water-use nuclear reduction of 9 million cubic meters of permitted water abstraction amount should be included in the original ownership rights of water resources and the

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rights and interests of water resources use respectively. In that year, the water resources fee declared and paid for agricultural water use was 40,000 yuan less than the budget, industrial water was 100,000 yuan more than the budget, and the corresponding water resources paid use of public reserves and natural resources assets were adjusted. When the lake was polluted in that year, the polluted water resources could not be used, which reduced the water resources assets, and also affected the rights and interests of the water resources owners, deducting the water resources assets and original ownership rights. The loss and treatment cost caused by the pollution of the reservoir totaled 2.2 million yuan, of which the state was responsible for the rest, except for the 1.6 million yuan penalty imposed by the polluting enterprise.

4. CONCLUSION

From the perspective of ecological civilization, this paper is based on the public statistical data of a city in my country, combined with the management data, statistical ledger and other data obtained through repeated investigations, and organizes the corresponding data on land resources, mineral resources, and water resources. The natural resource management status of natural resources shall be accounted for in natural resource rights and interests. According to the collected data, the original ownership rights and use rights of land, minerals and water resources were accounted for. The main results are as follows:

1. After calculating the impact of the transfer of land use rights on the original ownership rights and use rights of the land, the transfer of land use rights resulted in a decrease of 146.2174 hectares of the original ownership rights of the land. The transfer fee was RMB 1,279,962,400, and the closing balance of natural resources taxes and fees and land resource reserves at the end of the year was RMB 279,560,000.

2. After accounting, it was found that a certain enterprise's destructive mining of coal resources caused a loss of 300 tons of coal resources and a loss of 2 million yuan due to the destruction of coal resources. This loss reduced the available coal resources in the future. Occupation should be included in the current natural resource liabilities to make up for future resource shortages.

3. According to the calculation, it was found that the water resources in this area increased by 87,250 million cubic meters due to natural recharge such as precipitation and inflow, respectively increasing the water resources assets and the original ownership rights of water resources. In the same year, the area decreased water resources by 85,062 million cubic meters due to natural reasons such as inflows, meters, reducing water assets and original ownership interests in water resources, respectively.

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This paper takes land resources, mineral resources and water resources as the representatives to carry out the accounting of natural resources in a city, which still has some limitations. Because there are many kinds of natural resources, in the future, we will continue to complete the accounting of natural resources that are not mentioned, improve the accounting system of natural resources, and provide some theoretical guidance for the actual work.

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/08/

IOT FINANCIAL MANAGEMENT SYSTEM FOR ENERGY ENTERPRISE MANAGEMENT RISK AND PREVENTION AND CONTROL STRATEGY UNDER THE BACKGROUND OF DOUBLE CARBON

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ABSTRACT

Despite the absolute number of developments and products of enterprise management systems and platforms, there are still limited ways to achieve risk assessment of enterprise financial management by energy enterprise stakeholders. To reduce the financial management pressure of energy enterprises as well as to reduce enterprise financial risks, this paper establishes an Internet of Things(IOT) financial management system. The system was also comprehensively evaluated based on the financial risk management status of each company for the period 2016-2020. The results show that a significant increase in the share of non-current liabilities was observed after the introduction of the IOT-based financial management system in 2018. Relative to the 2017 data, the current liability ratio decreased by 2.96%, 7.98%, and 14.59% for 2018, 2019, and 2020, respectively. The ratio of corporate investments to revenue decreased by 8.74%, 22.91% and 16.83%, respectively. Investments as a percentage of earnings decreased by 6.22%, 5.48%, and 6.82%, respectively. The ratio of undistributed earnings decreased by 9.69%, 18.82% and 35.39%, respectively. Finally, the introduction of the IOT's financial management system reduced financial management costs by a factor of 2.822, 4.358 and 5.501, respectively. And the cost of managing people in an integrated manner was reduced by 2.964, 3.012 and 4.004 times respectively.

KEYWORDS

IOT engineering; financial management; low-carbon energy; risk assessment; carbon daub

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1. INTRODUCTION

Global climate change has led to sea level rise and frequent extreme weather disasters on Earth [1-2]. Biodiversity is severely affected, and global climate change has brought serious adverse impacts to human society [3-4]. More importantly, many of the adverse effects are already frequently visible and the situation is becoming increasingly critical [5]. Recent disasters such as extreme droughts and persistent forest fires due to superheated temperatures in North America, persistent heavy rains and floods in Western European countries, persistent heavy rains in many parts of northern China, and other natural disasters are most likely related to global climate change [6-7]. To actively respond to climate change, China has explicitly proposed the strategic goal of carbon peaking and carbon neutrality [8]. Carbon peaking and carbon neutrality will change China's energy and industrial structure, reducing the share of high consumption, high input, and high pollution industries [9-10]. Rather than simply sacrificing economic growth and national wealth accumulation, carbon peaking and carbon neutrality will lead to a comprehensive, coordinated, sustainable and high-quality development under carbon emission reduction constraints. The investment in "dual carbon" is both an expense and an opportunity for economic transformation and development [11]. The economic development mode will also shift to a green and sustainable development model. All activities of human society have been inseparable from energy, from clothing, food, housing and transportation to culture and entertainment, all of which consume a certain amount of energy directly or indirectly [12]. Energy is the material basis for the survival and development of human society [13]. Energy is the blood of industrial development, which drives the operation of industry-. Therefore, it is essential to achieve the goal of carbon peaking and carbon neutrality in a way that will affect the development of energy companies.

Energy as a strategic resource has a particularly important position in global economic development and has a wide and far-reaching impact on many aspects of international politics, military, science and technology [15-22]. China is not only a major energy producer but also a major consumer in the world, and with the rapid development of the Chinese economy, it is facing enormous pressure in terms of energy demand [23]. Especially under carbon-peaking and carbon-neutral policies, China's energy development model needs to be adjusted accordingly. The study of the interrelationship between the economic growth of energy companies, financial risks and the implementation of the carbon peaking policy is an important guide for the development of the national economy. Lu, S. [24] conducted an in-depth study on the impact of carbon peaking policy on energy funds, using a sample of 231 energy funds in China between 2008 and 2019, and examined the effect of carbon peaking policy on the network herding effect of energy funds as measured by hybrid network centrality, as well as the herding effect on profitability and stability. The results show that the network herding effect has a positive impact on the short-term profitability and risk-resilience of energy funds. However, the network herding effect reverses when long-term stability is tested. On the contrary, it can trigger greater systemic risks. Li, T. 25] evaluated the environmental performance of thermal power enterprises by

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considering peak carbon. They constructed an index system that comprehensively considered the whole process of environmental management of power generation enterprises and the factors affecting the environment. The environmental performance of thermal power enterprises was evaluated comprehensively by factor analysis, and then comparability of the environmental performance of power generation enterprises was achieved. This study enables timely, accurate, and comprehensive monitoring by stakeholders such as the government and the public. Cui, X 26] proposed an energy consumption prediction model based on an improved whale algorithm to optimize a linear support vector regression machine. The model combines multiple optimization methods to overcome the shortcomings of traditional models. They used the model to forecast the improvement of China's energy consumption under the peak carbon target. The results concluded that China needs to adjust its current policies to achieve the peak carbon target. Lin, J. [27] developed a three-level economic-environmental-behavioral demand response model for incentive price setting. Their model extends the analysis beyond the traditional disciplines of economic entities and incorporates new customer psychological cues. The findings suggest that through a reasonable carbon price, demand response models can be an effective tool to improve energy efficiency and decarbonization. Chen, J. [28] argued that the energy supply and demand model for China includes a planned peak scenario and an advanced peak scenario, which are designed by taking into account China's economic development, technological progress, policies, resources, and environmental capacity. In addition, they argue that decarbonization will become a fundamental feature of the structural change in energy supply and demand. The realization of the carbon peak requires the joint efforts of all industries. However, based on carbon peak realization, we need to consider the development of energy companies. With the promotion of the smart city concept, every industry in the city needs to become smarter. Ban, Y. [29] proposed an energy management system that can be used to monitor energy consumption in real-time, keep track of the company's energy consumption, and allocate the company's energy consumption. They developed two functions in the energy management system, energy allocation and energy consumption prediction, so energy companies can get better production plans, reduce their energy consumption, and improve their competitiveness. Considering the physical limitations of different energy networks, Mirzaei, M.A. [30] proposed a new entity called Multi-Energy Distribution Company. They argue that multi-energy storage systems and integrated demand response are considered to increase the flexibility of multi-energy distribution companies to serve multiple energy demands. Wang, L. [31] analyzed supply chain financing and blockchain technology for energy companies based on theoretical studies. They analyzed the management system, cash flow, and risk control system of the supply chain in the context of the current specifics of blockchain in supply chain financing. The results show that the supply chain financing parties of energy enterprises can optimize the supply chain financing risk control system while reducing business costs and improving enterprise efficiency, which greatly reduces the risk of the supply chain financing parties of energy enterprises and thus improves the competitiveness of enterprises. Zhang, X. [32] argues that effective financial management of prepayment is an important option for service providers and customers' financial IoT. They propose a scalable accounting solution where each user where the hosting user is located occupies a prepaid account that forms part of an embedded system, thus better serving each financial customer and reducing financial risk. From the above analysis, we can see that the realization of the carbon peak requires the joint efforts of all industries. The implementation of the peak carbon policy has a significant impact on the economic profitability of energy companies and the structure of energy sales. Therefore, in the context of the carbon peak, energy companies need to be prepared in advance for the arrival of financial risks and to do a good job of prevention and control.

The financial management risks and prevention and control of energy enterprises need to control and manage the financial risks and financial crises that may occur in advance. The traditional financial risk and financial crisis control and management methods have some shortcomings, such as low efficiency, slow speed, high accuracy and so on. Therefore, in this study, we introduce the Internet of Things financial management system to unify the management and prevention of financial management risks of energy enterprises. It focuses on the financial management of energy enterprises, financial risk assessment of energy enterprises, financial statistical statements of energy enterprises, basic financial data of energy enterprises, financial query of energy enterprises and protection of financial management system of energy enterprises. We hope our research can contribute to reducing the financial risks of energy enterprises and improving the core competitiveness of energy enterprises in the context of the carbon peak.

2. OVERVIEW OF THE INTERNET OF THINGS (IOT) FINANCIAL MANAGEMENT SYSTEM

With the increasing complexity of the financial management of energy enterprises, this study provides unified management of energy enterprise finance by enterprises and institutions through IOT financial management system. IOT financial management system is a study of risk and prevention and control strategies of energy enterprise financial management based on the background of Carbon Dafeng and the comprehensive use of modern information technology, and there are unique designs and innovations in all stages of IOT financial management system [33, 34]. The main manifestations are as follows.

1. Advanced. Through the IOT financial management system, most of the operations such as asset transfer, allocation and contract information signing in the past financial management of energy enterprises are dispersed to various departments of energy enterprises to complete, which makes the financial management of energy enterprises less stressful and makes the work risk of the original enterprise financial management reduced.
2. Structured. the IOT financial management system is based on the current financial management system of energy enterprises and the prevalent unit

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establishment status, based on a tree structure for an intuitive representation of financial management, eliminating the authority of the internal level of energy enterprises and maximizing the time saving of energy enterprise finance operations.

3. Comprehensiveness. the IOT financial management system can handle different types of management affairs in parallel by incorporating the financial management risks in the context of carbon peak into the financial management system for unified management, which not only facilitates the operation of enterprise personnel but also can reflect the financial management status of energy enterprises comprehensively.

2.1. THE FUNCTIONAL DIVISION OF THE IOT FINANCIAL MANAGEMENT SYSTEM

IOT financial management systems can be divided into client, server and mobile through C/S architecture. The client side of the IOT financial management system is mainly divided into four functional modules: financial management of energy enterprises, financial risk assessment of energy enterprises, financial statistics and reports of energy enterprises, and basic financial data of energy enterprises. The IOT financial management system is divided into two functional modules, namely, downloading financial information of energy enterprises and returning financial information of energy enterprises.

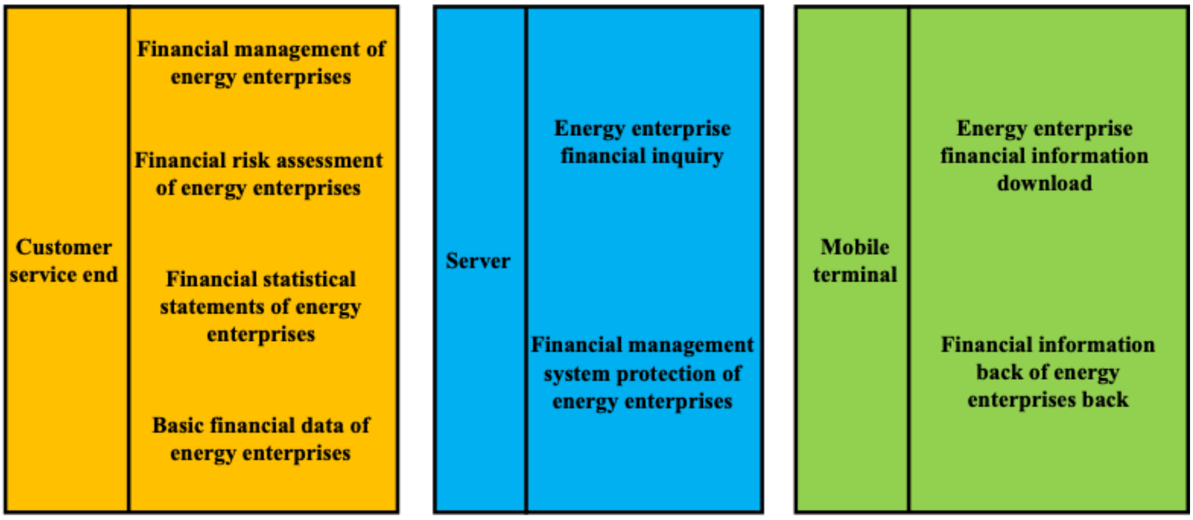

Figure 1. The functional division of IOT financial management system

2.2. MAIN MODULE FUNCTIONAL DESCRIPTION

IOT's financial management system will manage the finance of energy enterprises comprehensively, including: financial information registration, financial information inventory, financial contract changes, financial depreciation and financial information reports, a total of five major functions.

1. Financial information registration. Users register the financial information of energy enterprises and institutions through mobile smart devices and transmit the data back to the database of the IOT financial management system through Web Service, and then improve the user details through financial information registration, which provides convenience for the management of back-end technicians of energy enterprises.

2. Financial information inventory: IOT financial management system takes inventory of financial information, replacing the time-consuming and laborious manual financial information inventory and tedious financial data recording, saving the labor cost and time cost of financial data inventory.

3. Financial contract changes, IOT financial management system facilitates the processing of changes to the important information of financial contracts and is used to record the changes of information after the review of energy company leaders.

4. Financial depreciation, IOT financial management system for automatic depreciation of financial data, the user only needs to regularly upload the data, eliminating the work of manual calculation and reduce the calculation of human error in the process of calculation, not only to reduce the data depreciation processing time but also to improve the accuracy of depreciation calculation rate.

5. Financial information report: IOT financial management system organizes the collected financial information and provides report service for energy enterprise management certificate so that managers can understand the information about fixed assets at all times.

2.3. USER CHARACTERISTICS AND SYSTEM APPLICATION SCENARIOS

The basic features of the IOT financial management system established in this paper are that it requires a simple operation to achieve its expected results, has a simple user interface, and practical office functions. The main objective of the IOT financial management system is to reduce the financial management pressure of energy companies and reduce the financial management risks of the companies.

Based on the background of Carbon Dafeng, we conclude that the IOT financial management system needs to achieve two major functions: identity identification and information query. The former, through the electronic tags attached to the various types of finances of energy enterprises, realize the scientific classification of the finances of energy enterprises, as well as the detailed financial information records and the identification of energy enterprise employees. It is convenient for the relevant personnel of energy enterprises to assess the enterprise's financial management risks and put forward prevention and control strategies.

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3. INDICATOR WEIGHTING

This paper uses an analytic hierarchy process to calculate the weight of each index in the evaluation system [35, 36]. By sending questionnaires to 100 experts in the field of financial management risks and prevention and control strategies, the importance of the selected factors was compared. See Table 1 for the scores of financial management evaluation indicators of energy enterprises.

Table 1. Scoring of financial management evaluation indicators of energy enterprises

Financial evaluation indicators	Capital concentration capacity	Business Service Capability	Profitability	Risk Management Capability
Capital concentration capacity	2	3	4	2
Business Service Capability	1	4	1	5
Profitability	4/5	2	3	1
Risk Management Capability	1	3	4	2

In summary, the judgment matrix of the financial evaluation indicators and the first-tier indicators of capital concentration capacity, operating service capacity, profitability, and risk management capacity are as follows.

$$A_1 = \begin{bmatrix} 2 & 3 & 4 & 2 \\ 1 & 4 & 1 & 5 \\ \frac{4}{5} & 2 & 3 & 1 \\ 1 & 3 & 4 & 2 \end{bmatrix} \quad (1)$$

Among them, A1 is the financial evaluation index. This paper calculates the product of each row element of judgment matrix A1 based on hierarchical analysis and calculates its n root , and the calculation process is as follows.

$$Ai = \prod a_{ij} \quad (2)$$

$$\bar{A}_i = \sqrt[n]{A_i} \quad (3)$$

Where a_{ij} is the element of the i row and j column of the judgment matrix A_1. We obtain the corresponding weight coefficients by summing up the square roots of the above equation.

4. ANALYSIS AND DISCUSSION

Among the economic control tools that drive the energy revolution, energy companies of all types prefer to have active and motivated employees and policy regulation within their own companies. Despite the absolute number of information

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and advice and control tools, there are still relatively limited and few ways to build a unified information and control system that allows energy companies to assess the risks of corporate financial management and propose prevention and control strategies for their personnel. It is still in the stage of development, but all of the employee engagement-type policy tools are distributed in this area. On the road to promoting low-carbon energy transition, the country hopes that energy-based enterprises will also take the initiative to participate and jointly promote the goal of carbon peak and carbon neutral strategy. Since the green and low-carbon transition of industries is mainly done by organizations such as enterprises, it is more direct and efficient to use more rigid policy tools such as regulation. In addition, energy enterprises hope that by providing a good business environment, political environment, legal environment, etc., the employees of enterprises and also the development team will vigorously carry out scientific and technological research and innovation in the field of energy-saving technology, carbon sink technology, etc., to promote the better implementation of the Carbon Dafeng carbon neutral policy.

Therefore, this paper establishes an IOT financial management system to reduce the financial management pressure of energy enterprises as well as to reduce the financial risks of enterprises. At the same time, it can also facilitate the personnel of energy enterprises to assess the enterprise's financial management risks and propose prevention and control strategies. In the analysis of this section, we conducted pilot experiments for several representative energy enterprises in Guangdong Province, China. We replace the financial management system of the target pilot energy enterprises with the IOT financial management system proposed in this paper and count the current status of financial risk management of each enterprise in the period of 2016-2020. The detailed aspects of the statistics are collected and assessed at four levels: financing, investment, operation and revenue distribution. We not only use a combination of statement analysis and indicator analysis but also will use a combination of horizontal and vertical comparisons.

4.1. IOT-BASED RISK ASSESSMENT IMPACT

Specifically, we put the built IOT financial management system to test at the pilot company in 2018, and collected and comprehensively evaluated data at four levels: funding, investment, operation and revenue distribution of the company. The results are shown in Figure 2. It is worth noting that in order to analyze the financial management of energy companies in the context of carbon peaking, several new energy companies are analyzed in this paper. Among them are representative new energy technology companies such as electrochemical energy storage, solar energy utilization and air energy storage. In terms of financing risk, the scale of liabilities of selected energy companies gradually expands in 2016-2020, with both current and non-current liabilities increasing in amount. However, in terms of the percentage of total liabilities, it is clear that energy companies are still dominated by current liabilities. In both 2016 and 2017, the proportion of current liabilities of enterprises reached more than 95%, which makes the financing means of enterprises relatively single. and leads to a higher risk of financing. And after the introduction of the IOT-based financial management system in 2018, a significant increase in the share of non-current liabilities was observed. Relative to the data from 2017, the share of current liabilities decreases by 2.96%, 7.98% and 14.59% in 2018, 2019 as well as 2020, respectively. As new energy technology is currently in a market with large economic and product fluctuations, the reduction in current liabilities is more beneficial to the long-term development of new energy technology companies in the current economic and policy context of China new energy companies. And the fixed liabilities that can be transformed into state funds are more conducive to the stability of new energy company financing. In conclusion, the IOT-based financial management system makes the financing structure of new energy companies more reasonable.

In terms of investment, it was observed that the corporate investment-to-revenue ratio was around 80% in both 2016 and 2017. And after the introduction of the IOT-based financial management system in 2018, the corporate investment-to-revenue ratio steadily increased year by year. Relative to the data in 2017, the investment-to-revenue ratio decreases by 8.74%, 22.91%, and 16.83% in 2018, 2019, and 2020, respectively. While 2020 saw a decline in the company's revenue-to-investment ratio due to the epidemic, the IOT-based financial management system still enabled revenue improvement to be maintained at a high level. This is also due to the volatility of traditional energy sources at the moment and the world's focus on new energy technologies in the context of carbon peaking.

In terms of operations, it was observed that the percentage of corporate current assets was as high as 88.5% in 2016, while it increased to 92.27% in 2017. In contrast, after the introduction of the IOT-based financial management system in 2018, the percentage of corporate current assets decreases and stabilizes year by year. Relative to the data from 2017, the investment-to-revenue ratio decreases by 6.22%, 5.48% and 6.82% for 2018, 2019 and 2020, respectively. In terms of earnings distribution, after the introduction of the IOT-based financial management system in 2018, the company's undistributed profit ratio decreases year by year. Compared to the data from 2017, the percentage of undistributed profit decreases by 9.69%, 18.82% and 35.39% in 2018, 2019 and 2020, respectively. This indicates that the IOT-based financial management system has led to a more rational structure of anti-disturbance and earnings distribution in the operation of the company, and the risk is significantly reduced.

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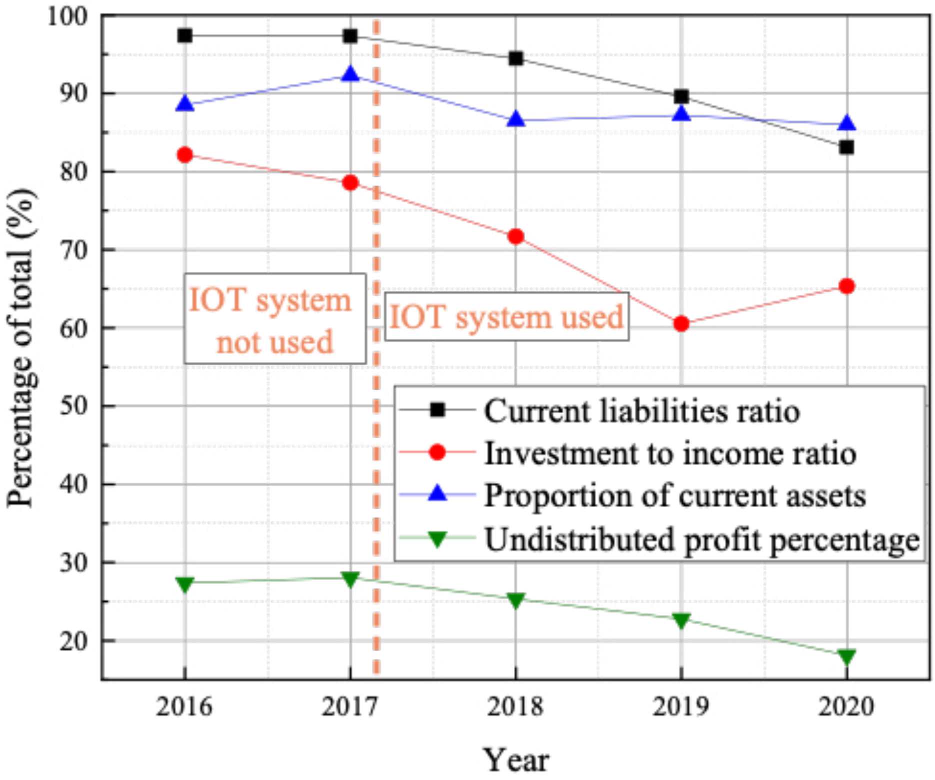

Figure 2. Impact of IOT financial management system on various financial indicators of the enterprise

4.2. THE OVERALL IMPACT OF IOT-BASED BUSINESS DEVELOPMENT

After collecting and comprehensively evaluating data at four levels of funding, investment, operations, and revenue distribution for pilot companies within the energy industry from 2016-2020, we then evaluated the entire enterprise based on its exhibition to determine the impact of the IOT-based financial management system on the overall financial management of the enterprise. We collected the mean values of financial management, integrated personnel management, and overall profit over the years 2016-2020 for several pilot enterprises in Guangdong Province, and the results are shown in Figure 3. It is observed that in terms of financial management and integrated personnel management, the capital spent on both in 2016 and 2017 remains high under the old management system, which results in the enterprises spending a lot of money on the management of financial and personnel aspects that are not related to the energy industry. At the same time, the average profit of the company was not high during the two years. Therefore, this poses a great challenge and difficulty for the development of the company. In contrast, after the introduction of the IOT-based financial management system in 2018, a very significant reduction in the funds consumed for financial management and integrated personnel management was observed. Compared to the data from 2017, the financial management costs in

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2018, 2019 and 2020 are 2.822, 4.358 and 5.501 times lower, respectively. And the money consumed for integrated personnel management is 2.964 times, 3.012 times and 4.004 times lower, respectively. This shows that the introduction, use and development of the IOT-based financial management system has made the overall management of funds more efficient and scientific, and the costs have been significantly reduced.

Finally, in terms of overall profit averages, it is observed that the average net profit of new energy technology companies has been steadily increasing year by year. This indicates that the introduction, use and development of the IOT-based financial management system has not affected the profit development of the companies, but the cost of management has been significantly reduced. This is more conducive to the current younger new energy technology companies to have more capital and time to develop their own energy conversion and utilization technologies and make longer-term investments for a low-carbon future.

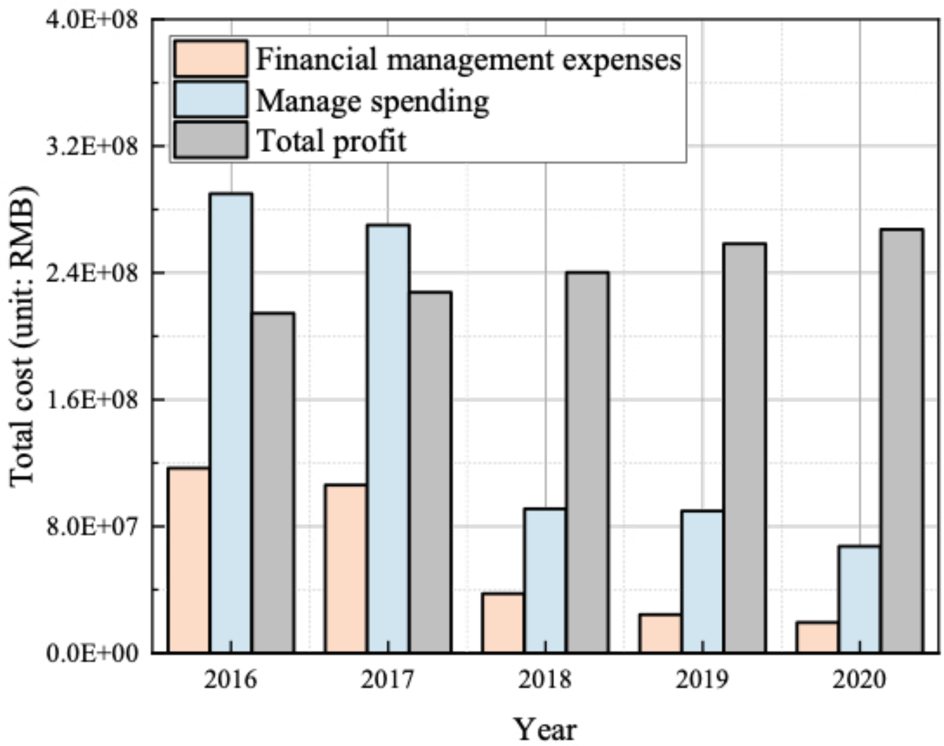

Figure 3. IOT financial management system on the overall capital impact of the enterprise

5. CONCLUSION

Despite the absolute number of developments and products of enterprise management systems and platforms, there are still relatively limited and few ways to build a unified information and control system that can enable energy enterprise stakeholders to assess enterprise financial management risks and propose prevention

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and control strategies. In this paper, we establish an IOT financial management system to reduce the financial management pressure of energy enterprises and reduce the financial risks of enterprises. At the same time, it can also facilitate the personnel of energy companies to assess the financial management risks and propose prevention and control strategies. We conducted a pilot experiment for several representative energy enterprises in Guangdong Province, China. We replace the financial management system of the target pilot energy enterprises with the IOT financial management system proposed in this paper and count the current status of financial risk management of each enterprise in the period of 2016-2020. The conclusions are as follows.

1. After the introduction of the IOT-based financial management system in 2018, a significant increase in the percentage of non-current liabilities was observed. Relative to the 2017 data, the percentage of current liabilities decreased by 2.96%, 7.98%, and 14.59% for 2018, 2019, and 2020, respectively. The corporate investment-to-earnings ratio decreased by 8.74%, 22.91% as well as 16.83%, respectively.

2. It is observed that the corporate current assets ratio was as high as 88.5% in 2016, while it increased to 92.27% in 2017. In contrast, after the introduction of the IOT-based financial management system in 2018, the investment-to-revenue ratio decreases by 6.22%, 5.48%, and 6.82% in 2018, 2019, and 2020, respectively. The ratio of undistributed earnings is reduced by 9.69%, 18.82%, and 35.39%, respectively. This indicates that the IOT-based financial management system has led to a more rational structure of anti-disturbance and revenue distribution in operations, and the risk is significantly reduced.

3. After the introduction of the IOT-based financial management system in 2018, a very significant reduction in the funds consumed for financial management and integrated personnel management was observed. Compared to the data from 2017, the financial management expenses are reduced by 2.822 times, 4.358 times and 5.501 times in 2018, 2019 and 2020, respectively. And the money consumed for integrated personnel management is 2.964 times, 3.012 times and 4.004 times lower, respectively. This shows that the introduction, use, and development of the IOT-based financial management system has made the overall management of funds more efficient and scientific, and the costs have been significantly reduced.

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STUDY ON THE COUPLED AND COORDINATED DEVELOPMENT OF VILLAGE CULTURAL INDUSTRY AND ECOLOGICAL ENVIRONMENT IN THE CONTEXT OF RURAL REVITALIZATION

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ABSTRACT

The development and transformation of the ecological environment is an important content and future indicator of global environmental change. At the same time, people of all countries are affected by comprehensive human factors such as local and local cultural industries and humanistic thoughts while jointly protecting the environment. This paper studies the coupling relationship between the development of village cultural industry and ecological environment changes and comprehensively considers the aspects of detecting regional ecological environment changes, optimizing cultural industry facilities, coordinating regional sustainable development, and constructing regional ecological security patterns in the context of rural revitalization. The results showed that the vegetation or forest coverage increased by 9.2%, 17.4%, 28.1% and 30.5% respectively under the cultural industry protection levels of 2-5. The air pollution index decreased by 11.2%, 17.9%, 25.2% and 30.3% respectively, and the pollution of river water resources decreased by 4.1%, 6.6%, 8.9% and 11.1% respectively. The comprehensive ecological environment development index increased by 9.43%, 17.41%, 28.59%, 30.48%, 31.61%, 33.22%, 34.80%, 35.71% and 36.27% respectively under the cultural industry development level of 2-10. Overall, the cultural relics protection strategy of the village cultural industry under the background of rural revitalization has significantly promoted the comprehensive ecological environment in the entire planned area.

KEYWORDS

rural revitalization; cultural industry development; ecological environment; coupling structure; comprehensive development.

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1. INTRODUCTION

Rural revitalization is the basic project of a country's modernization [1,2]. For China, rural issues are even more fundamental to development [3,4]. Ensuring food security, narrowing the gap between the rich and the poor, protecting the ecological environment, enhancing cultural confidence, and promoting sustainable and stable economic growth [5,6] are all inseparable from rural revitalization. Rural revitalization mainly includes the following aspects, as shown in Table 1: it mainly includes talent revitalization [7], cultural industry revitalization [8], and ecological environment revitalization [9]. The development of rural revitalization cannot be separated from innovation, and innovation cannot be supported by talent [10]. Village culture is a valuable treasure of Chinese culture. It is an important part of the development history of Chinese culture and an important soft power for China [11,12]. A good ecological environment has a positive effect on human development. A place of water and soil nurtures a person, and the temperament of nature and human temperament often have the characteristic of mutual nurturing. A good ecological environment inevitably contributes to the formation of a good human temperament [13]. Protecting the ecological environment is equal to protecting the resources that can be used in the future [14], which is conducive to the sustainable development of national resources. Most importantly, in carrying out rural revitalization, we must adhere to the priority development of agriculture and rural areas. According to the general requirements of prosperous industry, ecological livability, civilized countryside, effective governance, and affluent living, we will accelerate the modernization of agriculture and rural areas. The key and focus of rural revitalization is industrial revitalization. Only when the rural industry is revitalized can more jobs and positions be created, and a sustainable and stable channel for farmers to increase their income and rural affluence can be developed. The cultural industry is an important part of rural revitalization. It is very meaningful to realize the coupled and coordinated development of village cultural industry and ecological environment for rural revitalization.

Table 1. Main contents of rural revitalization

Content	Features
Talent Revitalization	Talent is the basic driving force of rural revitalization development
Cultural Industry Revitalization	Cultural dynamics is the deep and lasting power of rural revitalization
Ecological revitalization	Focus on regional characteristics, respect local ecological differences, reflect the diversity of characteristics

For the present, studies on the culture of village industry related to the ecological environment have also received much attention. Village revitalization is an inevitable requirement for China to achieve the great rejuvenation of the Chinese nation. Zhang, T. [15] analyzed the characteristic village revitalization in the context of China's rural revitalization strategy with historical and cultural accumulation, climatic characteristics and residential lifestyle [16]. Their improved vernacular residential model has better regional adaptability and echoes the local living culture and habits. Further, the study not only has a positive effect on the preservation of local architectural culture but also plays a crucial role in improving the living standard of residents. Huang, Y. [17] started their study from within the village to reveal the rural transformation process in placemaking theory from a micro perspective. Their research shows that the relationship between people and land can be reconciled in the process of place-making. Yang, S.X. [18] applied technology analysis to update China's understanding of the site and the technological [19,20] economic behavior of the cultural industry in the Loess Plateau region. Ye, C. [21] presented the spatial production of rural culture in three dimensions: ideational space, superficial space, and daily life space based on the theory of spatial production, and analyzed the rural culture The reasons for the gradual decline of rural culture. Culture is the root of rural development. A lost culture leads to a lost village. They argue that adequate daily living space is important for the flourishing of rural culture. In a study by Chen, Z. [22], they proposed cultural heritage as a resource for development in many rural areas in China. They collected data through participant observation [23,24] as well as conducting a series of unstructured and semi-structured interviews. Arguing how cultural heritage as rural economic development involves the entanglement and interplay of various powers, Wodarczyk-Marciniak, R. argued [25] that current patterns of agricultural intensification pose a threat to traditional agricultural landscapes through landscape simplification [26] and lead to the loss of biodiversity, ecological functions and key ecosystem services in rural areas [27]. Therefore, in rural revitalization, more attention needs to be paid to ecological protection. Jiang, Y. [28] first explored the theoretical and practical model of land remediation for rural development from the perspective of multifunctional land use [29] and explored its intrinsic mechanism. They argued that land remediation contributes to rural development by changing the type and intensity of rural land use functions and by studying the industrial structure, ecological environment, and cultural construction. The ecological approach to agriculture has received increasing attention in rural development, and the ecological approach has been demonstrated mainly in the multifunctionality discourse [30]. Xie, J. [31] showed that soil degradation and water pollution associated with excessive use of chemical fertilizers, pesticides and agricultural films lead to serious ecological problems. Duan, Y. [32] concluded that accurate identification of the rural "production-life-ecology" space is important for optimizing rural space in China. They based their research on participatory mapping, semi-structured interviews, and spatial analysis techniques to promote rural ecological protection and economic development. We have synthesized the studies of scholars related to village industrial development and the ecological environment. We find that for village revitalization, the development of the village industry is one of the important links. Culture is the root of rural development and culture is the soul of villages. By promoting the development of cultural industries in rural villages and forming cultural industries with various characteristics, we can provide lasting power to rural revitalization. In addition, we need both rural revitalization and a good living and living environment. Rural revitalization cannot be done at the cost of the ecological environment.

Achieving rural revitalization is a great initiative that has never been done before or since. The revitalization of the countryside encompasses all aspects. For cultural revitalization, the countryside in China has created a glorious farming civilization, and the excellent traditional culture accumulated in history relies on the maintenance and inheritance of the rural society. For ecological revitalization, the environment is the foundation on which our survival depends. However, in previous research work, they often isolated the cultural industry revitalization of rural villages from the ecological environment for research. Therefore, in our research, we coupled the village cultural industry with the ecological environment. We fully consider the revitalization of the cultural industry while taking into account the revitalization of the ecological environment, and explore the way of coordinated development of the cultural industry and ecological environment.

2. CURRENT SITUATION OF THE VILLAGE CULTURE INDUSTRY UNDER THE STRATEGY OF RURAL REVITALIZATION

2.1. ENCOURAGE VILLAGE ABORIGINES TO PARTICIPATE IN THE TRANSMISSION OF VILLAGE CULTURAL INDUSTRIES

To further strengthen the promotion of the training program for the indigenous people of traditional village culture industry, it is necessary to educate a lot of ideas and cultivate generations of indigenous people who are interested in traditional village culture industry, are inculcated by traditional village culture industry, and strengthen the inheritance and maintenance of traditional village culture industry, to stimulate the initiative of the indigenous people of traditional village culture industry to inherit traditional village culture industry and call for the indigenous people of traditional village culture industry to pursue traditional village culture industry, as shown in Figure 1.

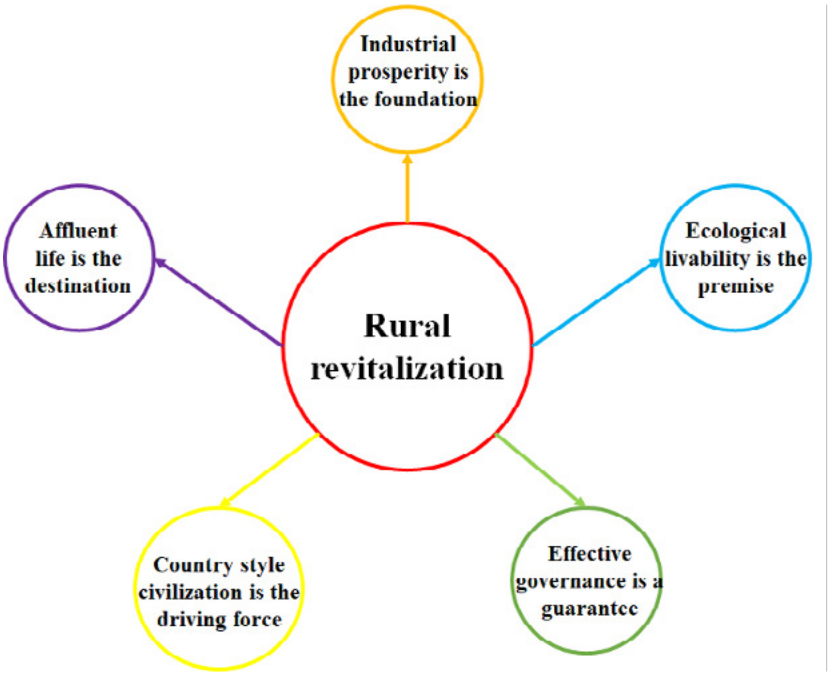

Figure 1. Village cultural industry and ecological environment coupled and coordinated development map

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In addition, through a large number of media to promote the traditional village cultural industry, to mobilize the traditional village cultural industry aborigines to the traditional village cultural industry. This further promotes the vast number of indigenous people of the traditional village culture industry to join the great cause of inheriting and maintaining the traditional village culture industry. In the process of promoting the traditional village culture industry, we deeply strengthen the impression of excellent village traditional culture industry to the aborigines of traditional village culture industry. We internalize the excellent village traditional culture industry in the hearts of the indigenous people of the traditional village culture industry by making the excellent village traditional culture industry. In this way, we can make the excellent village traditional cultural industry outwardly visible in the behavior of the indigenous people of the traditional village cultural industry, and strengthen the inheritance and maintenance of the traditional village cultural industry.

Finally, it is the social elites coming out of the villages that are the main support for realizing the traditional village cultural industry; they have a large amount of social resources and have a unique understanding of the traditional village cultural industry. Therefore, we can make use of the advantages of village elite talents to make reasonable planning for traditional village cultural industry resources, plan parallel development paths of inheritance, protection, development and utilization, and vigorously promote the sustainable development of traditional village cultural industry. With the construction of roads and traffic, industrial upgrading and old village renovation, traditional villages will not only undergo a radical change in their environment but will also inevitably attract a large number of high-quality talents and contribute to the enhancement of the land value of the area.

2.2. THE MARKET DRIVES THE HERITAGE OF THE VILLAGE CULTURE INDUSTRY

It is worth mentioning that traditional villages are rich in characteristic food, manufacturing, handicraft and other vernacular industrial resources, and the innovative development of the village handicraft industry is an important force to realize the revitalization of traditional villages. The social market is the main core of the traditional village cultural industry, which plays an important role as a bridge between the city and the traditional village cultural industry, and between consumers and the indigenous people of the traditional village cultural industry, and also has the irreplaceable position of the unified village cultural industry to realize the inheritance and innovation of the traditional village culture. Therefore, the market should characterize the ecological environment, historical relics, traditional agriculture, handicraft, folk culture and other resource endowments of traditional villages. Further, the market allows the indigenous people of the cultural industry of traditional villages to obtain higher economic returns through this, giving rise to a strong endogenous impetus for the protection of traditional villages. Adapting to the new changes of diversified market demands, we create new types of agriculture such as ecological agriculture, scientific and technological agriculture, creative agriculture and leisure and health agriculture. Thus, we can promote the transformation of agriculture in

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traditional villages from a single production-oriented business to a new market-oriented business with diversified and integrated development.

2.3. THE GOVERNMENT DOES A GOOD JOB OF GUARANTEEING THE CULTURAL INDUSTRY

Emphasize and strengthen the leading role of government departments, promote the construction of relevant policies and laws and regulations, provide strong political guarantees for the inheritance of traditional village culture, and ensure the stability, effectiveness and long-term nature of cultural inheritance work. Second, promote the construction of the village culture heritage development system. Good project off, in conjunction with the District Party Committee Propaganda Department, District Justice Bureau, and District Culture and Tourism Bureau together on the project selection process and conditions, the use of the fund's management agreement signed and other aspects of the gatekeeper. To keep the funds, the proposed support projects for financial settlement evaluation, according to the evaluation amount by the principles of support determine the support funds. At the same time, the government should also accelerate the standardization and equalization of basic public cultural services to achieve the goal.

2.4. ECOLOGICAL ENVIRONMENT QUALITY EVALUATION

Eco-environmental quality is a comprehensive concept that is put forward after a series of eco-environmental problems have occurred in natural factors or human production and living activities. It is used to measure the scope, degree, advantages and disadvantages of human activities in the ecological environment.

2.4.1. GREENNESS INDEX

Normalized vegetation index ($NDVI$) is one of the most widely used indexes in multi vegetation index. It is widely used in analyzing crop growth, vegetation coverage and spatial distribution.

$$NDVI = \frac{(\rho 4 - \rho 3)}{(\rho 4 + \rho 3)} \tag{1}$$

Among them, $\rho 4$ and $\rho 3$ represent the reflectance of the near-infrared band and visible red band respectively. $NDVI$ value represents the vegetation status of the basin. The larger the normalized $NDVI$ value is, the higher the vegetation coverage is.

2.4.2. HUMIDITY INDEX

The humidity component is widely used in ecological environment monitoring, which can not only represent the water resource status of regional rivers and

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reservoirs but also calculate the humidity of land use types such as cultivated land and forest land.

$$Wet = 0.0315\rho1 + 0.2021\rho2 + 0.3102\rho3 + 0.1594\rho4 - 0.6806\rho5 - 0.6109\rho7 \quad (2)$$

Among them, ρ_i is the reflectivity of TM bands. After normalization, the higher the wet value, the greater the humidity.

2.5. COUPLED EVALUATION MODEL

2.5.1. DEVELOPMENT DEGREE(T)

The material culture protection assessment is composed of the number of cultural relics protected items, the degree of restoration, and the completeness of cultural relics background knowledge, which can be established as follows:

$$A = w_1B + w_2C + w_3D \quad (3)$$

Where A is the material culture protection assessment, B is the degree of restoration and D is the completeness of cultural relics background knowledge. w_1, w_2 and w_3 are the weights for each variable are equal to 0.4, 0.4 and 0.2, respectively.

Development degree refers to the comprehensive development level of economic development and ecological environmental protection, reflecting the overall benefits of both. The expression of its function is as follows.

$$T = af(x) + bg(y) \quad (4)$$

Where a and b denote the weights of economic development and ecological environmental protection indicators respectively. $f(x)$ and $g(y)$ denote the economic quality index and ecological environmental protection index respectively.

2.5.2. COUPLING DEGREE (C).

The coupling degree can measure the coupling development degree of economic development and ecological environmental protection, and its function is as follows.

$$C = 2\sqrt{\left((f(x) \cdot g(y))/(f(x) + g(y))^2\right)} \quad (5)$$

Where a larger value of C indicates that the two are more coupled.

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2.5.3. DEGREE OF COORDINATION (D).

The coordination degree integrates the development degree and coupling degree, which is characterized by high stability and can be used to measure the coordinated development of the research object.

$$D = \sqrt{C \cdot T} \tag{6}$$

3. THE CURRENT SITUATION OF THE ECOLOGICAL ENVIRONMENT UNDER THE STRATEGY OF RURAL REVITALIZATION

Rural ecological environment governance and the implementation of the rural revitalization strategy promote each other. Rural ecological environment governance is not only an important way to implement the rural revitalization strategy but also its due meaning. The relationship between the two is mutually reinforcing and can also produce a positive multiplier effect. Promote rural ecological revitalization, and build beautiful villages with clean and beautiful living environments, stable and healthy ecosystems, and harmonious coexistence between humans and nature. In addition, farmers' weak awareness of environmental protection and the limited ability of NGOs to participate in governance cannot be ignored. To promote the governance of the rural ecological environment and realize the comprehensive revitalization of the rural society, there is an urgent need for "stakeholders" such as local enterprises, farmers, NGOs, and rural communities to perform their respective functions under the leadership of the local government, and "multiple governances". Among them, the local government should take the responsibility of "leading"; local enterprises should strengthen the social responsibility of protecting the rural ecological environment; farmers should enhance their awareness of the main body of governance; NGOs should improve their ability to participate in the governance of rural ecological environment; The "main position" of ecological environment governance. Rural communities should give full play to the "home field" advantage of ecological environment governance.

4. ANALYSIS AND DISCUSSION

In recent years, more and more attention has been paid to the ecological environment, which is in line with the intent of the Paris Agreement, the global climate and carbon emissions, and other environmental factors. The development and transformation of the ecological environment is therefore an important element of global environmental change and an indicator of the future. At the same time, the common protection of the environment by all peoples is influenced by a combination of human factors such as local and local cultural industries and humanistic thinking. Local cultural industries are inextricably linked to the sustainable development of the environment and ecology and the further rational development of agricultural land and the increase of construction land for better social and economic development. Therefore, by using the active promotion of humanistic village cultural industries and

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the active control of environmental ecology, we can further realize the coupled development under rural revitalization. At the same time, the passive properties of the above two main factors confer a passive gain effect in the regulation, which is expected to make the future integrated development a positive cycle in nature. A large number of previous studies have been conducted on different scales and contexts. The results show that there is a complex dynamic coupling relationship between the two, that changes in land use and ecological service values are bound to bring about changes in one or the other, and that the village cultural industry is one of the important drivers of ecological change, and that the transformation of the village cultural industry leads to changes in its service values by changing the structure and function of the ecosystem. Therefore, studying the coupling relationship between cultural industry transformation and ecological environment change in villages is of considerable critical practical significance for detecting regional ecological environment change, optimizing cultural industry facilities, coordinating regional sustainable development and constructing regional ecological security patterns in the context of rural revitalization.

And the cultural revitalization in the rural revitalization strategy has created positive and remarkable innovations in China's rural construction. The excellent traditional culture accumulated in history relies on the maintenance and transmission of rural society. For ecological revitalization, the environment is the basis on which we live. However, in previous research work, they often studied the revitalization of rural village cultural industries in isolation from the ecological environment. Therefore, in our study, we coupled the cultural industry and ecological environment of villages together. We fully consider the revitalization of the cultural industry while taking into account the revitalization of the ecological environment, and explore the way of coordinated development of the cultural industry and ecological environment.

4.1. THE IMPACT OF CULTURAL CONSERVATION ON THE ECOLOGICAL ENVIRONMENT

First, we considered the important and significant change variables in the development of village cultural industry in the context of rural revitalization. We selected two major regions of Ganzi and Aba in Sichuan Province for a specific analysis related to the coupled development relationship between the village cultural industry and the ecological environment. The variables involved in the analysis are the combined effects of material and non-material cultural conservation on the comprehensive ecological environment evaluation index. Among them, the material culture protection assessment is composed of the number of cultural relics protected items, the degree of restoration and the completeness of cultural relics background knowledge are calculated by weights, and the weights are 0.4, 0.4 and 0.2 respectively. Similarly, the assessment of intangible cultural protection is composed of the frequency of holding cultural evenings, the number of Internet APP broadcasts, and the integrity of the cultural network. The weights are 0.4, 0.2, and 0.4, respectively. As for the comprehensive index of ecological environment, we considered the vegetation coverage rate of the area near the cultural industry of each village, the pollution degree of water resources of rivers and the air pollution index.

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For the comprehensive index of the ecological environment, we considered comprehensive factors such as the vegetation coverage rate in the vicinity of each village's cultural industry, the pollution degree of river water resources, and the air pollution index. The way to obtain these parameters comes from the statistics of government platforms in Sichuan Province from 2018 to 2020. The results are shown in Figure 2. It is observed that the vegetation coverage rate of the comprehensive evaluation index of the ecological environment increases with the increase of the protection degree of cultural relics, while the pollution degree of river water resources and the air pollution index decrease with the increase of the protection degree of cultural relics. In general, the ecological environment in the vicinity of the village cultural heritage sites increased significantly with the increase in the level of protection of cultural heritage in the village cultural industry. Specifically, the vegetation or forest cover of the surrounding areas increased by 9.2%, 17.4%, 28.1%, and 30.5%, respectively, under the cultural industry protection level of 2, 3, 4, and 5, compared to the cultural industry protection level of 1, with an average rate of increase of about 10% with the cultural industry protection level. At the same time, the air pollution index decreased by 11.2%, 17.9%, 25.2% and 30.3% under the cultural industry protection level of 2, 3, 4 and 5, respectively, with an average reduction rate of about 8% with the cultural industry protection level. In addition, the pollution level of river water resources decreases by 4.1%, 6.6%, 8.9% and 11.1% under the cultural industry protection level of 2, 3, 4 and 5, respectively, with an average reduction rate of about 3% with the cultural industry protection level. The results of the integrated environmental index with the degree of cultural protection are shown in Figure 3, where it is observed that the integrated ecological index increases by 17.32%, 24.27%, 29.99%, and 32.44% under the overall cultural industry protection degree of rank 2, 3, 4, and 5, respectively.

The overall situation shows that the local government and related organizations attach importance to tangible and intangible cultural heritage as well as policy implementation is reflected, which is reflected at a deeper level in the coupled development relationship with the ecological environment. The heritage conservation strategy of the village cultural industry in the context of rural revitalization has significantly promoted the comprehensive ecological environment in the whole plan area.

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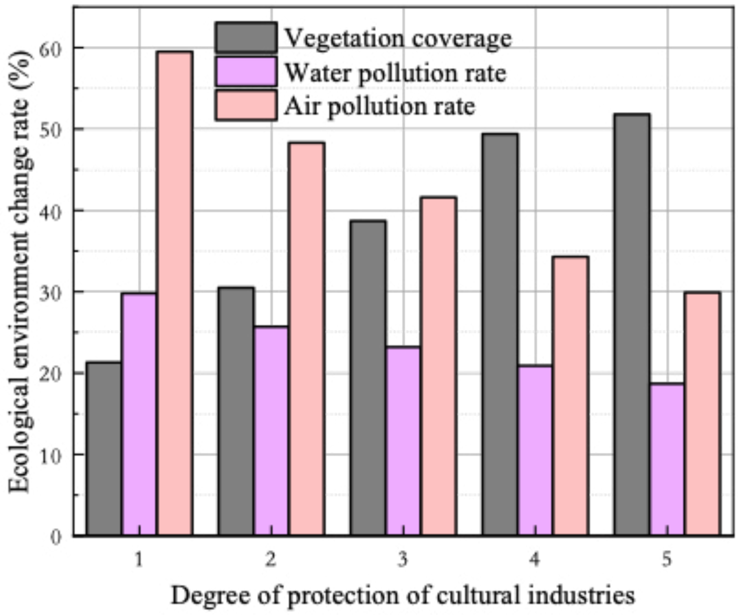

Figure 2. Variation of each ecological index with the degree of cultural protection

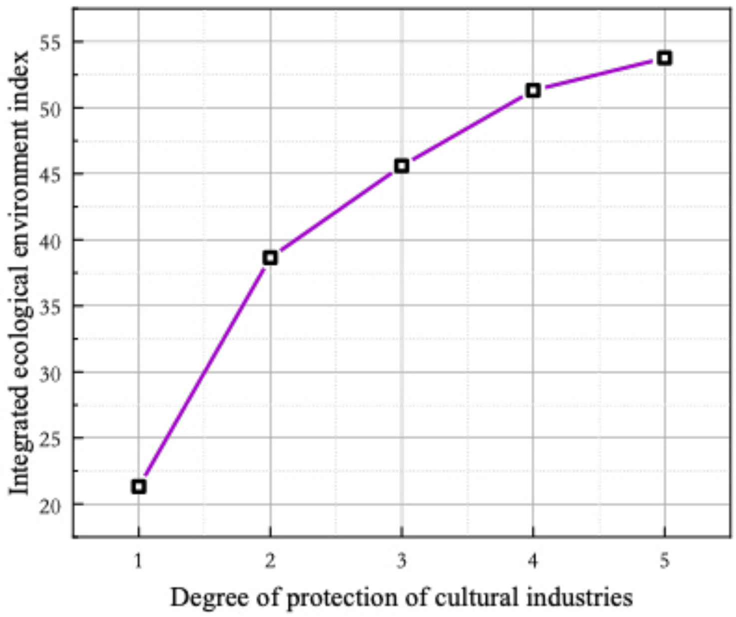

Figure 3. Variation of integrated ecological environment indicators with the degree of cultural protection

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4.2. THE RELATIONSHIP BETWEEN CULTURAL INDUSTRY DEVELOPMENT AND THE ECOLOGICAL ENVIRONMENT

Subsequently, we conducted a comprehensive assessment of the coupled development relationship between the development of cultural industry and the ecological environment in villages in the context of rural revitalization. Among them, we selected the cultural industry development levels (0-10) of different villages in two major regions of Ganzi and Aba in Sichuan Province as the independent variables, while the integrated development index of the ecological environment on the horizontal axis was used as the dependent variable. The development trend is shown in Figure 4, where it is observed that the comprehensive eco-environmental development index increases with the degree of cultural industry development. Specifically, relative to the degree of cultural industry development at rank 1, the eco-environmental comprehensive development index changes significantly at the degree of cultural industry development at ranks 2, 3, 4, 5, 6, 7, 8, 9, and 10. They improved accordingly by 9.43%, 17.41%, 28.59%, 30.48%, 31.61%, 33.22%, 34.80%, 35.71%, and 36.27%. The improvement of the overall eco-environmental composite development index obtained a greater increase at the lower level of cultural industry development, with an average increase of about 9%. After the development level of the cultural industry reaches 4, the increase of the overall ecological environment comprehensive development index gradually slows down, which means that the cultural industry needs more to maintain a good ecological environment after taking shape, which is more conducive to sustainable development. Therefore, when the development degree of cultural industry in a certain region reaches a certain level, the relevant government and enterprises can appropriately develop more other fields, which means that the coupling degree of cultural industry development and ecological environment is reduced.

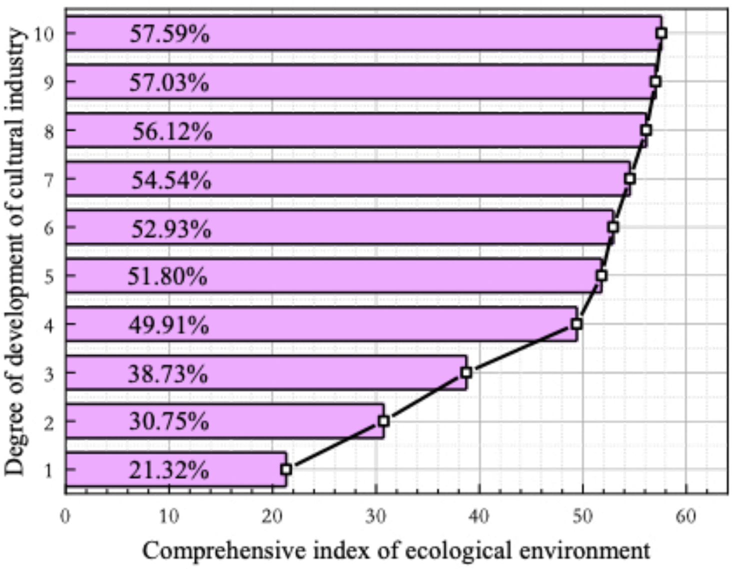

Figure 4. Changes in comprehensive indicators of the ecological environment with the degree of development of the cultural industry

5. CONCLUSION

The development and transformation of the ecological environment is an important element of global environmental change and an indicator of the future. At the same time, the common protection of the environment by all peoples is influenced by comprehensive factors such as localized industries and humanistic thoughts. By using the active promotion of the humanistic village culture industry and the active control of environmental ecology, we can further realize the coupled development under rural revitalization. In this paper, we study the coupling relationship between the development of village cultural industry and ecological environment changes and give comprehensive consideration to detecting regional ecological environment changes, optimizing cultural industry facilities, coordinating regional sustainable development and building regional ecological security patterns in the context of rural revitalization. The conclusions are as follows.

1. There is a complex dynamic coupling between the development of cultural industries and changes in the ecological environment. The cultural industry of villages is one of the important drivers of changes in the ecological environment, and the transformation of the cultural industry of villages leads to changes in the value of its services by changing the structure and function of the ecosystem. The study of the coupling relationship between the transformation of village cultural industries and ecological environment changes has considerable critical practical significance for detecting regional ecological environment changes, optimizing cultural industry facilities, coordinating regional sustainable development and building regional ecological security patterns in the context of rural revitalization.

2. The vegetation or forest cover in the surrounding areas increased by 9.2%, 17.4%, 28.1%, and 30.5% under the cultural industry protection levels of 2, 3, 4, and 5, respectively, compared to the cultural industry protection level of 1, with an average increase of about 10% with the cultural industry protection level. At the same time, the air pollution index decreased by 11.2%, 17.9%, 25.2% and 30.3% under the cultural industry protection level of 2, 3, 4 and 5, respectively, with an average reduction rate of about 8% with the cultural industry protection level. In addition, the pollution level of river water resources decreased by 4.1%, 6.6%, 8.9%, and 11.1% under the cultural industry protection level of 2, 3, 4, and 5, respectively, with an average reduction rate of about 3% with the cultural industry protection level.

3. Compared with the cultural industry development level of rank 1, the overall eco-environmental development index increased by 9.43%, 17.41%, 28.59%, 30.48%, 31.61%, 33.22%, 34.80%, 35.71%, and 36.27% for the cultural industry development levels of rank 2, 3, 4, 5, 6, 7, 8, 9, and 10, respectively. The improvement of the overall eco-environmental composite development index obtained a greater increase under the lower level of cultural industry development, with an average increase of about 9%. And when the degree of

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cultural industry development reaches 4, the overall ecological environment comprehensive development index gradually slows down, which means that the cultural industry needs more to maintain a good ecological environment after taking shape, which is more conducive to sustainable development.

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ANALYSIS OF THE IMPACT OF HIGH-DENSITY URBAN DESIGN ON REGIONAL ECOLOGICAL ENVIRONMENT AND EVALUATION IN EASTERN CHINA

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ABSTRACT

As the world's largest developing country, China's rapid economic development has caused more serious damage to the environment, and environmental pollution has become the number one problem in China's development. How to correctly deal with the coexistence of economy and environment is very important for the construction of our country. This paper analyzes the impact of urban design on regional ecology and how these influences can be evaluated, using a high-density city in eastern China as an example. This study takes the layout structure, spatial structure, facility support, flow organization and environmental ecology of the urban space as the direct carrier, and the cultural integration and technical response as the indirect carrier, and carries out the corresponding urban design in the above-mentioned space through the corresponding principles, strategies and methods. The impact of these elements on the urban ecological environment was also analyzed. The results of the study show that the ranking of ecological environment quality score in Anhui Province has been rising, and the number of the top five regions has increased from 20% to 80%.

KEYWORDS

High-density cities; urban design; regional ecological environment; evaluation system; influencing factors

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1. INTRODUCTION

The Earth is the home we depend on for our survival, and its enduring beauty is the cornerstone of the continuous development of human society. However, since 1960, with the global expansion of the industrialist development model, the uncoordinated development of the world's population, resources and environment has led to serious ecological and environmental problems [1-3]. The destruction of the ecological environment has seriously affected human health and life. With the accelerated development of China's economy and society, the construction of ecological civilization is gaining more and more attention from the state, society and people, and China is vigorously promoting the protection and construction of ecosystems [4-6]. And to the current development trend of China's economy, ecological problems have become a constraint for the continued development of China's economy to a certain extent, so the future construction of China must focus on environmental protection [7,8].

Currently, from the perspective of dynamic evolution, the cluster development of cities has become an important trend in urban development. From the objective results, the urban clusters formed by cluster development have become new economic growth poles, and this has led to the accelerated introduction of a series of urban cluster development plans [9-11]. At the same time, years of ultra-high speed and rough development have brought enormous pressure on resources and the environment, making China's green development increasingly important under the new normal [12,13]. In recent years, scholars have explored the issue of urban cluster construction and its green development. Zhang et al [14] predicted the future urban spatial state by using a linear model fitting method in Jinan, China, as an example. A comprehensive analysis of the urbanization development trend of Jinan and its impact on the vegetation cover within the city was also conducted based on the data on urban development trends in recent years. The results showed that the ground conditions and changes in Jinan were accurately reflected by linear model parameter clustering: high-density, stable urban types were found in the city center, while stable dense vegetation types were found in the southern mountainous areas. This approach demonstrates the prospect of urban growth in terms of environmental protection and conservative urban development. Ye et al [15] analyzed the changes in urban green spaces in Macau from 2010 to 2015, and they found that urban green spaces have a significant impact on the lives of urban residents, especially in high-density cities. Based on the prediction results of the two-step floating catchment area model, they concluded that the distribution of urban green space in Macau is extremely uneven, but it will gradually become more uniform over time, which is caused by the upgrading of related facilities and relevant policies. Zhang et al [16] proposed a new three-dimensional spatial design network analysis method for the built environment. They used the high-density urban area of Central, Hong Kong as an example to analyze the spatial configuration and its relationship with human activities in a three-dimensional spatial network. The results indicate that it is unrealistic to consider only outdoor pedestrian networks to study multilevel pedestrian networks in high-density built

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environments, and indoor and outdoor pedestrians should be considered comprehensively. Wang et al [17] studied the effects of greenways on microclimate in high-density cities using Shenzhen, China as an example. They analyzed the microclimate characteristics such as temperature, relative humidity, light intensity, and wind speed of five green roads in Shenzhen during daytime in summer, and compared the effects of green road microclimate on human comfort under different greening conditions using temperature and humidity index and wind efficiency index as evaluation indexes. The results show that when the summer temperature is high, green roads can significantly reduce the temperature as well as the light intensity and improve human comfort. The presence of green roads can significantly improve the microclimate characteristics of cities and increase the comfort of the population. Shi et al [18] used surface urban heat islands to describe the deteriorating thermal environment in high-density cities. They studied the urban design factors affecting surface urban heat islands in humid subtropical regions of China, using Guangzhou city as a representative city. Based on a series of satellite data as well as GIS databases, they found that surface temperature, vegetation cover, volume ratio, ground emission rate, and building density all have an impact on urban design. Hua et al [19] studied street greenery in Hong Kong using street-view images and deep-learning techniques. They found some spatial variation in street greenery, with less greenery generally occurring in private residences in high-density areas as well as in commercial centers. They also found that integrating street greening with urban morphology in an integrated analysis is very beneficial for urban and greening planning in sustainable and healthy cities.

Due to the misalignment between humans and nature, the relationship between economic development and environmental protection is seriously imbalanced, resulting in major environmental pollution events such as air pollution, river pollution, marine pollution, soil pollution, etc., and due to the inherent characteristics of the atmosphere and water flow, environmental problems also all present a regional character [20-23]. It is not only the focus of attention and ardent hope of the national people to develop the economy while paying more attention to protecting the environment, but also the necessary and proper way to realize the Chinese dream at an early date [24]. Regional eco-environmental co-construction is a new research development trend in the field of ecological compensation, which is a new development model for economic and social development to ensure the healthy operation of the ecosystem and achieve environment-friendly, ecological harmony and efficient use of material and energy [25-27]. Hu et al [28] analyzed the land utilization rate in the rapidly urbanizing region and the ecological effects of the region based on land use data from 2000 and 2015 in the PRD region. The results showed that the ecological quality of the PRD region was relatively stable during these 15 years, but there was a slight overall decline. Land use changes were mainly manifested in the gradual decrease of arable land, forest land, and unused land, indicating that the spatial expansion brought about by urbanization has largely affected the ecological quality of the PRD region. Zhang et al [29] used the entropy value method and the coupled coordination method to address the inconsistency in development between

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the economy and the ecological environment by examining the economic development, logistics development, and ecological environment development of 30 Chinese provinces and cities from 2008-2017, logistics development and ecological environment development levels were analyzed. The results show that the coupled and coordinated development of the economy and ecological environment varies greatly in space. Most cities in China have reached a medium level of coupled and coordinated development of economy and ecological environment, and only a few regions in the Middle East, such as Shanghai, have reached a high-quality level, while the coupled and coordinated level in the western region has been at a low level. Therefore, in future development, it is still necessary to take into account the economy and ecological environment to make the two develop in a coordinated and stable way. Li et al [30] analyzed the factors limiting the sustainable development of the region using the Pearl River Delta urban agglomeration in China as an example. They established a coupled coordination degree model and an ecological security evaluation system. The results showed that the developing regions performed better in terms of the degree of coordination between ecological security and development in terms of sustainable development. Meanwhile, factors such as urban vegetation, per capita GDP and population density can limit the sustainable development level of the urban agglomeration in the Pearl River Delta to a certain extent. In addition, cities with more native environments are more vulnerable to external factors, and cities with developed industries are more lacking in ecological restoration ability. When deploying development planning for urban agglomerations, coordinated development among different cities should be considered. Tian et al [31] analyzed the factors affecting the ecological environment of land reclamation areas from the perspective of land reclamation. Fang et al. [32] established a regional ecosystem management system model based on a two-layer plan to manage the ecosystem and sustainable development in Xiamen, China. The results showed that the main ecological service values of ecosystems are carbon sequestration, oxygen release, and water retention. Compared with the single-level model, this model reduced the system benefits by 15.3% and increased the value of ecological services by 17.6%.

In summary, high-density cities are a state of urban development with a concentrated regional economy, an advanced regional spatial organization brought about by highly developed industrialization and urbanization. The formation of high-density cities often implies a highly developed economy and modernization level of a region, and their economies of scale can bring huge benefits and have far-reaching effects on the regional ecological environment. This paper analyzes the impact of urban design on the regional ecological environment of cities based on high-density cities in eastern China and establishes an ecological index evaluation system to evaluate the regional ecological environment of high-density cities. At the same time, this study also introduces the urban clustering degree and urban eco-efficiency measurement method as a way to examine the time-series evolution of cluster development and eco-efficiency in high-density cities in eastern China.

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2. RELEVANT THEORIES AND MATHEMATICAL MODELS

The protection of ecology and environment needs to fully consider the interrelationship between the natural environment and human society, on the one hand, to deal with the relationship between humans and nature; on the other hand, to coordinate the internal relationship of human society, and to protect the integrity and development of ecological environment with benign development as the driving force. Theoretical disciplines tend to be more complex, and with the help of theories and methods from basic disciplines, combined with the characteristics of ecological environmental protection, several disciplines have been formed, such as ecological environmental science and environmental engineering. Based on the existing theoretical knowledge, the laws of the ecological environment are understood, the relationship between humans and the ecological environment is regulated by using economic and technical means, and the relationship between the ecological environment and social development is revealed by sociological methods.

2.1. BASIC THEORY

2.1.1. ECOLOGICAL RESTORATION THEORY

Ecological restoration refers to the reduction or interruption of human intervention in the ecosystem, and the development of the ecosystem in an orderly and good direction through its self-regulation and organization, or the use of the ecosystem's self-repair and regulation ability to reduce the environmental load pressure, so that the damaged ecosystem gradually restored to its original state. In other words, ecological restoration refers to the work of restoring and rebuilding ecosystems when the environment suddenly changes or suffers damage caused by human activities, either by self-restoration or artificial reconstruction, or both.

2.1.2. SYSTEM SCIENCE THEORY

Systems science is the science of complex systems in different fields, and its main content is to study the laws of structure, function and evolution of the system under study. From a holistic system perspective, systems science is mainly concerned with analyzing the laws of the nature of relatively complex systems, to clarify the correlations between different systems and the laws to be followed in the process of evolution. Ecological and environmental assessment is carried out based on the environment, and in the study, it is necessary to have a comprehensive and specific consideration instead of starting from a single influencing factor. At the same time, it is also necessary to adhere to the dynamic principle in the research process and to evaluate the ecological environment change status comprehensively.

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2.1.3. SUSTAINABLE DEVELOPMENT THEORY

Sustainable development, meaning that development is not a one-time event, is based on the sustainable use of renewable resources, but the concept of sustainable development became popular worldwide in 1987 with the publication of "Our Common Future" by the WCEA. Sustainable development refers to the emphasis on economic, social and ecological coherence and integration to achieve the goal of integrated development. The principle of equity requires that development should focus on the equity of all generations, both horizontally and vertically, and that it should not chase its side of development at the expense of others and squander resources, which is also an international common opinion. Sustainability requires the continuity of development without disturbance, the resources can be developed and renewable, and there will be no vulnerability of resources. Commonality requires all human beings to act together, the world is the whole, one party to destroy sustainable development, the global will be affected.

2.1.4. THEORY OF COLLECTIVE ACTION

The theory of collective action can explain the behavior of each of the subjects in collaborative ecological governance. It is as if each subject is an economic person in the economic society, and they all want to maximize their interests rather than bear the cost of governance, which will only further deteriorate the environment of the region.

2.1.5. THEORY OF EXTERNAL EFFECTS

When there is a conflict between the marginal costs and benefits of the two, private and social, it is difficult to solve the problem by compensating for it, and there should be external forces that exclude both to solve the problem so that the interests of both society and people can be optimized. Because of this, the theory of externalities is widely used in ecological environmental protection.

2.2. ECOLOGICAL ENVIRONMENT QUALITY EVALUATION

Eco-environmental quality is proposed after a series of eco-environmental problems arise from natural factors or human production and living activities, and is a comprehensive concept used to measure the scope, degree, and merit of the impact of human activities on the eco-environment.

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2.2.1. GREENNESS INDEX

Normalized vegetation index ($NDVI$) is one of the most widely used indices among various vegetation indices and is widely used to analyze crop growth, vegetation cover and spatial distribution.

$$NDVI = \frac{(\rho 4 - \rho 3)}{(\rho 4 + \rho 3)} \quad (1)$$

Where $\rho 4$ and $\rho 3$ represent the reflectance in the near-infrared and visible red bands, respectively. the $NDVI$ value represents the vegetation status of the watershed, and the larger the $NDVI$ value after normalization, the higher the vegetation cover.

2.2.2. HUMIDITY INDEX

Moisture components are widely used in ecological monitoring, not only to represent the water resources status of regional rivers and reservoirs but also to calculate the moisture content of arable land, forest land and other land use types.

$$Wet = 0.0315\rho 1 + 0.2021\rho 2 + 0.3102\rho 3 + 0.1594\rho 4 - 0.6806\rho 5 - 0.6109\rho 7 \quad (2)$$

Where ρ_i is the reflectance of each waveband of TM. Wet after the normalization process, higher values represent higher humidity.

2.2.3. DRYNESS INDEX

The dryness index is used to study the status of land desertification and land degradation in arid zones.

$$NDSI = (SI + IBI)/2 \quad (3)$$

Where SI is the bare earth index and IBI is the building index. The higher $NDSI$ value indicates the more serious land degradation and desertification in the study area and the worse ecological environment quality.

2.2.4. HEAT INDEX

The heat index is expressed in terms of surface temperature, and global and regional thermal environmental problems, which are receiving increasingly widespread attention, and how to mitigate the regional ecological and environmental impacts caused by abnormal changes in surface temperature have become urgent and realistic problems.

$$Ts = [a(1 - C - D) + (b(1 - C - D) + C + D)T6 - DTa]/C \quad (4)$$

$$C = \varepsilon\tau \tag{5}$$

$$D = (1-\tau)[1+(1-\varepsilon)\tau] \tag{6}$$

Where Ts is the surface temperature, Ta is the atmospheric temperature, and $T6$ is the brightness temperature in the thermal infrared band. a and b are constants. ε is the surface-specific emissivity, and τ is the atmospheric transmittance.

2.3. DETERMINATION OF INDEX WEIGHTS

Principal component analysis (PCA) is a multivariate statistical method and is one of the basic mathematical analysis methods. Its mathematical meaning is to select a small number of important variables from the original numerous indicators with correlation and recombine them into a new set of comprehensive indicators, which helps to analyze the indicator attributes more objectively. In this paper, with the help of ER Mapper software, the normalized 4 indicators are imported into the software for principal component analysis and synthesize the RSEI index. The coefficients of each index after the principal component analysis are large or small, positive or negative, and each index is given different weights and practical meanings, with positive values indicating a positive correlation between the index and the composite index and negative values indicating a negative correlation. The larger the eigenvalue in the principal component analysis, the higher the variance contribution of the "component", and the better it represents the attribute characteristics of each index.

$$X = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1p} \\ x_{21} & x_{22} & \cdots & x_{2p} \\ \cdots & \cdots & \cdots & \cdots \\ x_{n1} & x_{n2} & \cdots & x_{np} \end{bmatrix} = \left[x_1, x_2, \ldots, x_p\right] \tag{7}$$

$$F_i = w_{1i}x_1 + w_{2i}x_2 + \ldots + w_{pi}x_p, i = 1,2,\ldots,p \tag{8}$$

Using a mathematical method to describe principal component analysis, for a data set X with n samples, $X_1, X_2, \ldots, X_P$, P variables. PCA is to synthesize the original P observation variables $X_1, X_2, \ldots, X_P$ to form P new variables (comprehensive variables).

2.4. URBAN DESIGN AND EVALUATION

2.4.1. URBAN DESIGN

The development trajectory of urban design can be roughly divided into three important historical stages. "The second generation of urban design emerged in the 1950s, and its design followed the rational guidelines of "economy and technology", focusing on efficiency and function, and meeting the general needs of modern cities. In the 1970s, the third generation of urban design, "green urban design", began to

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emerge, with the design guidelines of "holistic priority" and "ecological priority", trying to create a harmonious development of the natural and man-made environment and shape a sustainable urban environment. The third generation of urban design, i.e. green urban design, covers different directions of urban design such as environment, economy and society, and needs to be completed from a social-economic-environmental multidisciplinary. The green urban design studied in this paper is the core component of the third-generation green urban design from the perspective of architecture: the green urban design based on bioclimatic conditions.

2.4.2. URBAN DESIGN IMPLEMENTATION ASSESSMENT

Urban design implementation evaluation is an important part of the urban design workflow, which provides feedback and corrections to the urban design implementation and guides the urban design to implement the planning and design content more realistically in the field. In general, the evaluation process is one iteration, and the results and updated design of each iteration will be used as the initial values for the next iteration. The purpose of this evaluation is to improve the urban design, which is an important part of the urban design process from planning to implementation and will become the basis and starting point for the next round of urban design.

The city master plan has a regular assessment and medical examination system. The Beijing Master Plan proposes to establish a scientific and effective planning implementation control system, an urban physical examination and assessment mechanism, a planning implementation supervision and assessment accountability system, and a planning implementation coordination and decision-making mechanism and proposes an evaluation index system for a livable city. To ensure that the target indicators are well implemented, a regular mechanism of periodic assessment will be adopted to evaluate the implementation of planning and design. Therefore, the normalization of urban design implementation evaluation will be a further extension of this work. The main work of urban design in the implementation stage is to form planning and design conditions together with the detailed control plan, and its role is to guide the subsequent architectural design and landscape design by transforming them into legal control elements.

This section introduces the relevant theories involved in the construction of regional ecological environments, such as ecological restoration theory, system science theory, collective action theory, and sustainable development theory. Then we introduce the methods of ecological quality evaluation and their evaluation indexes. Finally, the high-density urban design method and evaluation guidelines are introduced. The theoretical foundation is laid for the later analysis.

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3. RESULTS AND DISCUSSION

The Yangtze River Delta region is a typical high-density urban area in eastern China, and this section uses the Yangtze River Delta region as a case study to evaluate its ecological environment from 2010 to 2019. This is used to determine the impact of high-density urban design on the regional ecological environment.

3.1. EVALUATION INDEX SYSTEM

From the perspective of ecological economics, the ecological environment quality system includes not only the quantity and quality of natural resources and energy but also the construction of municipal systems, the state of infrastructure construction and the level of basic public services, which reflect and measure the quality of human life, so the index system must be a comprehensive system. Therefore, this paper uses the PSR model established by OECD and UNEP to construct a basic index system reflecting the pressure-state-response of the ecological environment under the principles of scientificity, representativeness, accessibility and comparability, and the index system is shown in Table 1.

Table 1. Ecological environment quality index system

Tier 1 Indicators	Secondary indicators	Tertiary indicators	Marking	Direction
Eco-environmental quality evaluation index	Pressure Indicators	Growth rate of construction land	Y_1	—
		Per capita residential electricity consumption	Y_2	+
		Total industrial wastewater discharge	Y_3	—
		Sulfur dioxide emissions	Y_4	—
		Solid waste generation	Y_5	—
	Status Indicators	Water resources per capita	Y_6	+
		Urban park area per capita	Y_7	+
		Road occupancy per capita	Y_8	+
		Greening coverage of built-up areas	Y_9	+
	Response Metrics	Urban domestic sewage treatment rate	Y_{10}	+
		Comprehensive utilization rate of industrial solid waste	Y_{11}	+
		Harmless disposal rate of domestic waste	Y_{12}	+
		Industrial fume removal	Y_{13}	+

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3.2. OVERALL EVALUATION OF THE LEVEL

Based on the above evaluation index system, the comprehensive scores of ecological environment quality of 26 cities in the Yangtze River Delta city cluster can be measured from 2010 to 2019, as shown in Table 2. As can be seen from Table 2, the scores and rankings of Shanghai and Jiangsu Province show a decreasing trend, those of Anhui Province keep rising, while those of Zhejiang Province remain almost unchanged. In 2010, the top five regions were Shaoxing, Nanjing, Suzhou, Ningbo, and Huzhou, and the provinces involved were Zhejiang and Jiangsu; in 2010, the bottom five regions were Chuzhou, Anqing, Nantong, Zhoushan, and Xuancheng, accounting for 60% of the total in Anhui. The top three cities with the fastest improvement are Chuzhou, Xuancheng and Anqing, all of which are from Anhui Province, which shows that the province's ecological and environmental quality level has improved significantly within the city group, which is due to the following reasons: in the process of regional integrated development, Anhui Province has accelerated its ecological and environmental quality ranking by In 2019, the bottom five regions are Shanghai, Changzhou, Yangzhou, Yancheng, and Suzhou, with Jiangsu Province accounting for 80% of the total, and the province's eco-environmental quality score ranking shows a decreasing trend, which shows that the province's eco-environmental quality level has decreased to a certain extent within the city group, which is related to the high pollution and high energy consumption enterprises in Jiangsu Province. This is closely related to the profit-oriented development model of Jiangsu Province and the heavy industrial density caused by the spread of this model in the provincial area. In addition, the ranking of Zhejiang Province is relatively stable within the city cluster over the 10 years. In the case of the Yangtze River Delta urban agglomeration, the ecological quality scores and rankings of each region show certain changes in different years, and the characteristics of such changes need to be analyzed in detail at the spatial and temporal levels.

Table 2. Comprehensive ecological and environmental quality scores of 26 cities in the Yangtze River Delta city cluster, 2010-2019

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Shanghai	0.4551	0.3582	0.3415	0.3912	0.3141	0.2584	0.2313	0.2179	0.2366	0.2250
Wuxi	0.4474	0.5165	0.5120	0.5026	0.4752	0.5218	0.3850	0.4340	0.4294	0.4404
Suzhou	0.5015	0.5051	0.5454	0.4734	0.4182	0.4288	0.3458	0.3698	0.4040	0.3494
Yangzhou	0.3844	0.3989	0.3630	0.3915	0.3036	0.3985	0.3385	0.3281	0.3426	0.3169
Taizhou	0.3717	0.3819	0.3134	0.3242	0.3210	0.4028	0.3600	0.3331	0.3234	0.3598
Nanjing	0.5355	0.5182	0.4836	0.4744	0.4653	0.6242	0.4736	0.5241	0.5532	0.4542
Changzhou	0.3666	0.3717	0.3229	0.3771	0.3348	0.3917	0.3489	0.3817	0.3639	0.3095
Nantong	0.3235	0.3463	0.3228	0.3385	0.3110	0.3736	0.3448	0.2937	0.3688	0.3690
Zhenjiang	0.4348	0.4526	0.4114	0.4329	0.3904	0.4801	0.3853	0.3891	0.4019	0.3560

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Yancheng	0.3573	0.3715	0.2745	0.3423	0.2800	0.3687	0.2843	0.3039	0.3377	0.3454
Ningbo	0.4716	0.4494	0.4820	0.5255	0.4778	0.3689	0.3710	0.4414	0.3832	0.3745
Huzhou	0.4604	0.5067	0.5330	0.5177	0.5263	0.6530	0.6262	0.6220	0.6142	0.6381
Zhoushan	0.3254	0.3718	0.3275	0.3635	0.3163	0.3976	0.3758	0.4071	0.3689	0.3767
Hangzhou	0.4398	0.4177	0.4255	0.4109	0.3886	0.4378	0.3915	0.4407	0.3825	0.3521
Jiaxing	0.3545	0.3763	0.3708	0.4003	0.3751	0.4247	0.3895	0.3871	0.3876	0.3688
Introduction	0.6004	0.5970	0.5468	0.5351	0.4404	0.4960	0.4691	0.4602	0.4510	0.4128
Taizhou	0.4240	0.4494	0.4576	0.4714	0.4537	0.3943	0.4052	0.4329	0.4526	0.4072
Jinhua	0.4411	0.4384	0.3997	0.4361	0.4142	0.4220	0.4280	0.4201	0.4263	0.4114
Hefei	0.4243	0.4679	0.3881	0.3788	0.4641	0.5207	0.4132	0.4935	0.5414	0.3997
Ma'anshan	0.4065	0.3978	0.3587	0.3669	0.3691	0.3378	0.3944	0.3982	0.4722	0.3840
Anqing	0.3206	0.3558	0.3339	0.3688	0.3825	0.4280	0.4067	0.4575	0.4383	0.4469
Chizhou	0.4044	0.5044	0.4897	0.5101	0.5448	0.4978	498	0.5768	0.5493	574
Wuhu	0.3686	0.4022	0.3960	0.4164	0.4099	0.5395	0.5482	0.5800	0.5266	0.4573
Tongling	0.4122	0.3834	0.3664	0.4642	0.3570	0.5150	0.5784	0.4927	0.5737	0.4001
Chuzhou	0.3149	0.3083	0.2723	0.2538	0.2990	0.4282	0.4094	0.4475	0.4084	0.5064
Xuancheng	0.3518	0.4238	0.4070	0.4154	0.4339	0.4213	0.3993	0.5004	0.4250	0.4916

3.3. ANALYSIS OF SPATIAL AND TEMPORAL CHARACTERISTICS OF LEVELS

3.3.1. ANALYSIS OF SPATIAL IMBALANCE

By measuring the spatial imbalance of ecological environment quality level in the Yangtze River Delta city cluster, as shown in Figure 1 below. Theoretically, a Gini coefficient within 0.2 indicates a highly balanced state of the spatial distribution of a factor characteristic; above 0.5 indicates a very unbalanced state of the spatial distribution of the factor characteristic. Among them, 0.4 is the critical point of spatial equilibrium and imbalance. Thus, the Gini coefficient provides a clear measure of the spatial unevenness of the comprehensive ecological environmental quality score in each year, but the spatial clustering characteristics of the ecological environmental quality scores of cities in the Yangtze River Delta city cluster in each node year still need to be given a more intuitive analysis and be explored in depth.

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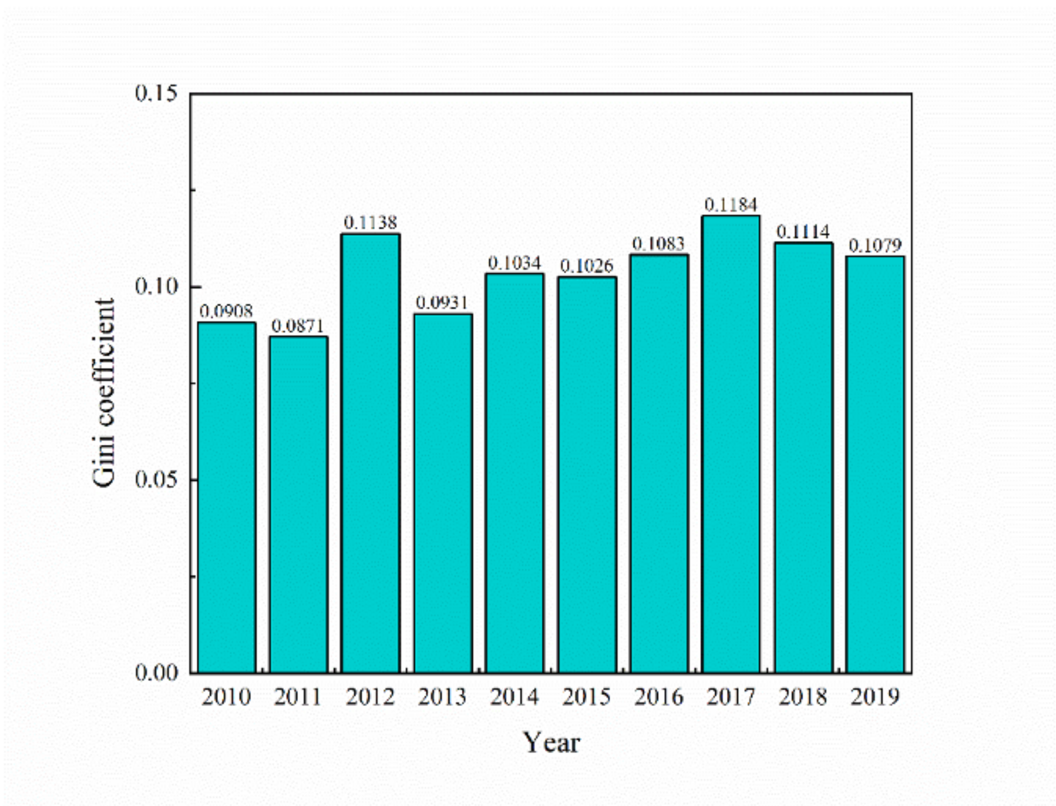

Figure 1. Gini coefficient of ecological and environmental quality in the Yangtze River Delta city cluster, 2010-2019

3.3.2. HOTSPOT ANALYSIS

To further analyze the spatial characteristics of the ecological environment quality of the Yangtze River Delta urban agglomeration, four times sections were selected for 2010, 2013, 2016, and 2019 at a time interval of three years, and the corresponding Gi* values were obtained by Arcgis technology and using Equation (4). Concerning the classification of cold hotspot areas in previous studies, the Gi* values of ecological environment quality in the Yangtze River Delta urban agglomeration were classified into five categories from high to low. This classification refined the previous 3 classifications by Gi* values, making the analysis more detailed and the conclusions more clear, as shown in Table 3.

Table 3. Gi* value range and description

Year	Cold spot area	Secondary cold spot area	Temperature point area	Sub-hotspot area	Hot spot area
2010	[-1.34，-0.68]	[-0.68，-0.05]	[-0.05，0.48]	[0.48，1.37]	[1.37，2.26]
2013	[-1.87，-1.40]	[-1.40，-0.36]	[-0.36，0.44]	[0.44，1.10]	[1.10，1.76]
2016	[-1.89，-1.72]	[-1.73，-0.34]	[-0.34．064]	[0.64，1.36]	[1.36，2.36]
2019	[-1.98，-1.40]	[-1.41，-0.70]	[-0.70，0.14]	[0.13，1.04]	[1.04，2.06]
Description	Eco-environmental quality score low value agglomeration area	Sub-low ecological quality score agglomeration area	Median Eco-environmental Quality Score Clustering Area	Eco-environmental quality score sub-engagement value agglomeration area	Eco-environmental quality score high value agglomeration area

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Taking 2019 as a representative, we list the Gi* values of these 26 cities in Table 4.

Table 4. Gi* value of 26 cities,2019

	Cold spot area	Secondary cold spot area	Temperature point area	Sub-hotspot area	Hot spot area
Shanghai	-1.452	-721	81	391	1.3141
Wuxi	-1.622	-881	-522	502	1.475
Suzhou	-1.588	-864	115	434	1.418
Yangzhou	-1.574	-876	-228	0.3915	1.303
Taizhou	-1.658	-819	-663	342	1.321
Nanjing	-1.524	-931	16	474	1.465
Changzhou	-1.482	-922	27	377	1.334
Nantong	-1.782	-877	-421	385	1.311
Zhenjiang	-1.533	-821	-31	439	1.390
Yancheng	-1.881	-816	121	423	1.280
Ningbo	-1.529	-1.121	-132	525	1.477
Huzhou	-1.886	-1.036	-325	517	1.526
Zhoushan	-1.922	-935	-365	635	1.316
Hangzhou	-1.478	-756	-517	849	1.388
Jiaxing	-1.568	-964	-378	743	1.375
Zhenjiang	-1.635	-1.322	54	535	1.440
Taizhou	-1.616	-1.224	72	474	1.453
Jinhua	-1.469	-1.066	-457	436	1.414
Hefei	-1.769	-891	-699	788	1.464
Ma'anshan	-1.555	-996	-328	669	1.369
Anqing	-1.878	-972	39	688	1.382
Chizhou	-1.855	-1.325	122	951	1.544
Wuhu	-1.699	-1.258	-368	647	1.409
Tongling	-1.522	-1.355	-149	658	1.357
Chuzhou	-1.485	-1.189	136	853	1.299
Xuancheng	-1.621	-1.056	-187	923	1.433

At the temporal level, the ecological environment quality level of each region in the Yangtze River Delta urban agglomeration showed a large fluctuation during 2010-2019, with the level ranking of Anhui Province on the rise, Jiangsu Province and

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Shanghai Municipality on the decline, and Zhejiang Province at a more stable level. At the spatial level, the Gini coefficient of ecological and environmental quality in the region is within 0.2 during 2010-2019, which is in a highly balanced state in space. The hotspot and sub-hotspot areas of ecological environmental quality in the Yangtze River Delta urban agglomeration are mainly in the south of the region, but there are small changes in the hotspot and sub-hotspot areas in different time sections, with the former moving gradually from east to west in the whole area of the urban agglomeration and the latter changing less spatially in the whole area of the urban agglomeration. The cold point and subcool point regions are mainly concentrated in the north, but there are small changes in the cold point and subcool point regions in different time sections, the former is stable in a small part of the whole urban area, while the latter shows the spatial change characteristics of moving from west to east.

4. CONCLUSION

High-density cities are the state of urban development in which the regional economy is concentrated and are the advanced regional spatial organization brought about by highly developed industrialization and urbanization. The formation of high-density cities often implies a highly developed economy and modernization level of a region, and their economies of scale can bring enormous benefits and have far-reaching impacts on the regional ecological environment. This paper evaluates the ecological and environmental performance indicators of the Yangtze River Delta, a typical high-density urban area in eastern China, from 2010 to 2019. This is used to analyze the impact of high-density urban design on the regional ecological environment. The specific findings of the study are as follows.

1. Between the decade of 2010 and 2019. The ecological environment quality scores and rankings of Shanghai and Jiangsu Province show a decreasing trend, while Anhui Province keeps rising and Zhejiang Province remains almost unchanged. 60% of the areas ranked in the bottom five in 2010 and 80% of the areas ranked in the top five in 2019 are occupied by Anhui Province.

2. The spatial and temporal characteristics of the ecological environment quality level of the Yangtze River Delta urban agglomeration show the following pattern, the maximum value of the Gini coefficient is only 0.1184 during 2010-2019, which is much smaller than 0.2. Therefore, the ecological environment quality of the region is in a highly balanced spatial state, and the difference between the ecological environment quality levels of each year is small.

3. The hotspot and sub-hotspot areas of ecological environmental quality in the Yangtze River Delta urban agglomeration are mainly in the south of the region, but there are small changes in the hotspot and sub-hotspot areas at different time cross-sections, with the former moving gradually from east to west in the

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whole area of the urban agglomeration and the latter having smaller spatial changes in the whole area of the urban agglomeration.

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INNOVATION OF SCHOOL-ENTERPRISE COLLABORATIVE CULTIVATION MODE FOR UNIVERSITY E-COMMERCE MAJORS IN THE CONTEXT OF SYMBIOSIS THEORY

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ABSTRACT

School-enterprise collaborative training model is a system of cultivating talents through school-enterprise cooperation and combining practice. This paper explores the practical model of university collaborative innovation based on symbiosis theory, aiming at examining and analyzing the complex synergistic relationship between each inner symbiotic unit, revealing the inner practical evolution logic, and providing useful reference and inspiration for the improvement of university collaborative innovation performance. The symbiotic model of collaborative innovation between universities and enterprises interacting with each other is constructed, and innovation is carried out with market demand as the link. Based on this, e-commerce majors in colleges and universities should integrate enterprise elements, form multilateral communication mechanisms and promote the stability of symbiotic relationships. In order to verify that the symbiosis theory can innovate the school-enterprise collaborative training model, a school-enterprise cooperation internship training platform was built. 19.1% of students felt very dissatisfied and 18.9% felt very satisfied with it before the internship. The students who were very dissatisfied after the internship decreased from 19.1% to 2.1% before the internship, and 53.1% of the students completely achieved the goal, which indicates that improving the symbiotic integrated governance system of university collaborative innovation can improve the ability of university collaborative innovation comprehensively.

KEYWORDS

Collaborative innovation symbiosis model; symbiosis theory; factor integration; multilateral exchange mechanism; practical evolutionary logic

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1. INTRODUCTION

In the context of the rapid development of information technology and the increasing popularity of the Internet, the competition of enterprises is undergoing significant changes, and e-commerce is becoming an important business model for enterprises, and the demand for e-commerce talents in society is becoming more and more urgent [1-3]. E-commerce is developing rapidly, and because the cost of innovation and entrepreneurship in the e-commerce industry is low, the success rate is high, and the development space is huge, a large number of innovative and entrepreneurial talents are needed more than in other industries [4-5]. It is one of the missions of colleges and universities to cultivate high-quality skilled talents for local economic development [6-7]. The "symbiotic" talent cultivation model of university and enterprise is a new model based on the theory of the development of applied talent cultivation and the idea of national supply-side reform. The "double main body" refers to the school-enterprise sharing and building educational resources and educational environment, giving full play to the advantages of both schools and enterprises in talent training, and jointly implementing talent training programs to achieve the goal of training high-end skilled professionals, realizing the goal of "symbiosis" between schools and enterprises, and developing and growing together [8-10].

Among them, e-commerce majors have achieved remarkable results due to their high relevance and easy integration with the field of practice. The talent cultivation model of school-enterprise collaboration is a talent cultivation method that integrates school education resources and enterprise resources and has a long history [11-13]. Its purpose is to jointly cultivate innovative and entrepreneurial talents in terms of curriculum systems, practical teaching, innovation and entrepreneurship through collaborative cooperation between schools and enterprises. The school-enterprise synergy mechanism can improve the effect of innovation and entrepreneurship cultivation and clarify the goal of talent cultivation. Therefore, the synergistic development of both schools and enterprises can share the transformation results and talent dividends, and further improve the system of training innovative and entrepreneurial talents in e-commerce majors, and realize the win-win situation between them, which is a strong necessity for both schools and enterprises.

The essence of training model innovation is management process innovation. The literature [14] demonstrated an improvement based on the transformer model, which reduced the difficulty of model training and training time cost and achieved higher model recall and accuracy in text sentiment classification. E-commerce reviews are chosen as the research object and deep learning theory is applied. The experimental results show that by comparing BiLSTM, Naive Bayesian model, Serial BiLSTM_CNN model and BiLSTM with the attention mechanism model, the method improves 9.71%, 6.05%, 5.58% and 5.12% in terms of recall and approaches the peak level of F1 value of the tested model. Thus, this finding demonstrates that it can be used to improve the accuracy of text sentiment classification and effectively apply the method to text classification. The literature [15] proposed countermeasures to improve the innovation capabilities of e-commerce practitioners in rural areas. Through the research, it is

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found that the innovation ability of rural e-commerce application talents is generally low. The key point of the solution lies in how to improve the innovation level of rural e-commerce application talents. Combined with the general environment of rural e-commerce industry development, countermeasures to improve the innovation level of rural e-commerce application talents are proposed. Improve the current situation of mediocre rural e-commerce application talents and promote the innovation of rural e-commerce application talents. Fundamentally promote agricultural development and the construction of new socialist countryside. A literature research method based on fuzzy comprehensive evaluation method, systematic analysis method and a combination of questionnaire and interview is used. Data processing was performed through big data and information science methods, and simulations were conducted with a company's Internet rural talent dataset, and the results showed that with the method of this paper, the recognition rate reached 98% and the speed was significantly higher, 20% faster than others. The literature [16] studied the talent needs of ocean-going cruise lines and sought high-quality talent development strategies for ocean-going cruise lines. The results of the study showed that there are many problems in cruise talent training at different levels, categories and contents. The cultivation of customized talents includes internal cultivation, intermediary cultivation, and university education cultivation; the strategy of ocean talent cultivation needs to be carried out at the system level, process level, and environment level. The results of the study provide a theoretical basis for the cultivation of talents in marine systems. The literature [17] analyzed the quality structure of composite tourism English talents in coastal cities in the context of all-area tourism, to provide a reference for the cultivation of composite tourism English talents in coastal cities. As the main force of talent cultivation, colleges and universities should clarify the new requirements of tourism for talent, give full play to the role of intellectual support and information guidance, update the concept of talent cultivation in time, reform the mode of talent cultivation, and assume the responsibility of talent cultivation. The literature [18] shows that the construction of professional core courses is an important part of professional construction and talent training, and plays a very important role in the cultivation of students' professional knowledge, ability and quality. To explore the innovative ideas and methods of integrating "curriculum ideological and political education" into the construction of professional core courses, "curriculum ideological and political education" has been integrated and implemented in the core course of "Internet marketing" of e-commerce majors. The content of "curriculum ideological and political education". The questionnaire was designed from eight aspects: integration effect, relevance, professionalism, richness, knowledge, ability enhancement, quality enhancement and learning effect. The empirical study was conducted with relevant students to explore their satisfaction with the integration of "curriculum ideology and politics" in the Internet marketing course. The professional training model proposed in the above literature has its limitations and lacks innovation, and cannot be committed to providing network and entrepreneurial services in universities.

Therefore, based on symbiosis theory, this paper aims to construct a new framework of collaborative innovation in universities, analyze the practical model of

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collaborative innovation embedded in the symbiosis model of universities by examining the structure of symbiotic units, symbiotic relationships and symbiotic environment, and then clarify the practical evolution of "uni-beneficial symbiosis, differential mutually beneficial symbiosis and balanced mutually beneficial symbiosis". Based on this analysis, the practical evolution of "unilateral symbiosis, differential symbiosis and balanced symbiosis" is clarified. On this basis, the paths of optimizing the collaborative innovation model of colleges and universities are proposed in terms of constructing a good-order system of collaborative innovation, reshaping the organizational form of collaborative innovation and building a regional cultural platform of mutual benefit and symbiosis. Through the integration of elements between universities and enterprises, a multilateral exchange mechanism is formed. According to the relevant characteristics and special schooling ideas of e-commerce, it forms a two-way embedding of school-enterprise double-body interaction. Taking the e-commerce profession in colleges and universities as a breakthrough, we innovate talent cultivation mode to the further development of e-commerce talent cultivation in colleges and universities.

2. SYMBIOTIC MODEL OF UNIVERSITY COLLABORATIVE INNOVATION

The interaction mode among universities, enterprises and governments determines the depth and breadth of collaborative innovation, which reflects the mode and intensity of action between units internally, and also affects the interests and information relationship among symbiotic units, involving the evolution of communication mechanism of symbiotic units. The co-innovation symbiosis model of colleges and universities refers to the specific forms of generation, interaction and evolution of technology flow, capital flow, information flow and knowledge flow among colleges and universities, enterprises and governments. Through the collaborative innovation model, innovation subjects such as universities, enterprises and government agencies take market demand as the link, center on technological innovation and industrialization, and use the collaborative innovation platform as the symbiotic interface to form a symbiotic system of mutual influence, mutual evolution and mutual collaboration, and then enhance their development potential. The innovation model of university collaborative cultivation based on symbiosis theory is shown in Figure 1.

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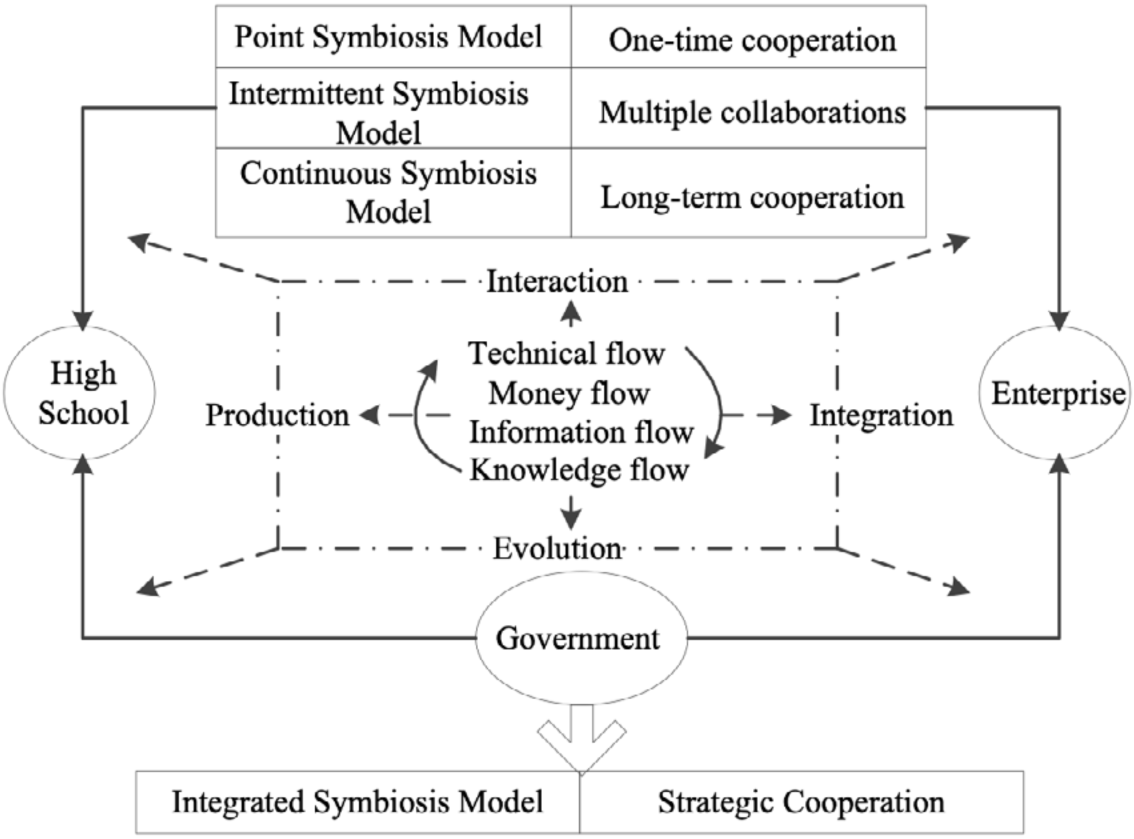

Figure 1. Synergistic innovation symbiosis model

As can be seen from Figure 1, there are four main types of symbiosis modes: point symbiosis mode, intermittent symbiosis mode, continuous symbiosis mode and integrated symbiosis mode, and there are differences in the degree of symbiosis under different symbiosis-derived modes. The point symbiosis mode often appears in the initial stage, due to the uncertainty of the market and the ambiguity of technology prospects, the cooperation between collaborative innovation subjects is random and unstable. After the formation of a symbiotic relationship, the cooperation mode tends to show one-time and transient nature because of less exchange of information and resources between unit elements. With the continuous integration of factor resources among participating subjects, to reduce information search cost and transaction costs, the cooperation among subjects gradually turns to intermittent symbiosis mode, which has relative stability and manifests as multiple cooperation. The continuous symbiosis mode is reflected in the complementarity and integration between the elements, with stability and high efficiency, which lays the foundation for long-term cooperation. In the symbiotic integration stage, the material, resource and information circulation between symbiotic units are based on the circulation within the symbiosis, and each participating part synergizes with each other and becomes an integral part of the whole symbiotic system. Multilateral exchange mechanisms are formed between universities, enterprises and governments based on the integration of elements, and the mediums complement each other, and the symbiotic relationship is stable with strong evolution and reciprocity.

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3. FRAMEWORK FOR COLLABORATIVE TRAINING OF E-COMMERCE IN UNIVERSITIES

The basic ideas of synergy theory can be summarized as the synergy effect, servo principle and self-organization. Synergy theory was first used to explain some phenomena in natural science, and then gradually extended to management science, education, economics and other fields, and now synergy theory has been widely used in many disciplines. There is no doubt that synergy theory is the development of modern system thought, and it provides new ideas for universities to explore the cultivation mode of e-commerce talents. As an emerging interdisciplinary discipline formed by the integration of many disciplines, students need to master the knowledge of information technology, business management, economy and trade, etc., and the process of capacity training involves many different subjects such as schools, enterprises and industries, etc. Meanwhile, because e-commerce is still developing rapidly, the field of e-commerce has typical innovation, entrepreneurship and uncertainty, and e-commerce talents should also have the corresponding quality. E-commerce talents should have the corresponding quality. Thus, it can be seen that the system of cultivating highly skilled talents in colleges and universities is a complex and open system. Collaborative training can be applied to guide the design of e-commerce talents and cultivate real high-skilled e-commerce talents. Based on the synergistic theory, the framework of the cultivation mode of highly skilled talents for e-commerce in colleges and universities is thought and designed in a new way.

In the framework of the new symbiotic e-commerce talent cultivation model, the traditional "symbiotic" talent cultivation model is revised and refined, trying to change the simple "symbiosis" in a crude way into the symbiotic talent cultivation goal of e-commerce majors, which is closely focused on We try to change the simple "symbiosis" in a crude way into the fine "knowledge symbiosis", "ability symbiosis" and "quality symbiosis" which are closely focused on the symbiotic talent training objectives of e-commerce majors. Through the flow of knowledge, the collision of skills and the integration of quality in different fields, it further realizes the interactive, holistic and cooperative effects among the subsystems of knowledge, ability and quality, to establish a coordinated talent cultivation system to realize the symbiotic goal.

4. ANALYSIS OF SCHOOL-ENTERPRISE COLLABORATIVE TRAINING MODEL INNOVATION

This paper forms a symbiotic system of mutual influence, mutual evolution and collaboration through the model of university collaborative innovation. Universities and enterprises interact with each other through symbiotic theory to solve the actual demand of economic and social development for talent training. Based on this, the university and enterprises collaborate and build a cooperative internship training platform. Make full use of the cooperative relationship between universities and enterprises, and build the internship training platform with enterprises, through which students can strengthen their understanding of the operation process of enterprises, the use of information technology in enterprises, and the organic combination of e-commerce website and back-end management information system. The introduction of the symbiosis theory approach in e-commerce majors can establish, in teaching practice and exploration, the educational concept of integrating innovation and entrepreneurship education into the whole process of talent training. Through exploration and practice, it gradually adjusts to the professional talent training goal of entrepreneurship and employment to cultivate students' innovative thinking and general education, and thus sets and optimizes personalized training programs and training goals for students. Students are the most direct participants and beneficiaries of the collaborative training model. To understand the development status of the model, we must first conduct experiments on the students' adaptability status of the training model. From the perspective of students, the main form of participation in this model is enterprise internship. Considering the difficulty of data acquisition, this study mainly focuses on the platform internship of students in school, with a total number of 62, including 17 male students, accounting for 36% of the sample size, and 45 female students, accounting for 64%.

In addition to this, a complementary group experiment was conducted with interns from some of the internship sites to further understand the specificity of the students' corporate internship status. The important results of the student's perception of the corporate internship are shown in Figure 2.

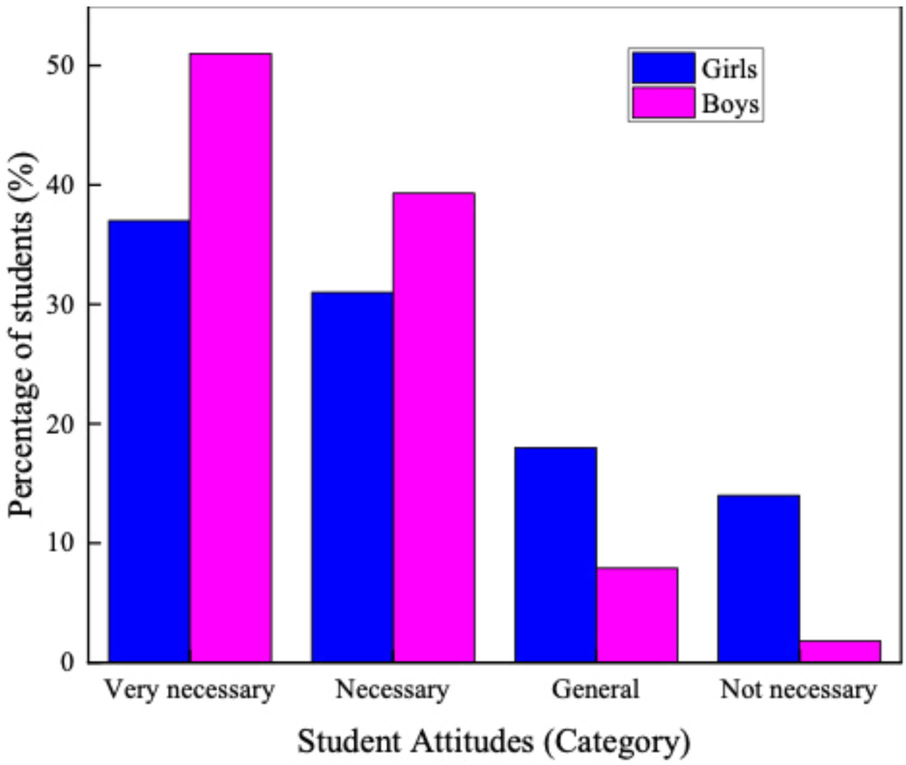

Figure 2. Students' awareness of the importance of going to companies for internships

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As can be seen from Figure 2, most e-commerce students have a positive attitude toward the role and significance of conducting enterprise internships. more than 90% of them think it is necessary to go to enterprises for a small trial after classroom study to apply what they have learned to concrete practice, among which 51% of the experimental subjects think it is necessary. According to the actual needs of both schools and enterprises, they jointly participate and carry out the work including the declaration and demonstration of specialties, the design and formulation of talent training programs, and the innovative curriculum system. The talent training program is formulated based on the development of the e-commerce industry and is oriented to the needs of e-commerce enterprises. The collaborating enterprises provide relevant practical training opportunities for schools and allow students to practice in real work scenarios. Reform the traditional curriculum system, set up courses according to e-commerce jobs, and realize "task-driven" modular teaching. Through the establishment of e-commerce innovation and entrepreneurship "fish pond" program classes, the e-commerce enterprises incubate the talents, so that the cultivated applied talents can be seamlessly connected with the employment needs of enterprises.

The practical teaching platform is mainly based on enterprises and has built an on-campus practical training base, an off-campus practical base and a platform for teachers to go to enterprises for attachment and exercise, which are dovetailed with e-commerce majors. It enables students to get in touch with the actual projects of real e-commerce enterprises during their school years and understand the job responsibilities and basic application skills requirements of relevant positions, which provides a guarantee for future employment. To further grasp students' specific perceptions of the significance of the role of collaborative training mode, this study categorized the reasons why students choose enterprise internship, and the results are shown in Table 1.

Table 1. Reasons for Choosing a corporate internship

	First Choice	Second Choice	Third Choice
Proximity	21		
The system is mature and can learn a lot	13	6	
With professional staff guidance	13	9	2
High level of identification with the company	2	7	4
Better service infrastructure	1	5	4
Easy access to supervisors	3	4	11
To obey the school's uniform arrangement	10	11	5

As can be seen from Table 1, 21 of the students chose proximity as their first choice of reason for doing an institutional internship. Proximity here is relative; on the one hand, some internship positions in the enterprise are arranged within the school, which saves students some time and cost for traveling to and from the internship site. On the other hand, the proximity of the core management system of the enterprise and the school facilitates the unified arrangement and management of the students by the school and the institution and also facilitates the students' access to the nuclear also management and institutional supervisors of the institution. Second, institutional advantages. Compared with other scattered internship bases, enterprises have a relatively mature standardized system for the management and training of colleges and universities. Students can have timely access to the most front-line and advanced network business innovations and understand the development of the industry, thus learning many contents that cannot be learned in the classroom or cannot be contacted and learned in depth. Third, the advantages of guidance. Internships in enterprises can get guidance and support from both enterprises and schools, which is also one of the important factors that attract students to enter the enterprise internship. The guidance advantage comes from the co-worker support of the front-line employees of the enterprise on the one hand, and the collaborative supervision of the school supervisor on the other.

A professional internship is an important part of social work personnel training. Some professional courses are oriented to work process systematization, and the collaborating enterprises provide teachers to teach on campus or bring students to the work site of the collaborating enterprises, and make efforts to strengthen the course content construction by completing 600-800 hours of professional internship teaching. The teaching contents are aligned with the needs of job clusters, and extra efforts are made to cultivate students' theoretical and practical abilities. The internship situation of students is shown in Figure 3.

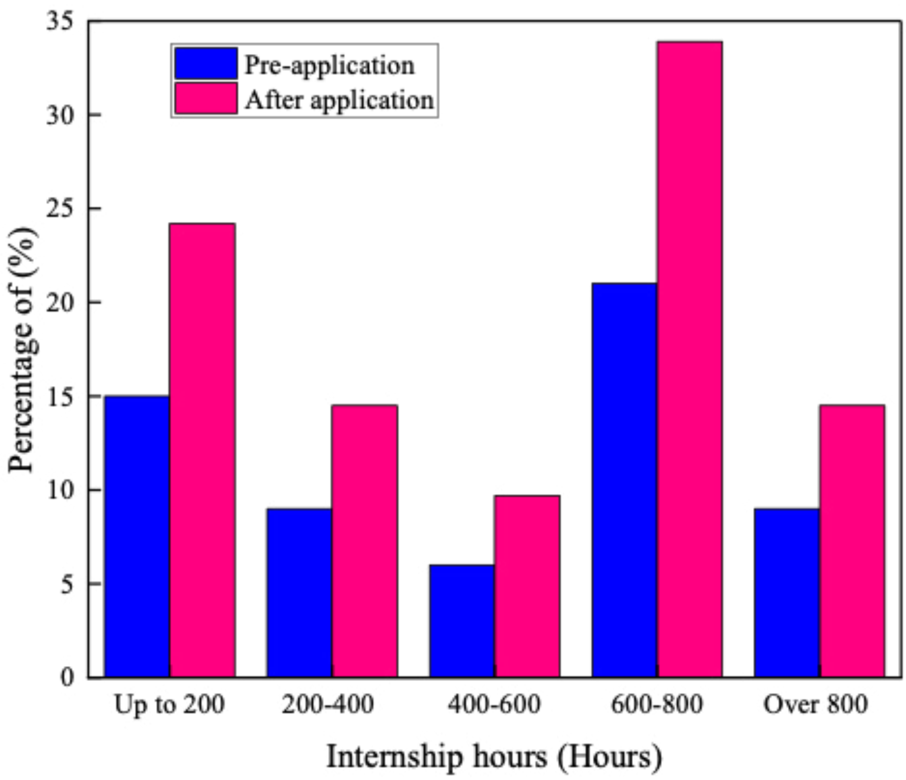

Figure 3. Total number of hours of student enterprise internship

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As can be seen from Figure 3, 33.9% of the students had a total internship of about 600-800 hours in e-commerce companies, and 14.5% had a total internship of more than 800 hours, which means that nearly half of them completed their practical training program in the internship platform. Secondly, in terms of the frequency of attendance at the internship unit, the attendance rate is at a high level. The frequency required by most internship positions after consultation and communication with the university is 3-4 times a week. Some of the internship positions are consistent with the unit staff's double-shift system, i.e., you have to go every day from Monday to Friday. Generally speaking, the durability and continuity of the internship time are closely related to the internship effect. The longer the internship time and the better the continuity, the better it is for the students to quickly adapt to the internship environment, understand and be familiar with the service objects and the service process, and ensure the effective succession and smoothness of the service activities so that the students can achieve the internship effect.

Under the premise of market orientation, we establish advanced innovation and entrepreneurship concepts and form the talent training mode of "innovation and entrepreneurship awareness + practical training + transformation of results". Universities should pay attention to developing students' continuous and active innovation and entrepreneurship spirit, inspire students' innovation and entrepreneurship consciousness through problems and tasks in classroom teaching, focus on guiding interests, mobilize students' autonomy, cultivate innovative thinking, respect students' differences, and let each student fully show his or her ability, to enhance innovation and entrepreneurship consciousness. Students should also be actively encouraged to devote themselves to practical activities of innovation and entrepreneurship, create a good atmosphere of innovation and entrepreneurship, cooperate with schools and enterprises to carry out innovation and entrepreneurship competitions, establish application-based platforms, open practice platforms to provide practical courses and projects on innovation and entrepreneurship now, help them to carry out innovative design and entrepreneurship simulations, continuously stimulate students' potential of innovation and entrepreneurship, and allow students to improve their creative and practical abilities in practical training. The overall effect before and after students' internship through the platform is shown in Figure 4.

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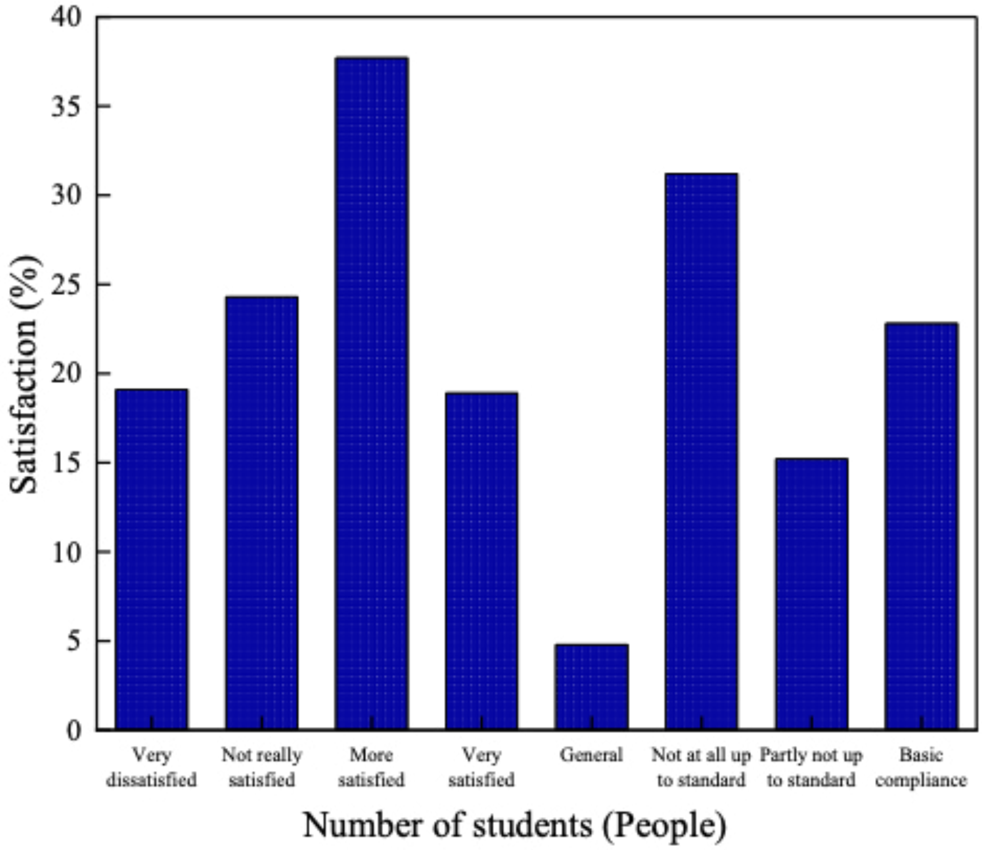
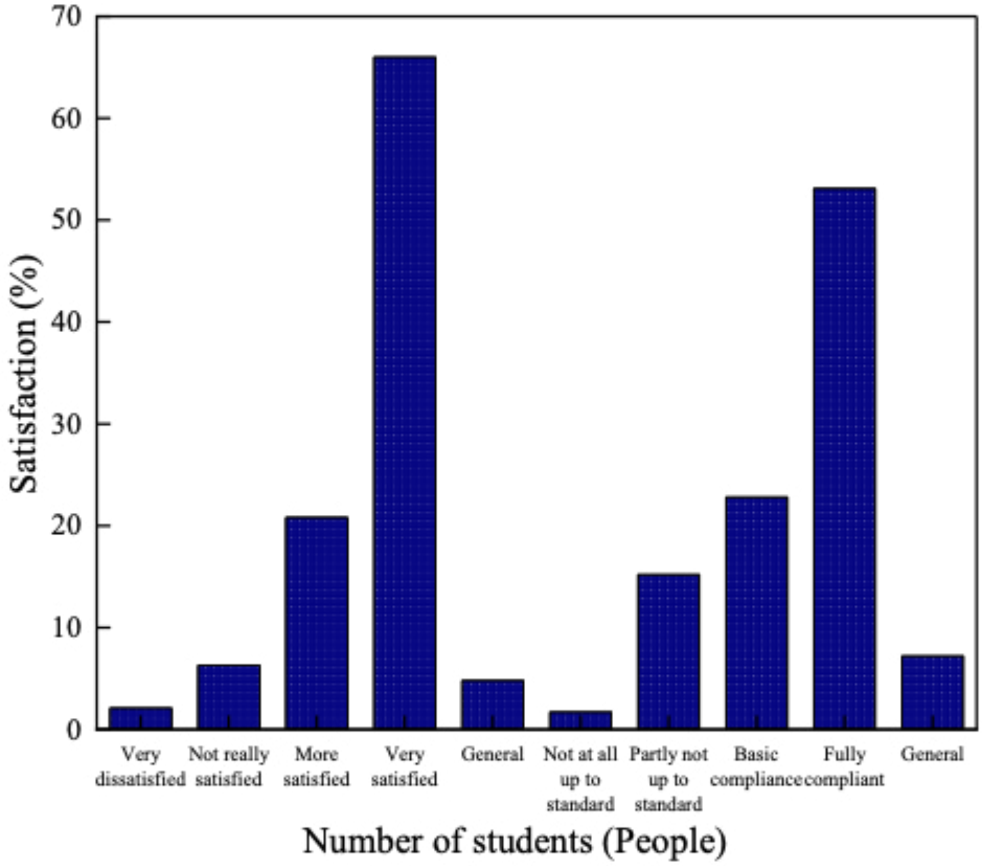


(a) Pre-placement student satisfaction and goal attainment



(b) Student satisfaction and goal attainment after the internship

Figure 4. Overall situation of students after the internship

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From Figure 4(a), it can be seen that through the platform pre-internship students' satisfaction status with the effect of their overall internship process, 19.1% were very dissatisfied, 18.9 were very satisfied, 31.2% did not meet the standard at all, and only 23.6 reached the goal completely. Further research on the achievement of students' internship goals revealed that the proportion of basic achievement was similar to the proportion of basic satisfaction, and the proportion of other corresponding options was chosen similarly. This requires students to accurately conduct self-assessments, set appropriate and feasible task and process goals, and ensure that the internship goals are compatible with their ability conditions and the real working environment during the internship process.

As can be seen from Figure 4(b), after the platform internship, students' overall indexes all rose substantially, and the number of very dissatisfied students dropped from 19.1% before the internship to 2.1%, and 66% of students felt very satisfied. 1.7% of students did not meet the target at all after the internship, and 53.1% of students achieved the target completely. The achievement of internship goals influences to some extent the satisfaction of students with their internship, and the better the achievement of goals, the higher the satisfaction. After being realized by the enterprise to ensure that students are relatively mastering the innovation and entrepreneurship process, the practical projects of the enterprise's e-commerce category can be outsourced to the excellent e-commerce student teams of the cooperating institutions, which not only cultivates the talent and courage of students' innovation and entrepreneurship, but also reduces the operation cost of the enterprise, and if the project is mature, it can be marketed to realize the transformation of innovation and entrepreneurship achievements.

5. CONCLUSION

On the one hand, it can enrich the connotation of e-commerce professional education and make the cultivation of e-commerce talents better serve the regional economic development, on the other hand, it can make the innovation and entrepreneurship education come into practice and develop in-depth. In addition, the "symbiosis theory" as a new research perspective and integration tool also further enriches the theoretical research on the integration of innovation and entrepreneurship education and professional education. It has important practical significance and theoretical research value for deepening education and teaching reform, improving the quality of e-business personnel training, and students' self-development. In this paper, through school-enterprise collaboration, we build a school-enterprise cooperation internship training platform, and the conclusions drawn after the internship are as follows:

1. 48.4% of the students' total internship in e-commerce enterprises is more than 600 hours, and the frequency of most internship positions is 3-4 times a week, accounting for 59.7% of the total. The implementation of a school-enterprise collaborative training mode is conducive to the joint development of schools

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and enterprises. Enterprises can obtain the talents they want in this talent training process, make talent reserves, shorten the talent training cycle, obtain cost-effective talent gains in the training process, and reduce operating costs.

2. Students' satisfaction with the overall effect of the internship process after the platform internship, "very satisfied" accounted for 66%, and 53.1% of students fully achieved the goal. The talent cultivation model cultivates talents according to the market needs and focuses on the simultaneous improvement of professional and vocational qualities of talents, which is good guidance for students to enter the entrepreneurial market in terms of employment and accumulation of experience.

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/12/

ANALYSIS OF SUPPLY CHAIN FINANCE RISK ASSESSMENT BASED ON NUMERICAL ANALYSIS ALGORITHM

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ABSTRACT

To promote the coordination and stability of supply chain finance and improve the financing environment of small and medium-sized enterprises, this paper designs a supply chain finance risk assessment and analysis platform. Combining the characteristics of a large amount of risk assessment data, a numerical analysis algorithm is introduced in the process of platform design, and the extrapolation method in the numerical analysis algorithm is used to calculate the risk assessment-related data. To make the calculation faster and the data more accurate, the central difference quotient extrapolation is used to accelerate and a downtime mechanism is introduced. Firstly, the approximation formula for the calculation is constructed, followed by the construction of a sequence of variable steps to obtain a sequence of approximations. Finally, the obtained approximate sequence values are used to construct an interpolating polynomial, and the constant term of the polynomial, which is the final risk factor, is obtained through continuous iteration. To verify the effectiveness of the numerical analysis-based algorithm in supply chain financial risk assessment, the simulation results show that the risk assessment accuracy of the numerical analysis-based supply chain financial risk assessment platform is as high as 99% and the time required is 17 seconds higher than other assessment models, which verifies that the numerical analysis algorithm can improve the accuracy and rapidity of risk assessment.

KEYWORDS

Numerical analysis, extrapolation, iteration, supply chain finance, risk assessment

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1. INTRODUCTION

In recent years, supply chain finance has gradually received wide attention from society, and as an innovative financial product, it has played a positive role in promoting the coordination and stability of the supply chain and solving the financing problems of SMEs [1-2]. However, as an innovative financial product, it has attracted close attention from all walks of life, including financial institutions and supply chain enterprise clusters, once it was proposed [3]. The orderly development of supply chain finance has promoted the coordination and stability of the supply chain, improved the financing environment of SMEs, and enhanced the operation quality of the financial system. However, China's supply chain finance is late and immature, and although some experience and achievements have been made in the assessment of credit risk in supply chain finance, it still needs continuous in-depth research and improvement.

The literature [4] studies the credit risk of SME financing from the perspective of supply chain finance. The supply chain finance system is constructed through blockchain technology, which integrates supply chain finance information into blocks. The literature [5] constructed a web-based search and matching platform through the EEnvest tool based on the analysis of the correlation between technology and financial risks, and their originating factors or root causes. This platform contains a large number of already defined key performance indicators necessary to assess investment risk, and the presence or absence of risk is known by searching and matching. An improved approach to credit risk assessment is proposed in the literature [6]. Based on credit data from the China Banking Regulatory Commission, the paper constructs a multidimensional and multilevel credit risk indicator system. In particular, it proposes an improved sequential minimum optimization learning algorithm for the credit risk classification model, named four variables. In each iteration, it jointly selects four variables into the working set and proposes a theorem to guarantee the analytical solution of the subproblem. It is evaluated on the Chinese credit dataset and two benchmark credit datasets. The experimental results show that the four variables are competitive in saving computational cost and outperform the other five advanced classification methods in terms of the accuracy of credit risk assessment. The literature [7] proposes a revised method for high-dimensional dynamic variance, and covariance matrix estimation through risk factor mapping. To validate the effectiveness of the method for risk assessment, a covariate multivariate generalized autoregressive conditional heteroskedasticity model is used to model the risk factors flexibly, and a Bayesian approach is used to estimate the unknown parameters and various risk measures. The results show that the method is able to obtain dependent estimates of asset returns in large portfolios with high computational efficiency. Although the above literature proposes a relatively feasible system and recommendations for supply chain finance risk assessment, it ignores the transfer mechanism of market risk and relies highly on credit ratings, resulting in a low precision of the assessed values.

Therefore, this paper constructs a supply chain finance risk assessment platform based on a numerical analysis algorithm. The numerical indicators of risk assessment are calculated with the help of the extrapolation method in the numerical analysis algorithm. To make the extrapolation faster, the central difference quotient is used to accelerate the extrapolation. By constructing an approximate formula for the risk factor function and continuously changing the step size, an approximate sequence of values of the risk factor function is obtained, and the obtained approximate sequence of values is used to construct an interpolating polynomial, to obtain the constant value in the polynomial, i.e., the final risk factor. Considering that the basic idea of numerical analysis is iterative, it is also necessary to introduce stopping in the process of iteration to remember. A sufficiently small value is determined beforehand, and if a number smaller than the determined value is obtained in the iterative calculation, the calculation is stopped. If the difference between the two values obtained is sufficiently small, the final risk factor can be determined, otherwise, the iterative operation is repeated. To verify the effectiveness of the proposed platform, the accuracy and time required for risk assessment of the proposed platform are analyzed in simulation experiments, and the relevant data show that the risk assessment analysis can be achieved accurately and quickly based on numerical analysis.

2. SUPPLY CHAIN FINANCE AND ITS RISK ASSESSMENT

2.1. SUPPLY CHAIN FINANCE

Supply chain finance is an innovative model of providing services to supporting enterprises upstream and downstream around the core of the supply chain using scientific management methods. The essence of supply chain finance is the logistics, capital flow, data flow and other services led by the transaction behavior, which mainly provides innovative financial services for SMEs with financing difficulties. Therefore, supply chain finance can be regarded as both a tool for financial financing using the assets in the industrial chain and a comprehensive financial product specifically serving upstream and downstream enterprises in the trade chain [8-9]. However, the early supply chain finance model was mainly applied in the management of customized customer needs and market transaction cost control, and also in the work of logistics and information flow services for a long time.

China points out in the concept study of supply chain finance that supply chain finance is a new financing method for the development of small and medium-sized enterprises, introducing various market enterprise institutions such as core enterprises and commercial banking institutions in the chain, and providing financial support for the business development of enterprises according to the cost situation in the process of supply chain production system. However, there is not an absolute unified standard for supply chain finance business in the current international academic research. However, it is recognized that a supply chain finance business should have the following characteristics: firstly, it needs to have real trade background; secondly, it

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needs credit from core enterprises; thirdly, it solves financing problems and reduces costs.

As an innovative service industry born in the financial field, supply chain finance is growing rapidly in China and has become an important tool for core supply chain organizations to enhance their competitiveness and broaden their development channels, while it has also started to become an effective channel for financing SMEs [10-11]. Supply chain finance can close the assets or physical property rights that are not highly liquid in the trade chain through financial means to realize the smooth operation of enterprise capital flow. Binding the relatively stable business performance of core enterprises is the key to the operation of supply chain finance, thus making the uncontrollable risks of financing enterprises into controllable risks in the supply chain, and the core enterprises and upstream and downstream trading enterprises form a community to implement financial services for real-time tracking of enterprise operations. The supply chain finance model is shown in Figure 1.

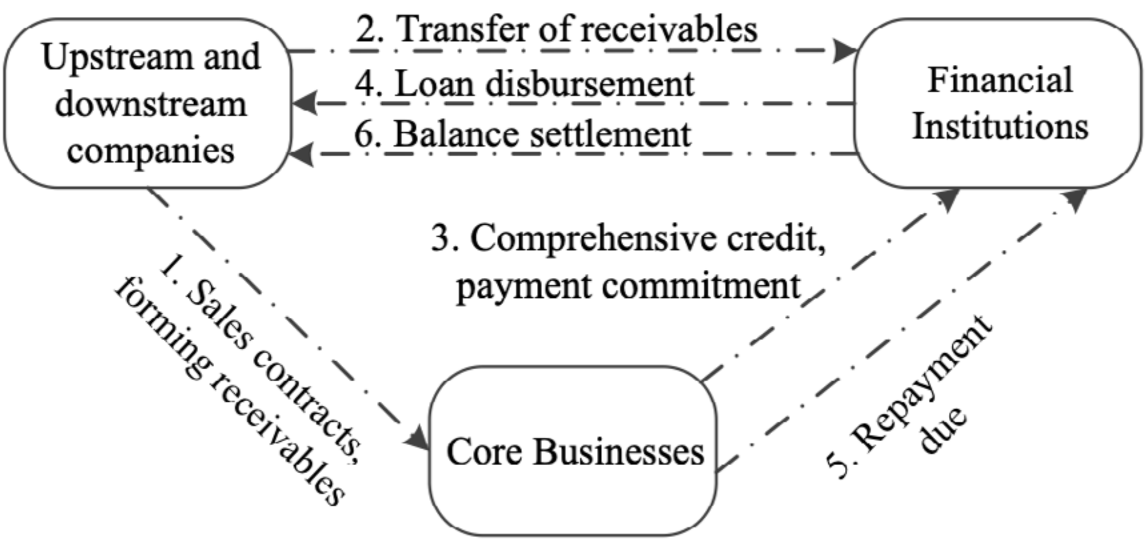

Figure 1. Supply Chain Finance Model

From Figure 1, it can be seen that the core of supply chain finance lies in the integration of different organizational forms such as suppliers, manufacturers, distributors and retailers in the supply chain with the core enterprise as the center, and providing financing and credit guarantee for enterprises through financial support. The introduction of supply chain finance can, on the one hand, provide financing guarantee for weak enterprises in the whole supply chain through effective injection of funds and avoid the emergence of supply chain imbalance, and on the other hand, introduce credit assessment mechanism to discipline the purchase and sales behavior of enterprises and regulate the commercial credit system, thus promoting the construction of long-term strategic synergy and enhancing the stability and competitiveness of the whole supply chain. Under the current situation, domestic financial institutions have started to combine theories and methods of supply chain finance to innovate in their respective product solutions.

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2.2. SUPPLY CHAIN FINANCE OPERATION PROCESS

Under the traditional credit model, banks analyze the credit of SMEs mainly for the financing companies themselves, but SMEs often fail to meet the banks' standards due to their own disadvantages, which limits the financing needs of SMEs. Supply chain finance, on the other hand, provides a new perspective on financing with its unique characteristics. Based on supply chain finance, bank credit requirements are not limited to SMEs themselves, but instead focus on the whole supply chain [12]. Financing is provided by the authenticity between enterprises, which can weaken the limitations caused by SMEs' own defects to a certain extent [13]. When financing, banks not only assess the borrower's credit status, but also examine the cooperative relationship between the enterprise and the core enterprise, and review it in conjunction with the authenticity of the trade background. On the basis of trade authenticity, banks provide flexible and variable financing solutions to SMEs for the assets generated in the transaction process, thus allowing more SMEs to enter the bank's service paradigm. The specific process is shown in Figure 2.

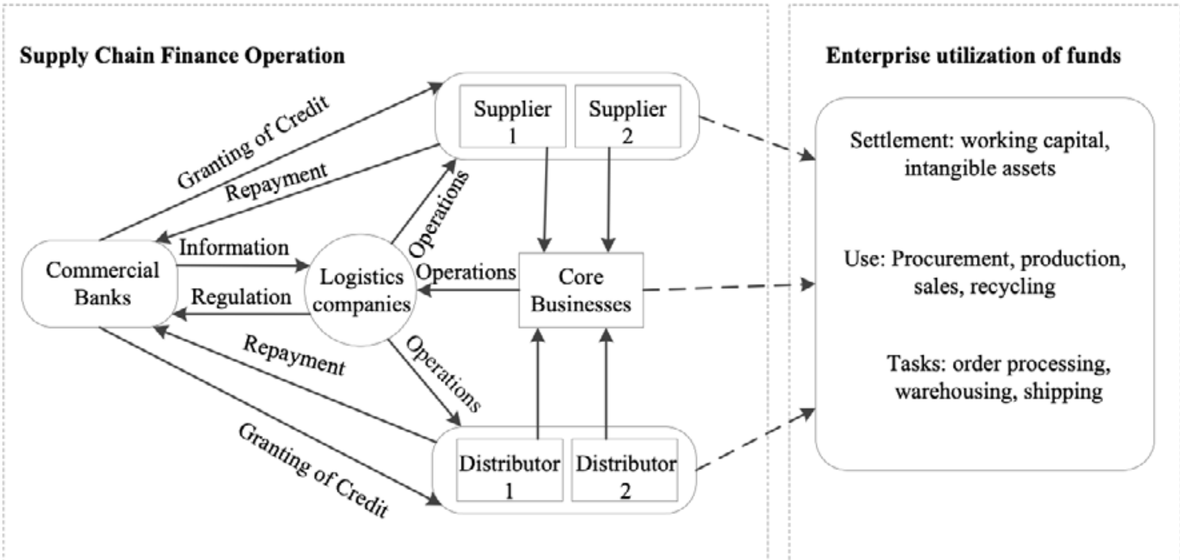

Figure 2. Supply chain operation process

As can be seen from Figure 2, supply chain finance is based on real trade background and supported by sufficient information, and the risks are effectively controlled or reduced to a certain extent. From the bank's perspective, compared with the traditional lending model, the financial strength of individual enterprises is no longer assessed separately, and the assessment system for credit access is more relaxed. In supply chain finance, banks first assess the financial status and development potential of the core enterprises. The bank provides financial services to its upstream and downstream enterprises by focusing on the quality credit of the core enterprise, which, as the main body of bank credit, ties its own credit with SMEs, and then evaluates SMEs not only considering their financial situation but also paying more attention to their cooperation with the core enterprise. Finally, supply chain

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finance also emphasizes the self-repayment of credit repayment sources, i.e., directing the sales revenue to repay the credit.

Relative to the core enterprises, supply chain finance can effectively solve the dilemma of difficult financing for its upstream and downstream enterprises, promote the stable cooperative relationship between each SME in the supply chain and the core enterprises, and ensure that the core enterprises have stable suppliers and sellers. Once the development of SMEs at each node of the chain is restricted, it will affect the supply and sales of the core enterprises. However, through supply chain financial services, the cooperative relationship between each enterprise in the supply chain can be consolidated, which in turn is conducive to the development and growth of the core enterprises themselves. The smooth flow of funds and reduced payment pressure of core enterprises also expand their own production and sales, thus driving the healthy development of the whole supply chain.

It can be seen that the financing model of supply chain finance can relax the financial analysis and access principle of banks to individual enterprises because supply chain finance is actually oriented to a collection of enterprises with business relations, and there exists a certain relationship bond within this collection itself, namely the existence of horizontal supervision mechanism. The existence of such horizontal supervision proves that there are still certain risks in the supply chain financing model, therefore, the risk assessment of supply chain finance becomes more and more important.

2.3. SUPPLY CHAIN FINANCE RISK ASSESSMENT

Supply chain finance risk refers to the possibility that commercial banks and third-party logistics companies may suffer losses due to the impact of various unpredictable uncertainties in the process of financing supply chain enterprises, which may cause the actual revenue of supply chain finance products to deviate from the expected revenue or the assets may not be recovered.

Therefore, banks must carry out risk assessments before helping enterprises to carry out supply chain finance financing. Therefore, the risk assessment index of supply chain finance should contain the following four aspects.

The first is the qualification of fiduciary, including profitability, solvency, operational capability and development potential. The qualification of the fiduciary is similar to the evaluation indexes of traditional business, focusing on the basic financial status and development trend of the enterprise, and the selection of indexes is mainly based on the evaluation indexes of traditional business.

The second is the core enterprise qualification. In supply chain finance, the counterparty of the SME is the core enterprise. The qualification of the core enterprise mainly includes industry status, profitability, repayment ability, etc. Because the core

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enterprise is tied to the credit of SMEs, the qualification of the core enterprise directly affects the supply chain finance business carried out by banks.

The third is the overall operation of the supply chain. The business capability of the trustee and the cooperation with the core enterprises are considered from the whole supply chain. Among them, the industry situation mainly shows the development prospect of the whole industry, and the cooperation situation examines the closeness of cooperation between SMEs and core enterprises and the authenticity of transactions.

The fourth is the condition of the assets under the financing. This is the most important thing for the bank to examine because the bank is to evaluate the value of the transaction assets, and then grant credit according to the evaluation result, if the fiduciary defaults, the transaction assets are also a guarantee for the bank to liquidate them to make up for the loss.

Combined with the main elements of risk assessment, this paper comes up with supply chain finance risk evaluation indexes, as shown in Table 1.

Table 1. Supply chain financing risk evaluation indicators

Tier 1 indicators	Secondary indicators	Tertiary indicators
SME Qualifications	Comprehensive competence	Self-qualification
Core Corporate Qualifications	Core own qualifications	Credit situation
	Industry status	Industry Impact
	Profitability	Operating profit
		Return on total assets
		Return on net assets
	Solvency	Gearing ratio
		Current ratio
		Quick ratio
		Operating cash flow ratio
		Sales cash flow ratio
	Operational capabilities	Total asset turnover ratio
		Accounts receivable turnover days
		Inventory turnover days
	Development potential	Operating income growth rate
		Net margin growth rate
Supply Chain Situation	Overall operation	Closeness of cooperation
Assets under financing	Physical characteristics	Trusted Bad Debt Rate

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As can be seen in Table 1, banks in the traditional credit business mainly examine the borrowers themselves, focusing on financial characteristics, industry status, and business situation. Each SME in the supply chain does business with its financing bank according to its situation, and banks individually assess only SMEs, so the credit access assessment of each SME is also relatively independent. As the efficiency of the supply chain increases, supply chain finance is developing rapidly, and banks have to provide financing for SMEs in need based on the whole supply chain. The credit evaluation of SMEs by banks in supply chain finance should be based on comprehensive analysis.

The description and assessment of the risks inherent in highly diversified investments in financial markets are often based on complex mathematical and computational models. Solving these models precisely in closed form, even at the level of a single instrument, is usually impossible, and therefore efficient numerical algorithms must be found. Accordingly, this paper introduces numerical analysis algorithms in supply chain finance risk assessment, seeking to provide a deeper grasp of risk.

2.4. APPLICATION OF NUMERICAL ANALYSIS ALGORITHMS IN RISK ASSESSMENT

2.4.1. NUMERICAL ANALYSIS

Numerical analysis is the study and analysis of numerical computational methods and their theory for solving mathematical computational problems by computer, and it is an important branch of mathematics [14]. Numerical analysis takes the theory and methods of solving mathematical problems by digital computers as the object of study and is the main part of computational mathematics. The main contents include interpolation, function approximation, curve fitting, numerical integration and numerical differentiation. Simply put, numerical analysis is the science of studying algorithms for continuous problems. The most important concepts in it are algorithms and continuous problems [15]. First, continuous problems are complex model problems abstracted from physics or other disciplines, generally infinite-dimensional problems and almost impossible to find analytical solutions. These intractable continuous problems are naturally the target of numerical analysis. Second, the design and analysis of algorithms for solving continuous problems are the core of numerical analysis. Their purpose is to discretize a continuous infinite-dimensional problem to obtain a discrete finite-dimensional solvable problem and then to obtain an approximate solution. Currently, numerical analysis is commonly used by hedge funds to calculate the market value of stocks and their variability using various numerical analysis tools and by insurance companies to perform actuarial analysis using numerical software.

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The purpose of numerical analysis is to design and analyze some calculations in such a way that approximate but sufficiently accurate results can be obtained for some problems. The numerical analysis mainly considers the numerical solution of a problem, including but not limited to the construction of numerical algorithms, the effect of error propagation, the estimation of computational complexity, and the implementation of efficient and reliable computers. Although there are different numerical models to construct for different problems, they generally have some commonalities:

1. Numerical analysis will generally use linear algebra, advanced mathematics, real analysis, and generalized functional analysis as the basis or analytical tools.

2. If a problem cannot be solved directly, try to consider an approximate solvable problem.

3. Have a certain degree of stability. Stability here refers to the sensitivity of the solution of the model problem to the initial data. That is, the numerical solution changes due to small changes in the initial data, and the smaller the change, the more stable it is.

2.4.2. NUMERICAL ANALYSIS OF EXTRAPOLATION METHOD TO SOLVE

Numerical analysis is divided into different areas depending on the problem to be solved. Among them, extrapolation is commonly used in economic calculations and forecasting.

Extrapolation is a general term for a class of methods that extrapolate the future based on past and present trends, and is used for forecasting scientific, technological, economic and social development, and is an important part of the intelligence research method system. In layman's terms, it is a good method of approximation calculation, for the low-precision approximation that has been obtained, just make a few times the simplest four operations, then immediately get a high-precision approximation. More simply, it is a method to process the low-precision approximation to a high-precision approximation, referred to as finishing.

Let the function be a continuous and differentiable real function in the supply chain finance calculation process. Numerical analysis is the direct use of the procedure for calculating the function to calculate the derivative value of the function at a certain place, which in turn leads to data related to risk assessment. To make the results more accurate, this paper uses a variable step method to improve the accuracy of the calculation. When the value of the step size is sufficiently small, the first-order difference quotient of the function at a fixed point can be used as an approximation to the risk assessment function, resulting in an approximate formula related to the step size. Next, a sequence of step lengths that converge monotonically to zero is

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constructed for calculation. Letting the given initial step size be greater than zero, a step series can be simply obtained, and accordingly, a sequence of approximations to the derivatives is obtained.

The basic idea of numerical analysis is iteration, so it is certainly an easy task to calculate a sequence using a loop structure, but a stopping rule needs to be determined. In this case, the decision to stop can be based on the actual accuracy required. Determine in advance a function value on a sufficiently small positive number, as long as the iterative process of computing a value less than this positive number, the system will automatically stop the calculation.

To obtain the risk assessment data quickly, the central difference quotient extrapolation acceleration can be used. The basic idea of the central difference quotient extrapolation acceleration is exactly the same as the extrapolation method, which also uses a three-step strategy:

1. Construct the approximation formula for the computational function.
2. Construct the sequence of variable steps so as to obtain the sequence of approximate values of the function.
3. Construct the interpolation polynomial using the obtained approximate sequence values, thus obtaining the constant term of the polynomial.

Since the central difference has an accuracy of order 2, the sequence here will converge a little faster and the final results that can be obtained will be more accurate [16]. This shows that it is practical to apply numerical analysis algorithms to supply chain finance risk assessment.

2.5. SUPPLY CHAIN FINANCE RISK ASSESSMENT PLATFORM

Applying numerical analysis to supply chain financial risk assessment analysis can improve the performance related to risk assessment, such as accuracy and rapidity. Accordingly, this paper constructs a supply chain financial risk assessment platform based on numerical analysis algorithms, as shown in Figure 3.

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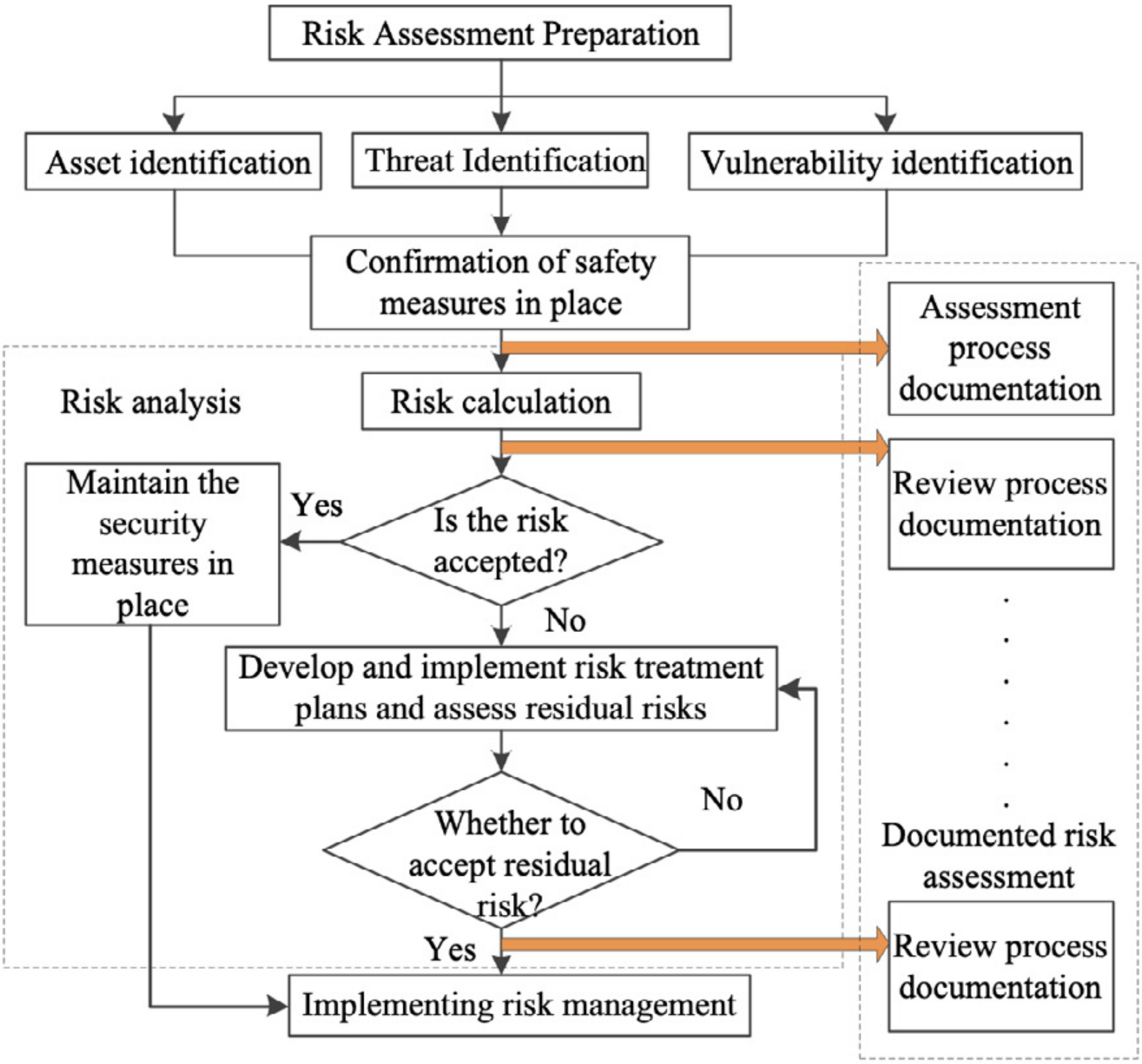

Figure 3. Supply chain finance risk assessment platform based on numerical analysis

As can be seen in Figure 3, the supply chain finance risk assessment and analysis platform built based on numerical analysis algorithms in this paper forms a set of integrated regulatory data control systems based on ex-ante and ex-post. The platform adopts the concept of a middle platform, facing the core enterprises, with custom data processing, data governance and control, data asset management, data replenishment, data reporting, risk management and monitoring capabilities, which can be well applied to major financial institutions and data empowerment for business users in the field of risk assessment. At the same time, the platform continuously carries out iterative data computing in the process of risk assessment, realizing all-around monitoring of risks and effectively preventing financial risks caused by residual risks.

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3. ANALYSIS OF THE EFFECT OF THE SUPPLY CHAIN FINANCE RISK ASSESSMENT PLATFORM

3.1. HIGH ACCURACY OF RISK ASSESSMENT

The main purpose of applying numerical analysis algorithms to supply chain financial risk assessment is to help banks and other related financial institutions accurately identify the possible financial risks of enterprises. To verify that numerical analysis can help the supply chain financial risk assessment platform to improve the accuracy of risk assessment, this paper randomly selects 10 enterprises in a city and combines the risk assessment indexes derived above to derive 180 financial risk factors. Using the numerical analysis algorithm constructed in this paper, the accuracy of the risk assessment was obtained by using the supply chain financial risk assessment platform and the traditional risk assessment model. The results obtained under the same conditions are shown in Figure 4.

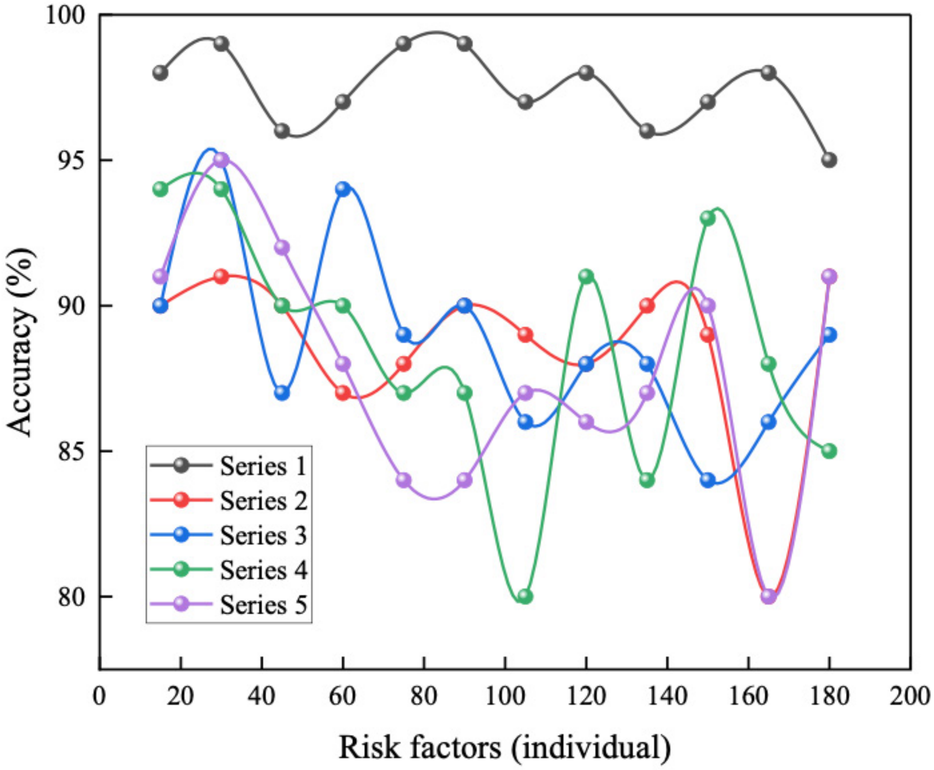

Figure 4. Accuracy of risk assessment under different platform models

As can be seen from Figure 4, the risk assessment accuracy of the supply chain finance risk assessment platform based on numerical analysis is consistently higher than that of the other four traditional risk assessment models. When the risk factors are 45 or less, the risk assessment accuracy of the supply chain finance risk assessment platform based on numerical analysis is always 96% and above, and can reach 99% at the highest. The risk assessment accuracy of the other four risk assessment models can only reach 95% at the highest. In particular, the risk

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assessment accuracy of the Credit Risk model is 87% when the number of risk factors is 45, which is 9% lower than that of the model proposed in this paper. When the number of risk factors is 60, the risk assessment accuracy of the supply chain finance risk platform based on numerical analysis is 97%, which is higher than the other four models by 10%, 3%, 7% and 9%, respectively. When the number of risk factors is 90, the accuracy rate of the risk assessment of the supply chain finance platform based on numerical analysis reaches its peak again, 99%. In contrast, the risk assessment accuracy of the logistic regression model reached its historical low of 84%, with a difference of 15% between the two.

With the increase of data, the risk assessment accuracy of the supply chain finance risk assessment platform based on numerical analysis always maintains a high level of more than 90%. In contrast, the risk assessment accuracy of the other four risk assessment models can only be maintained above 80%. When the number of risk factors reaches 165, the accuracy of risk assessment of the platform built in this paper is 98%, while the accuracy of risk assessment of the other four platforms is 88% at the highest and 80% at the lowest, which is 10% and 18% different from the platform built in this paper respectively. When the number of risk factors reaches 180, the risk assessment accuracy of the supply chain finance risk assessment platform based on numerical analysis is still the highest among the five platforms, which is higher than the other four models by 4%, 6%, 10% and 4%, respectively. The difference in accuracy rates is small in terms of percentage, but when converted to the number of specific risk factors through calculation, the difference is large.

It can be seen that after the introduction of a numerical analysis algorithm in the risk assessment analysis of supply chain finance, the accuracy rate of risk assessment is always maintained at a high level, which can help banks identify the risks of enterprises in time and reduce the risk of investment.

3.2. SPEEDY RISK ASSESSMENT

The development of supply chain finance affects not only a large number of SMEs and banks but also the employees in the companies. If the financial help related to supply chain finance is not timely, it is likely to cause an economic crisis in a series of enterprises, which will affect livelihood issues. Therefore, the risk assessment of supply chain finance must be guaranteed to be fast. To verify the rapidity of risk assessment of supply chain finance based on numerical analysis, this paper shows the simulation experiment again based on the relevant conditions in 3.1 to derive the speed of risk assessment of platforms and models in 5, and the results are shown in Figure 5.

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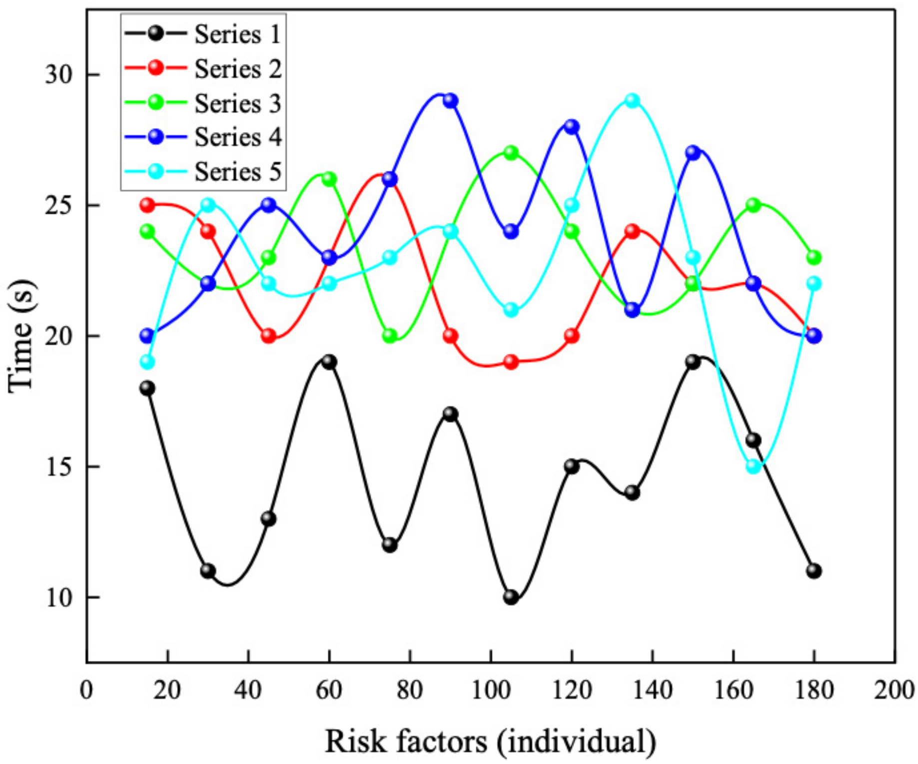

Figure 5. Time required for risk assessment under different platform models

As can be seen in Figure 5, when the number of risk factors is 15, the logistic regression model takes only 19 seconds to derive all the risk factors, which is less time. However, the supply chain finance risk assessment platform based on numerical analysis only takes 18 seconds to derive all the risk factors, which is still 1 second faster than the logistic regression model. The KMV model takes 25 seconds to calculate all the risk factors, which is 7 seconds longer than the numerical analysis-based supply chain financial risk assessment platform. When the risk factors are greater than 15 and less than 90, the platform built in this paper takes at least 11 seconds to calculate all the risk factors. The other four platforms take at least 20 seconds to derive all the risk factors, which is 9 seconds longer than the platform built in this paper. When the number of risk factors is 105, the supply chain finance risk assessment platform based on numerical analysis can derive all the risk factors in 10 seconds, which is 17 seconds less than the other risk assessment platforms. When the number of risk factors is 150, the supply chain financial risk assessment platform based on numerical analysis takes the most time, 19 seconds, but it still takes less time than the other four models. When the number of risk factors is 165, the platform built in this paper takes 16 seconds to derive all the risk factors. This is 6 seconds, 9 seconds, 6 seconds and 1 second faster than the other four models, respectively. When the number of risk factors is 180, it takes only 11 seconds to derive all the risk factors, which is twice as long as the logistic regression model.

By comparing the risk factor discovery time, it can be seen that the risk factor discovery time of the supply chain finance risk assessment platform based on numerical analysis is always controlled within 20 seconds, with a minimum of 10 seconds. As the risk increases, the speed of risk assessment remains at a high level. Thus, the application of numerical analysis to supply chain finance risk assessment is helpful to help banks quickly discover the risks of enterprises, and then reduce financing to enterprises to ensure the safety of capital.

4. CONCLUSION

To improve the financing environment of SMEs, this paper calculates the numerical indicators of risk assessment with the help of the extrapolation method in the numerical analysis algorithm. To make the extrapolation faster, the central difference quotient is used to accelerate the extrapolation. Firstly, an approximate formula for the risk factor function is constructed. Secondly, a sequence of variable steps is constructed to obtain an approximate sequence of risk factor functions. Finally, the obtained approximate sequence values are used to construct an interpolating polynomial, to obtain the constant term of the polynomial, i.e., the risk factor value. Combined with the above numerical analysis process, this paper constructs a supply chain finance risk assessment platform based on numerical analysis. To verify that the platform built in this paper can accurately and quickly identify the risks in supply chain finance, 180 risk factors are screened out in 10 companies, and the built platform is applied to risk assessment with other four risk assessment models, and the accuracy and speed of risk assessment of the five platform models are obtained respectively. The results show that the supply chain finance risk assessment platform based on numerical analysis has the highest risk assessment accuracy of 99% and takes at least 11 seconds to find all risk factors, while the other models take 20 seconds to find all risk factors. The accuracy and speed of supply chain finance risk assessment shows that efficient risk assessment analysis can be achieved by relying on numerical analysis algorithms.

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/13/

OPTIMIZATION OF CHINA'S ECOLOGICAL TAX SYSTEM BASED ON GEP DEVELOPMENT STRATEGY

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ABSTRACT

To reduce ecological environmental pollution and economic loss, and improve national environmental awareness, this paper puts forward the optimization of China's ecological tax system based on the GEP development strategy. Firstly, the analysis shows that GDP focuses on economic operation, while GEP focuses on ecosystem operation. Then, GEP is used to calculate the data of water conservation, soil conservation function, flood regulation and storage, air and water purification, carbon fixation and oxygen release, climate regulation, biological community, and other indicators to obtain the corresponding value. We will use fiscal principles to adjust the sensitivity of economic changes, the principle of fairness to narrow income disparities, and the principle of efficiency to adjust market collection and management, simplify the tax system, and improve national treatment. Finally, the maximization of tax benefits is realized with the minimum tax cost under the tax system. Through experiments, it is proved that this method can effectively explore the development of an ecological tax system, to optimize the overall optimization of tax collection and management up to 0.77.

KEYWORDS

GEP development strategy; Ecological taxes; Tax optimization

INDEX

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1. INTRODUCTION

For a long time, China's economic development has excessively relied on the extensive [1] economic growth mode of expanding investment scale and increasing material input, thus making the contradiction between economic development and resources and environment more and more acute [2]. To coordinate the harmonious development of man and nature, higher requirements are put forward for the construction of a sustainable economic system in China [3]. Arable land resources, forest resources, grassland resources, water resources, and some mineral resources, as well as Marine fish resources, have been in a rather tight state of supply and demand [4]. Contrary to the overall situation of resource shortage in China, it is a huge waste in resource exploitation and utilization [5].

According to the Bulletin on China's Environmental Situation, the trend of worsening environmental pollution in China has been basically controlled, but the problem of environmental pollution is still serious, and the scope of ecological damage is still expanding. The air quality of two-thirds of the cities does not meet the second-class national standard for the water environment. Organic pollution of surface water is widespread, oxidation of major lakes is prominent, groundwater is polluted by spots or planes, and the water level is falling. Mild or above environmental pollution is one of the four major factors affecting the health and death of residents in 84.6% of cities. In terms of resource utilization, China is still in a state of high input and low output, and resources have been hollowed out [6], which does not meet the requirements of sustainable development. Therefore, the waste of resources exploitation and utilization, and the problem of environmental pollution have increasingly become the factors that restrict China's social and economic development, as well as the important factors that endanger people's health and affect local social stability.

Taxation is an important means of national macro-control [7], and the taxation system is an important part of the formal system of national economic management. Introduction of ecological tax, setting up ecological tax system is a director of environmental policy innovation, and contemporary issues of sustainable development of ecological tax can be either as an economic tool for manufacturers and consumers of energy waste, environmental pollution behavior constraints [8], but also can increase the corresponding public finance income in our country can not only bring environmental improvement of social and economic benefits, Moreover, under certain conditions, it is beneficial to the improvement of China's overall tax system [9].

Literature [10] emphasizes the cultural basis and life proposed in ecosystem services described in the International Common Classification method of Ecosystem services and proposes a new social landscape order. Taking Hequ County of Shanxi Province as a case study, the gravity method is used to evaluate the ecological level of social capital. Literature [11] on urban agricultural ecological space evaluation is helpful to optimize land space and high-quality social and economic development. Urban development and ecological protection in urban agglomeration are evaluated, and the ecological security model of sustainable land space utilization is described.

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Literature [12] studies that China's current tax system structure contradicts the concepts of economic structure optimization and upgrading, coordinated development of regional economy, improvement of ecological environment, improvement of people's well-being, and narrowing of the income gap. To solve these problems, the reform of income tax, turnover tax, resource tax, property tax, and behavior tax must be carried out with the help of modern development concepts. Literature [13] uses urban agricultural ecological space evaluation to help optimize land space and high-quality social and economic development, evaluates the urban development and ecological protection of the Changsha-Zhuzhou-Xiangtan urban agglomeration as the research area, and describes the ecological security model of sustainable utilization of land space. From the above, we know the importance of the ecosystem in economic development, indicating that tax revenue has a great relationship with production and life, and it is very important to optimize the tax system. Therefore, this paper puts forward an analysis of eco-tax system optimization based on the GEP development strategy. Through the analysis of GDP and GEP accounting, the ecological system is used to calculate each indicator to complete the optimization of ecological tax collection and management.

2. GDP, GEP ACCOUNTING ANALYSIS

2.1. INADEQUATE GDP ACCOUNTING

As a measure of the total value of final products and services produced and provided by a country or region in a certain period, the traditional GROSS Domestic Product (GDP) accounting system reflects the economic strength and social wealth of a country or region [14] and has become the most widely used economic and economic accounting indicator in the world. But the defects of the GDP accounting system are also very obvious, it ignores the natural resources and ecological environment of great value, not the resource consumption, environmental pollution, and ecological damage cost included in the national accounts, even translating the environmental pollution of economic contribution in pairs, this will lead to the one-sided pursuit of economic development and ignore the resources and environment protection, It is an unsustainable view of development and achievements [15]. As the adjustment and correction of traditional GDP, "green GDP" refers to the remaining GDP after deducting the loss costs of resource consumption, environmental pollution, and ecological damage from the current GDP, to get the real total national wealth.

The concept of sustainable development advocated by the United Nations calls for the coordinated development of ecology-economy-society. However, both GDP and adjusted "green GDP" focuses on the operation of the economic system, without paying attention to and accounting for the existing value of the ecosystem and its contribution to human beings, even though "green GDP" focuses on the loss and cost of resources and environment to a certain extent [16].

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2.2. GEP ACCOUNTING

The ecosystem and the whole biospheres are the life support system of the earth and the material basis for human survival and development. The degradation of ecosystem services makes people re-examine the relationship between themselves and the ecosystem and the conservation and restoration of the ecosystem from a scientific perspective. Gross Ecosystem Product (GEP) accounting refers to the analysis and evaluation of the economic value of the products and services provided by the Ecosystem for human survival and well-being and is the sum of the value of Ecosystem products, Ecosystem regulation services, and ecosystem cultural services [17]. GDP focuses on the health of the economy, while GEP focuses on the health of the ecosystem.

Ecosystem products mainly include productive products and non-productive products provided by an ecosystem that can be directly used by human beings, such as food, medicinal materials, wood, fiber, freshwater resources, gene resources, etc. Ecosystem regulation services mainly include water conservation, climate regulation, carbon fixation, oxygen release, soil conservation, pollutant degradation, pollination, and other regulatory functions, as well as wind prevention and sand fixation, flood storage, pest control, storm prevention, and mitigation and other protective functions. Ecosystem cultural services mainly include landscape values such as tourism value and aesthetic value, as well as cultural values such as cultural identity, knowledge, education, and artistic inspiration, which are spiritual, entertainment, and cultural benefits. The value of ecosystem products is usually called direct use-value, and the value of ecosystem regulation service and ecosystem culture service is called indirect use-value. Some scholars call all Ecosystem products and Services that contribute to human survival and quality of life Ecosystem Services.

3. ECOSYSTEM (GEP) DATA ACCOUNTING

The water conservation function is that the ecosystem passes through the forest canopy and litter layer. Roots and soil layers intercept stagnant precipitation [18] and increase soil infiltration and storage, thus effectively conserving soil water, mitigating surface runoff, supplementing groundwater, and regulating river flow. Using water conservation as an evaluation index, water conservation is calculated by the water balance equation. Using the shadow engineering method, the value of water conservation is calculated according to the construction cost of the reservoir.

$$Q_{\mathrm{w}} = \sum_{\mathrm{i}=1}^{j} \left(P_i - R_i - ET_i\right) \cdot A_i \tag{1}$$

$$V_w = Q_w \cdot P_w \tag{2}$$

Where, Q_{w} describes water conservation; P_i describes the rainfall; R_i is rainstorm runoff; ET_i represents evapotranspiration; A_i describes the area of type i ecosystem;

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i describes the category i ecosystem type in the study area; j describes the number of ecosystem types in the study area; V_w describes the value of water conservation services; P_w describes the engineering cost of the reservoir per unit capacity [19].

Soil conservation function ecosystems (such as forests and grasslands, etc.) reduce the erosion energy of rainwater at various levels, such as forest canopy, litter, and root system, and increase soil erosion resistance to reduce soil erosion, reduce soil loss, and maintain soil function. Soil conservation, i.e., the amount of soil loss reduced by the ecosystem (the difference between potential soil loss and actual soil loss), was selected as the evaluation index of the soil conservation function of the ecosystem. Soil conservation was calculated by the general soil erosion equation. Using the substitution cost method, the value of the soil conservation function is calculated by the sum of sediment reduction and non-point source pollution reduction. Among them, the value of sediment reduction is:

$$V_{s1} = \lambda \cdot \frac{A_s}{\rho} \cdot P_s \tag{3}$$

Where, V_{s1} describes reduced sedimentation value; λ describes the sedimentation coefficient; A_s describes the amount of soil conservation; ρ describes the bulk density of soil; P_s describes the cost of dredging the reservoir.

The value of reducing non-point source pollution is:

$$V_b = \sum_{i=1}^{2} A_e \times c_i \times p_i \tag{4}$$

Where V_b describes the reduction of non-point source pollution; A_e describes the amount of soil conservation; c_i describes the pure content of N and P in soil; p_i describes the cost of environmental engineering degradation.

Flood regulation and storage function refer to the wetland ecosystem (lake, marsh, river) having special hydrophysical properties, has a strong storage function. The reservoir plays the flood regulation and storage service function mainly, so the adjustable flood storage volume of the reservoir is selected as the flood regulation and storage service function quantity of the wetland ecosystem. The value of flood regulation and storage is calculated by the cost of reservoir construction using the shadow engineering method.

$$V_t = C_r \cdot P_{\mathrm{w}}$$

Where V_t describes the flood regulation and storage value; C_r describes the flood storage capacity of the reservoir; P_{w} describes the engineering cost per unit capacity of the reservoir.

The air purification function is that green plants absorb harmful substances in the air through the stomata on the leaves and the lenticels on the branches within the

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range of its resistance, and transform them into non-toxic substances through the REDOX process in the body. At the same time, it can rely on the special physiological structure of its surface (such as villi, grease, and other viscous substances) to block, filter, and adsorb the air dust, to effectively purify the air and improve the atmospheric environment. The air purification capacity of the ecosystem was calculated by using the indexes of sulfur dioxide absorption, carbon oxide absorption, and dust absorption. The value of air purification is evaluated by the control cost of sulfur dioxide, carbon oxide and industrial dust.

$$Q_{ap} = \sum_{i=1}^{m} \sum_{j=1}^{n} Q_{ij} \times A_i \tag{6}$$

$$A_{ap} = \sum_{i=1}^{3} Q_{ap} \times c_i \tag{7}$$

Where Q_{ap} describes the atmospheric purification amount of the ecosystem; Q_{ij} describes the purification amount of type j air pollutants per unit area in type i ecosystem; i describes the type of ecosystem, dimensionless; j describes categories of air pollutants, dimensionless; A_i describes the area of category i ecosystem type; A_{ap} is the value of air purification; c_i describes the cost of treating different types of air pollutants.

Water purification function refers to the ability of the water environment to partially or completely restore the ecological function of the water body to its original state through a series of physical and biochemical processes such as adsorption, transformation, and biological absorption of pollutants entering the water environment [20]. The absorption of COD, ammonia nitrogen, total phosphorus and other indicators of wetland ecosystem are used to calculate the capacity of ecosystem water purification. Using the control cost method, the value of water purification of the ecosystem was calculated by the treatment cost of COD, ammonia nitrogen and total phosphorus discharge.

$$Q_{wp} = \sum_{i=1}^{n} Q_i \times A \tag{8}$$

$$V_{pw} = \sum_{i=1}^{3} Q_i \times c_i \tag{9}$$

Where Q_{wp} describes the amount of ecosystem water quality; Q_i describes the purification amount per unit area of class i water pollutants; A describes the wetland area; i describes the pollutant category, dimensionless; V_{pw} is the value of water purification; c_i describes the treatment costs of different types of water pollutants.

Carbon fixation and oxygen release function refer to the function of green plants to absorb carbon dioxide from the atmosphere through photosynthesis and convert it into

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carbohydrates such as glucose, which are fixed in the plant body or soil in the form of organic carbon and release oxygen. The carbon sequestration and oxygen release were used as the evaluation indexes of ecosystem carbon sequestration and oxygen release. The afforestation cost method and industrial oxygen production cost method were used to calculate the value of ecosystem carbon sequestration and oxygen release, and finally, the value of ecosystem carbon sequestration and oxygen release was obtained.

$$V_g = Q_e \cdot P_e + Q_o \cdot P_o \tag{10}$$

Where V_g describes the value of carbon fixation and oxygen release; Q_e represents the amount of carbon sequestration; P_e represents the cost of carbon sequestration; Q_o is oxygen release; P_o is the cost of oxygen production.

Climate regulation function refers to the ecological effect that the ecosystem reduces the temperature, reduces the temperature variation area and increases the air humidity through transpiration, photosynthesis [21] and water surface evaporation, to improve the comfort level of the human living environment. The energy consumed by ecosystem cooling and humidification was used as the evaluation index of ecosystem climate regulation function. Through the substitution cost method, the value of electricity consumption and electricity price to climate regulation is calculated.

$$Q = \frac{\sum_i^3 GPP \times Si \times d}{3600 \cdot R \cdot 2} + \left(EQ \times q \times 10^3/3600 + EQ \times \gamma\right) \tag{11}$$

$$V = Q \times P \tag{12}$$

Where Q describes the energy consumed by the transpiration and evaporation of the ecosystem; GPP describes the amount of heat consumed per unit area by transpiration in different ecosystem types; S describes the area of ecosystem type i; R describes the energy efficiency ratio of air conditioning; d^d describes the number of days with air conditioning; i describes different ecosystem types in the study area; EQ is water surface evaporation; q describes volatile latent heat; γ describes the power consumption of the humidifier to convert 1m3 water into steam; V describes the value of climate regulation; P is the price of electricity.

By increasing the level of species diversity, the community can increase natural enemies and reduce the population number of herbivorous insects [22], to achieve the purpose of disease and insect pest control. The area of forest pest control was used as the evaluation index of the pest control function, and the cost method was used to calculate the value of ecosystem pest control by the area of self-healing and the cost of artificial pest control.

$$V_f = FS \times (\gamma_1 - \gamma_2) \times FP \tag{13}$$

Where V_f describes the value of forest pest control; FS is natural forest area; γ_1 describes the incidence of pests and diseases in plantation forests; γ_2 is the incidence

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of pests and diseases in natural forests; FP describes the cost per unit area of forest pest control.

The ecological gross product accounting method is the premise of specific accounting [23]. On the whole, GEP is the accumulation of ecosystem products, ecological regulation services and ecological culture services. The specific accounting method of the three factors in Ecological Gross Product Accounting is mainly the product of product output and price.

$$GEP = \sum_{i=1}^{n} EP_iP_i + \sum_{j=i}^{m} ER_jP_j + EC_tP_t \tag{14}$$

Where EP_iP_i describes the total value of ecosystem products; R_jP_j is ecological regulation services; EC_tP_T describes the total value of ecological and cultural services; i, j and t corresponds to ecosystem products, ecological regulation services and ecological culture services respectively; P_i, P_j and P_t correspond to the prices of different ecological value measurement factors.

In the accounting method, the ecological value accounting system of the forest region constructed according to GEP is further interpreted. On the one hand, it is helpful to understand the algorithm of different factors [24] in total ecological production. On the other hand, it helps to construct the relationship between the existing economic and social statistical dimensions and these factors. Through the calculation of the above dimensions and indicators, the optimization method of the ecological tax system is analyzed.

4. OPTIMIZATION OF THE ECOLOGICAL TAX SYSTEM

4.1. OPTIMIZATION PRINCIPLE OF THE ECOLOGICAL TAX SYSTEM IN CHINA

1. Fiscal principles

The basic meaning of the tax fiscal principle is as follows: the establishment and reform of a national tax system [25] must be conducive to ensuring national fiscal revenue and realizing national intelligence.

The fiscal principle requires that the revenue obtained through taxation can fully meet the needs of fiscal expenditure in a certain period. Therefore, the design adjustment of ecological tax should choose abundant and reliable tax sources. Another requirement of fiscal principle is that tax revenues be flexible. In case of a fiscal increase, tax revenue should be able to increase tax revenue by law or automatic revenue increase [26].

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Tax elasticity refers to the ratio between the tax revenue growth rate and the economic growth rate. The expression is:

$$E_{\mathrm{T}} = \frac{\Delta T/T}{\Delta Y/Y} \tag{15}$$

Where E_T describes the tax elasticity; T describes the tax revenue; ΔT describes the increment of tax revenue; Y describes the national income; ΔY describes the increment of national income; Tax elasticity reflects the sensitivity of tax revenue to economic changes. The tax system should be designed and adjusted to make the tax more flexible. Generally speaking, $E_T > 1$ to ensure that fiscal revenue grows in step with national income.

2. The principle of equity and efficiency

First, is the principle of equity.

The basic principle of the market economy is fair competition, and one of the elements of fair competition is fair to tax burden [27]. Most countries in the world regard the principle of fairness as the universal principle followed in the design and application of the tax system.

The principle of equity contains two interrelated aspects: one is horizontal equity, that is, people with the same ability to pay taxes bear the same tax. The other is vertical fairness, which means that people with different tax capabilities pay different taxes. That is, the excessively high income is adjusted to narrow the income difference and achieve fair distribution. This is conducive to maintaining social stability. Horizontal unfairness will directly lead to the loss of economic efficiency. Therefore, given the current economic situation, the optimization of the tax system should be strengthened in the realization of horizontal fairness.

Second, is the principle of efficiency.

Efficiency is divided into administrative efficiency and economic efficiency.

The administrative efficiency of taxation can be considered from two perspectives: tax collection cost and tax payment cost. The levy tax charge is to point to all sorts of charges that the duty department produces in the levy tax process. To improve the administrative efficiency of tax collection, on the one hand, advanced means of collection and administration should be adopted to save manpower and material resources. On the other hand, the tax system should be simplified to make it easy for taxpayers to understand and grasp [28] and reduce tax payment costs.

Economic efficiency refers to the efficient use of resources. In a completely free competitive market, producers adjust their output according to the market price until the marginal cost is equal to the price and the producer can get the maximum profit, while consumers adjust their purchase quantity according to the market price until the

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marginal effect is equal to the price and the consumer can get the maximum effect. Tax distorts the price, making the price obtained by producers lower than that paid by consumers. In this way, the price cannot truly reflect the marginal cost and marginal effect, resulting in an additional loss of economic efficiency, also known as the additional burden of the tax.

3. National treatment

National treatment means that the government of a country applies uniform standards to foreigners or foreign enterprises in its territory in terms of economic and trade policies with its nationals or enterprises. Now widely introduced in the field of taxation, mainly refers to the territory of foreign taxpayers and shall not be discriminatory tax policies. National treatment is not an independent tax principle, but the embodiment of the efficiency principle and fairness principle of a country's tax under certain conditions, which belongs to the scope of national sovereignty. Emphasizing the principle of national treatment mainly points out how to treat and grasp the preferential policies for foreign businessmen.

4. The principle of gradual progress

Taxation, as a kind of distribution and superstructure, cannot exist independently from the economic foundation. According to the theory of building socialism with Chinese characteristics, economic, political and social choices must be based on China's actual national conditions. It is impossible to set up a complete tax system quickly. China's current ecological tax situation is not perfect, there are many problems, in the design and adjustment of forest ecological tax, according to the actual situation, step by step.

4.2. ECOLOGICAL TAX COLLECTION AND MANAGEMENT OPTIMIZATION MODEL

The mode of tax collection and administration is the confirmation of the rights and obligations of the taxpayer in the process of tax collection and payment under a certain tax system. The collection and management mode is the overall grasp and target positioning of collection and management work under a tax system. The current collection and management mode in China is based on tax affection and optimized service, relying on a computer network, centralized collection and key inspection [29].

The collection and management of ecological tax are carried out with the cooperation of the tax department and related ecological departments, which requires regular monitoring of the ecological environment. The tax department provides various tax data, and the tax department calculates and collects taxes, and supervises and manages taxpayers. This mode of collection and management gives full play to the expertise of ecological departments and tax departments and improves the efficiency of taxation. The goal of tax collection and management mode should be to maximize tax benefits with a minimum tax cost. To provide taxpayers with services in the best,

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fastest and most convenient way of handling tax; To provide the most level playing field for taxpayers with the best level of enforcement; The most appropriate economic regulation activities to provide financial resources for the state to meet the needs of social public goods. The Forest area ecological tax collection management model can be optimized from the following aspects.

First of all, the forest ecological tax collection mode should echo the current economic system and tax system as well as social and cultural Beijing. We should not blindly adopt other tax collection and management modes but should combine them with the actual situation. Secondly, the management of tax sources should be strengthened in the management of the forest ecological tax system. Thirdly, the collection and management of the forest ecological tax system should permeate legal principles. The legal principles of taxation are mainly reflected in tax enforcement. The first is the legal constraints on taxpayers, the second is the legal norms of tax collectors, tax collectors must be by the provisions of tax substantive law and procedural law, should be collected, should not be collected resolutely cannot be collected, all advance collection, tax, tax return, idle are illegal. Finally, the collection of forest ecological tax should pay attention to collection efficiency and cost-saving. The level of tax cost and tax efficiency is an important symbol of the legalization, institutionalization, and conscientization of tax collection and administration. With scientific management and reasonable allocation of personnel and property [30-34], the maximum expected tax benefits can be obtained with the minimum labor cost and cost of tax collection and administration.

The forest ecological tax system should be based on the current tax collection and administration mode of the citizen's tax awareness as the prerequisite, based on the tax sources management, to improve the collection efficiency and the quality of collection and management as the goal, to speed up the development and application of electronic computer in tax work, strengthen the tax inspection, strictly by the law ZhiShui, adjust measures to local conditions, scientific and accurate block tax revenues. In specific practice, also want flexible use, and adjust measures to local conditions.

In addition, the optimization and adjustment of forest ecological tax in China need to take into account the characteristics of unbalanced economic development between urban and rural areas and between regions and adopt a collection and management mode suitable for China's national conditions.

5. RESULTS AND ANALYSIS

5.1. ANALYSIS OF ECOSYSTEM CONTRIBUTION

To calculate the total ecological production of the forest region in GEP, a city was selected as the research object. It was found that the ecosystem products, ecological regulation function, and ecological cultural services of the city all had a certain

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importance in the GEP accounting results, among which the ecosystem products contributed 21.02 billion yuan, and GEP contributed 56%. Ecological regulation services amounted to 12.58 billion yuan, accounting for 33%; Ecological and cultural services amounted to 4.25 billion yuan, accounting for 11% of the total. Among the contributions, ecocultural services are the lowest, and GEP's contribution cannot be ignored. In terms of ecosystem products, the forest area of the city has more than 2 million hm2, covering 66.3% of the total area. Meanwhile, the city is rich in water resources, which makes a high contribution to ecosystem products. There are many wetlands, swamps, and lakes in this area, which have obvious advantages in ecological regulation. In terms of ecological cultural services, the number of tourists is small, the service awareness is poor, and the development of ecological products is not enough, so the contribution of ecological cultural services is the lowest. The possible impact of this aspect is to restrict the development of the city's ecotourism industry, and improve the development level of the city's ecotourism industry is an important attempt to comprehensively improve the GEP accounting value and promote the high development of the city's forest region by carrying out regional ecotourism.

Table 1. GEP forest area ecological gross production calculation

Production system product and service summary	Total value/100 million yuan
Crop	265.13
Tree breeding	212
Afforestation	12.151
Timber mining and transportation	171.26
Fruit growing	3.214
All kinds of planting	8.159
Irrigation water	187.54
Industrial water	399.75
Urban public water	87.545
Energy usage	9.178
Water conservation	111.246
Soil fertility	187.48
Sedimentation	145.97
Vegetation carbon sequestration	180.55
Oxygen released by vegetation	40.258
Water accumulation	210.54
Wetland storage	19.49
Lake storage	98.48
Swamp storage	25.487
Amount of pollutants absorbed	158.45
Ammonia nitrogen purification effect	17.52
Temperature regulation	45.25
Eco-tourism	415.25

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According to the statistics of CITY's GDP, its annual GDP was 27.27 billion yuan, and the comparison between the GEP accounting results and GDP accounting results in the forest region was as high as 10.58 billion yuan. Based on the accounting results in Table 1, the differences are mainly from the above three aspects:

First, the ecological value of forestry products is difficult to be transformed into commercial value because of the country's restricted logging mechanism. In an analysis of the city's GEP, it was found that the total amount of agricultural products accounted for only 7.11%, while forest resources accounted for 21.48%. In GDP accounting, the output value of agricultural products is the main accounting object of GDP, and the accounting of forest resources is limited to economic forest harvesting, but the potential value of forest resources is not calculated. It is difficult to measure the input-output value of forest resources, which is caused by the absence of forest resources in the total value of the existing ecosystem, and also by the low input-output efficiency of forest resources, which makes it difficult to transform the ecological value of forest products into commercial value. Relevant departments should pay close attention to promoting the upgrading of the forestry industry, promoting the value of forestry products with the upgrading of the forestry industry, ensuring the protection and restoration of forest grass paper cups, increasing the area of forest land and the stock of standing trees, thus enhancing the value of forest resources and realizing the transformation from the ecological value of forestry products to commercial value.

Second, in terms of ecological services, the GDP contribution of water resources comes from industrial water use, farm irrigation, and household water use. GEP accounts for carbon sequestration, oxygen release and water conservation. So, the GEP calculation result is helpful to accurately measure the amount of forest ecosystem services, and explain its ecological value not only in terms of water, but also in all aspects, such as carbon, and oxygen release to measure the value of forest ecosystem services, avoiding the single measure for water-resources based on the measuring deviation, and comprehensive measurement of forest ecosystem services value contribution. Given the ecological service the lack of docking with the international accounting system of the accounts, the ecological service value of the new size may be used for carbon and releasing oxygen and water conservation value of various factors, to establish a new measuring diameter and measurement standard also can try to translate the ecological service quantitative measurement factors.

Thirdly, in terms of ecological and cultural services, the tourism economy in the forest region of the city has not been effectively developed. As the primeval forest with a fragile ecological environment, only combining development and protection can release the maximum value. At present, the absolute value and relative value of the ecological cultural service are low, which indicates that it has great potential for development. The development of ecological tourism and other industries will activate the tourism development pattern in the forest region of the city, and form the industrial linkage mechanism of "ecological agriculture + tourism", that is, relying on ecological agriculture and under forest economy to achieve a substantial increase in the output value of tourism. This is the way to realize the integration of industry in the forest

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region, and also the strategy to maximize the value of its ecological cultural services and improve the gross value of ecosystem production.

To sum up, under the background of ecological civilization construction, there are significant regional differences in forestry production efficiency. The ecological contribution of the forestry resource-based city represented by this city is very obvious. Its contribution is not only reflected in its contribution to the overall social benefits of the city but also in the achievements that can be transformed into economic value. Combing the contribution of forest areas such as this city to the regional economy and society further improves the calculation accuracy of the forest ecological total value accounting system. Improving the understanding of the importance and necessity of GEP accounting in forest areas is of great significance to protecting forest ecology. It is because of the huge ecological contribution value of the forest region in the city, ignoring its multiple ecological values will affect the actual value of the forest region represented by the forest region in the city from a comprehensive perspective, and lead to one-sided development. The ecological service value of the forest region is huge, and it is of great significance to the sustainable development of ecology, economy and society.

5.2. ECOLOGICAL COST EXPENDITURE AND OPTIMIZATION

To better verify the feasibility of this method, experiments were carried out. According to ecosystem data and parameter assignment under current conditions, Vemsim software was used to calculate the simulation results of national forest ecological costs from 2009 to 2018, to conduct research. By analyzing the consistency between the simulation results and the actual data, the simulation trend of some data running results is compared with the historical data, and the relative error between them is calculated.

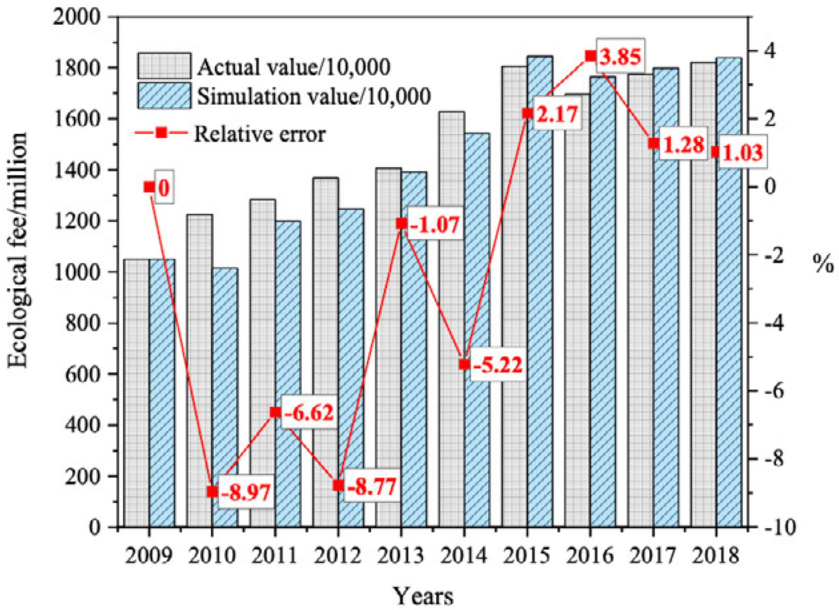

Figure 1. Comparison diagram of simulation value and the actual cost of ecological cost in the forest region

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Through comparison, it can be found that the absolute relative error of ecological cost in more than 70% of years is within 6%, and only the absolute relative error of some years is beyond 6%, but it can be controlled within 9%. In 2016, the actual cost decreased because people began to pay attention to ecological aspects, reduce damage, and pay attention to protection in daily production and life. However, the simulation value is still calculated based on historical data, but the relative error is 1.05%. In 2010, there was a large difference of 8.97% in the data. The analysis indicated that a certain area suffered large-scale unnatural damage and needed large-scale repair. For the comparison of the two kinds of data, it can be intuitively observed from Figure 1 that the ecological cost budget result is consistent with the actual cost trend. Therefore, it can be believed that the ecological system accounting used in this paper has certain authenticity and accuracy. Before 2014, the predicted value is lower than the actual cost. Consumers do not care about whether the ecology is damaged, but only care about their interests, and spend a large amount. Therefore, consumers pay more ecological taxes, and tax authorities collect more. Since 2015, the actual cost has decreased, indicating that people begin to pay attention to the ecological environment and reduce the destruction of resources, which is conducive to the ecological and economic balance.

The ecological tax optimization proposed in this paper is based on ecosystem accounting. According to the optimization measures, the important tax factors are changed, and the operation results are tested to whether they can achieve the desired optimization goals, to realize the research value of this paper.

After-tax system optimization. The changes of key variables are mainly reflected in the following three aspects: 1) the reduction of payment fees in the stage of ecological development; 2) The cancellation of land farming fees, reduced taxes and fees in the stage of land development and transfer, and reduced development tax rates; 3) Increase the tax intensity of consumption of ecological resources to prevent damage to the ecological environment, so the optimized ecological cost is shown in Table 2.

Table 2. Simulation results of ecological costs from 2009 to 2018

year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Actual value/Ten thousand yuan	1050	1225	1284	1368	1406	1628	1805	1696	1775	1820
Simulation value/Ten thousand yuan	745	789	845	1051	1124	1284	1358	1420	1468	1504

The simulated ecological cost data from 2009 to 2018 in Table 2 shows a decrease compared with the actual data. As shown in Figure 2, the trend of the impact of tax system optimization on ecological costs can be intuitively shown, which increases at a slow rate and is lower than the actual data. It can be seen that the optimization and integration of the ecological tax system can play a certain control role in ecological tax and prevent excessive waste.

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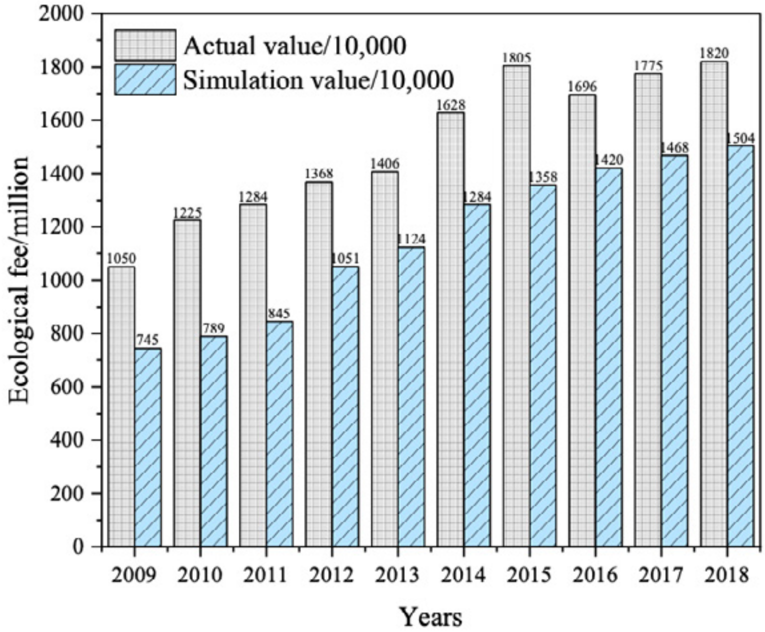

Figure 2. Comparison between simulation value and the actual cost of ecological cost in the forest region

It can be seen from Figure 2 that the ecological cost after optimization is less than the actual cost, especially in 2015, the difference is 4.47 million, and in 2013, the difference is at least 2.82 million. Be able to know the cost reduction after optimization, thus reducing tax collection. Through calculation, the overall optimization rate is 0.77, which proves that the optimization effect is good and can well reduce unnecessary costs and resource waste.

6. CONCLUSION

In recent years, with the rapid development of the economy, many global ecosystem problems have become increasingly prominent, seriously threatening human existence, such as water depletion, desertification, the greenhouse effect and so on. Based on this, he has a profound understanding and transformation of the ecological system and gradually pays more attention to ecological problems. Therefore, the proposal of ecological civilization construction in China requires the transformation of China's economic construction. The GDP has changed from GDP-only economic growth to the proposal of green GDP, and then to the study of the GEP project. China is practicing ecological civilization construction step by step, using GEP to quantify the value of the ecosystem and green development. It is an urgent way to improve the current ecological environment and boost ecological civilization. The research on GEP accounting will fill in the gap in ecological asset accounting and evaluation in China, and make preparations for integrating with national economic statistics and accounting system and gaining acceptance in the international community. This paper analyzes the advantages of GEP, calculates the data accounting of all aspects of ecology, finds suitable optimization principles, and makes

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a balanced and stable collection and management way to maintain the sustainable development of the ecological environment. Through experiments, it is concluded that:

1. through the ecological cost of the actual value compared with the simulation values, to learn that the error is small, the maximum of 8.97%, the minimum value is 1.05, that the budget results are more accurate, can be calculated in advance can reduce the ecological damage, not only reduce tax cost, also can protect the ecological environment, add a beautiful scenery, a balance of energy and economic benefits.

2. After optimization, the ecological cost of the forest region is less than the actual ecological cost, and the tax payment is also reduced, with the overall optimization rate reaching 0.77. It shows that the ecological environment after optimization can be protected, the damage degree is significantly reduced, the awareness of environmental protection is increasing, and the tax collection and management effect is obvious.

The method in this paper can better calculate the cost of the ecosystem, optimize the strategy to reduce the cost, save resources as much as possible, ensure ecological stability, promote economic development, and ensure that national economic interests are not affected, and achieve a good global environment.

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DISCUSSION ON THE DESIGN OF COMPENSATION STANDARDS FOR REGIONAL ENVIRONMENTAL POLLUTION FROM THE PERSPECTIVE OF NEW STRUCTURAL ECONOMICS

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ABSTRACT

How to effectively protect the ecological environment while socio-economic development, to achieve the harmonious and sustainable development of human society and the natural ecological environment, has been paid more and more attention by governments and academic circles around the world. Therefore, the design of compensation standards for regional environmental pollution is proposed from the perspective of new structural economics. Based on the perspective of new structural economics, this paper provides a new explanation of the impact of fiscal decentralization on environmental pollution, according to the economic and technical indicators related to ecological environmental pollution, with the help of the subjective and objective empowerment method combined with the analysis of hierarchy method and entropy method, the weight of each ecological environment pollution evaluation index in the evaluation and division of ecological environmental pollution level is studied, and the comprehensive evaluation method is used to construct the ecological environment pollution technology rating evaluation model, and the compensation value of regional environmental pollution is finally obtained by combining the panel regression model. The method of this paper has wide applicability and significant advantages. The experimental results show that the COD emission of the North Water Source Area (QZ) of the Qingzhang River is 208t/a, and the upstream of the drinking water source area needs to compensate 3.88 million yuan downstream for water quality and water ecological restoration.

KEYWORDS

New structural economics; Ecological environment; Fiscal decentralization; Compensation standards; Panel regression model

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1. INTRODUCTION

With the rapid economic growth, the large-scale development and consumption of resources, and the increasingly serious damage to the environment, environmental problems such as the destruction of species habitats, the sharp decline in biodiversity, and the decline in ecological functions have become one of the important ecological problems that plague the sustainable social and economic development of all countries in the world [1-3]. In this process, the environmental problems brought about by the development of the industry have attracted the attention of people from all walks of life such as governments, non-governmental organizations, and scientific research, and the contradiction between environmental protection and economic development has become one of the key issues in the region [4-5]. To enhance ecological functions and improve the ecological environment, in addition to providing positive externalities (such as returning farmland to forests and grasslands to provide ecosystem services such as soil and water conservation), it is often necessary to reduce negative externalities, such as reducing resource development and pollution emissions in industries with high environmental risks in the region [6-9]. In particular, high-environmental risk industries located in important ecological function zones even need to be completely withdrawn. In the short term, protecting the environment requires sacrificing certain economic interests, and even "shutting down and transferring" enterprises that have previously obtained access permits to restrict their production and development [10]. For example, to provide high-quality and sufficient water resources downstream, upstream and midstream mining enterprises need to reduce production capacity, reduce production and discharge, and give up some of their development authority. To maintain the continuity of water flow and protect important aquatic biological resources, hydropower enterprises located in nature reserves or important ecological function areas need to be closed [11-13].

As an institutional arrangement to regulate the relationship between environmental damage and the protection of the interests of the main body of the ecological environment, ecological compensation has become an effective way to protect the ecological environment [14]. Ecological environment compensation mainly refers to the maintenance of ecosystem stability by improving the ecosystem status of the damaged area or establishing new habitats with comparable ecosystem functions or quality, to compensate for the decline or destruction of existing ecosystem functions or quality caused by economic development or economic construction [15-18]. In the ecological compensation mechanism, the subject and object of compensation, the standard and compensation method of compensation is a core issues, of which the determination and accounting of ecological compensation standards is a difficult point of ecological compensation mechanism [19-20]. The research on ecological compensation in China began in the 1980s on ecological compensation in the ecological sense and the exploration of ecological compensation in the economic sense, and after the United Nations Conference on Environment and Development, it entered the active theoretical discussion stage based on environmental loss compensation and became a hot issue in all sectors of society in China [21-24]. Due

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to the low existing ecological compensation standards in China and the inconsistent cost accounting of compensation standards, it is of great significance to build an effective ecological compensation standard cost accounting system to provide the main basis for the formulation of ecological compensation standards to protect the interests of relevant entities and promote the healthy and benign development of the ecological environment [25].

Literature [26] aimed at the current problems of single ecological compensation standards and limited scope of determination. This paper proposes indicators such as the utilization of pollution footprint, pollution footprint efficiency, environmental carrying capacity, regional average absorption capacity and economic benefit loss value. Establish a standard model of ecological compensation. Taking 31 provinces in China as examples, an empirical analysis was conducted. First, set each province as a group. Compare pollution footprints within the group with national pollution footprints to determine the subject-object of compensation. Secondly, the ecological compensation model is used to calculate the ecological compensation (compensation) standard of each group (province), combined with the per capita pollution footprint and pollution footprint efficiency, and the provinces are divided into high, low, low, low and low combinations. Finally, personal suggestions are put forward for different combinations, the combination of low and high is the ideal combination, the combination of high and high should reduce pollution, adjust the industrial structure, and the combination of high and low should be supported by policies to improve the efficiency of the regional ecological environment, and the combination of low and low should be through scientific and technological progress. Improve regional output efficiency. Literature [27] believes that the evaluation of the comprehensive benefits of ecological compensation in water source areas is the key to scientifically formulating the ecological compensation mechanism and ensuring the effective operation of ecological compensation, and is also an important reference for determining reasonable compensation standards. Based on the influencing factors of all aspects, a comprehensive benefit evaluation system for ecological compensation in water sources was formulated, including 15 evaluation indicators such as ecological benefits, economic benefits and social benefits, and monetary value accounting was carried out on the ecological compensation benefits of Yunmeng Lake in Shandong Province using the market value method and the shadow engineering method. After the implementation of the ecological compensation of Yunmeng Lake, the ecological benefits increased by 106.4975 million yuan, the economic benefits were 77.1859 million yuan, and the social benefits were 56.0318 million yuan, with significant comprehensive benefits, but there were also problems such as education, tourism and other benefits were not obvious, and the ecological, economic and social benefits increased unevenly. In the future, we should pay attention to the economic and social driving role of ecological compensation in water source areas, enhance interaction with farmers, implement differentiated compensation, and extend the period of ecological compensation to promote the sustainable development of ecological compensation in water source areas. In literature [28], a standard model of ecological compensation based on pollution footprint was constructed, and the ecological

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compensation standard in Guangzhou was studied using this model: taking the emission of four major pollutants as the accounting goal, the population was divided into three major groups according to the three major industries, the per capita pollution footprint and per capita pollution footprint efficiency of the three major groups were calculated, and the compensation or compensation standards of the three major groups were calculated based on the average ecological status of Guangzhou. The results show that Guangzhou's primary and tertiary industries should receive ecological compensation of 67.379 billion yuan and 1926.728 billion yuan respectively due to the transfer of pollution footprints, while the secondary industry should pay 207.037 billion yuan in ecological compensation due to the excessive occupation of ecological footprints. The study of ecological compensation standards based on pollution footprints attempts to introduce pollution footprint theory into the study of ecological compensation standards, which can not only enrich the connotation of ecological footprint theory but also provide a useful reference for the study of ecological compensation standards. Literature [29] reveals the willingness and payment level of farmers in Yongdeng County, Gansu Province, to compensate for agro-ecological compensation, and provides a basis for the government to carry out relevant agro-ecological construction in the future. Based on the questionnaire survey, the conditional value assessment method (CVM) was used to analyze the willingness and payment level of farmers in Yongdeng County for agroecological compensation. Farmers in Yongdeng County have good ecological cognition and willingness to compensate. The number of farmers willing to compensate reached 87.76% of the total number of people surveyed, and the average level of agricultural ecological compensation payment reached 52.11 yuan per capita. The degree of importance affecting farmers' willingness to pay for agricultural ecological compensation is, in order: the degree of education> the importance of per capita annual net income> the importance of the ecological environment> the degree of impact on themselves> the number of days of migrant work> the degree of environmental concern> whether to manage the geographical location of > age >area. Farmers in Yongdeng County have a strong willingness to compensate for agricultural ecology, and the level of payment is in line with the actual situation, which is affected by personal cognition and per capita income. Literature [30] first expounds on the meaning and significance of watershed ecological compensation, then analyzes the subjects and objects in the process of watershed ecological compensation, introduces and analyzes the current ecological compensation methods of river basins, and finally explains the standards and mechanisms of watershed ecological compensation, to ensure the objectivity of the ecological compensation process of river basins and achieve the role of protecting the ecological environment of river basins. The above literature explains the significance of the study on ecological compensation standards for economic development and ecological benefits in various places, and the environmental information and value are not included in the accounting scope, and the research perspective is relatively narrow. Therefore, how to embed the basic methods of environmental pollution into the accounting of ecological compensation standards, establish a complete set of ecological compensation standard cost accounting

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systems, and provide a meaningful reference for the determination of ecological compensation standards is a focus of text research.

From the perspective of new structural economics, this paper defines the concepts of ecological pollution compensation and market-oriented models, refines and summarizes the relevant theories, and proposes a theoretical model for the design of market-oriented ecological pollution compensation standards. At the technical level, through data and information collection and application of subjective and objective empowerment methods to set weights, the comprehensive evaluation model is used to assess the technical level of ecological and environmental pollution, and the compensation value of regional environmental pollution is obtained through the panel regression model, to better guide policy formulation and implementation and promote ecological development.

2. NEW STRUCTURAL ECONOMIC ANALYSIS AND CHARACTERISTIC FACTS

2.1. FISCAL DECENTRALIZATION

New Structural Economics (NSE), proposed and advocated by Lin Yifu, emphasizes that economic development is a process of continuous change in industry, technology, infrastructure, and institutional structure, in which there must be both an "efficient market" and a "promising government" [31]. Among them, the government itself is the most important institutional arrangement in economic development, and the development strategy it formulates plays an important role in the national economy. Starting from the degree of matching between the industrial structure and the factor endowment structure, it is proposed to classify the various economic development policies of the government into different development strategies. The concept of development strategy is a highly abstract summary of the various economic policy actions of the government. According to whether it is in line with comparative advantage, it is divided into a development strategy that follows comparative advantage and a development strategy that violates comparative advantage. Specifically, (1) under the development strategy of comparative advantage, the government's economic policies are to select the corresponding industry, product and technology structure to support the enterprise by selecting the corresponding industry, product and technology structure according to the local factor endowment structure of the backbone, and the enterprise chooses to enter the industry that meets the comparative advantage and the specific technology production product according to the relative price information of the factors in the market. Since enterprises are entering industries that are in line with local comparative advantages, such enterprises are self-sustaining and able to survive without external support. (2) On the contrary, if the development strategy contrary to comparative advantage is adopted, and the government's various economic policies ignore the comparative advantages determined by the endowment structure of the region, thus causing the industrial structure of the region to deviate from the optimal structure, once the enterprise enters an industry that does not have a relatively favorable heat, and the products produced are not competitive in the market, then the type of enterprise is not self-sustaining, and at this time, if the enterprise wants to survive in the fierce market competition, it can only be maintained through a series of economic distortions such as government subsidies and tax incentives.

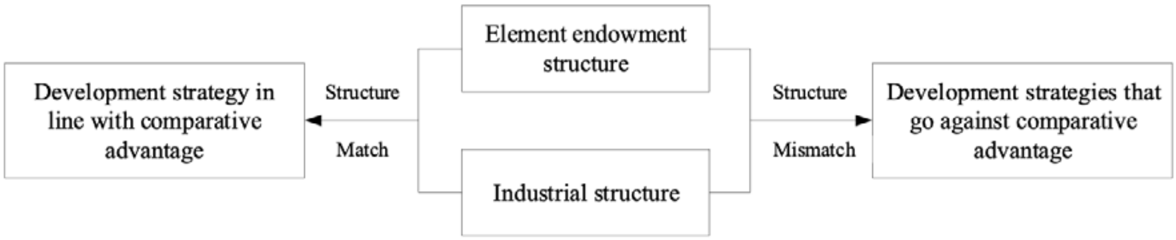

Figure 1. Conceptual definition of a development strategy

Conceptually, fiscal decentralization refers to the process of decentralization of some fiscal management and decision-making power by the central government to local governments, so a certain degree of fiscal decentralization always corresponds to the fiscal autonomy owned by a certain level of government. Due to the wide geographical area and obvious regional differences in China, the resource endowments and potential relatively favorable heat of each region are different, and only by fully grasping the information such as the resource endowments of each region and the constraints it faces can we formulate a development strategy that is in line with its relatively favorable heat [32]. In this context, if the central government directly formulates development strategies for each region, due to information asymmetry and excessive cost of collecting and processing information, it is difficult for the central government to formulate a development strategy that meets the comparative advantages of each region's resource endowment conditions, resulting in a "one-size-fits-all" situation. Compared with the central government, local governments have obvious information and enthusiasm, and they have a better understanding of the stage of development that the local government is in, thus making local governments more efficient than the central government in formulating development strategies. Therefore, under the fiscal decentralization system, the higher the degree of regional decentralization, the greater the autonomy of the local government over economic development, and the higher the probability of it following a more favorable development strategy according to the information held by the local government. The more the development strategy is in line with comparative advantage, the less environmental pollution will be caused.

If the degree of regional fiscal decentralization is low and the central government interferes greatly with local development, then the possibility of local development strategies violating their comparative advantages is very large, resulting in distortion of the local industrial structure and deviation from its endowment structure, and the enterprises in it cannot live on their own, and while the enterprises cannot obtain profits, the overall regional economy is also developing slowly. However, under the

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political promotion and economic incentive of GDP-oriented, to achieve the goal of economic development, local government officials have to adopt a series of distorting mechanisms such as lowering environmental access barriers to attract foreign investment, relaxing the level of environmental regulations, distorting the structure of fiscal expenditure, and insufficient environmental governance to promote economic growth. The economic growth stimulated in this context is unsustainable, on the one hand, enterprises cannot live on their own, even if environmental constraints tighten, they cannot internalize environmental pollution, and environmental soft constraints appear. On the other hand, the fiscal revenue of local governments is not enough to pay for environmental governance, which leads to the deterioration of environmental pollution problems.

Based on the above theoretical analysis, the research hypothesis is put forward that the higher the degree of fiscal decentralization, the more the development strategy is in line with its relatively favorable heat, and the environmental pollution problem will be less light.

2.2. CHARACTERISTIC FACTS

Before conducting an empirical analysis, the preliminary relationship between fiscal decentralization and development strategy is first observed by describing characteristic facts. The statistical relationship between fiscal decentralization and development strategy is obtained based on the level data using the Fiscal Autonomy (FDEC1) and the Technology Choice Index (TCIR) as proxy variables for fiscal decentralization and development strategy, respectively [33]. The scattering points of fiscal decentralization and development strategies are shown in Figure 2.

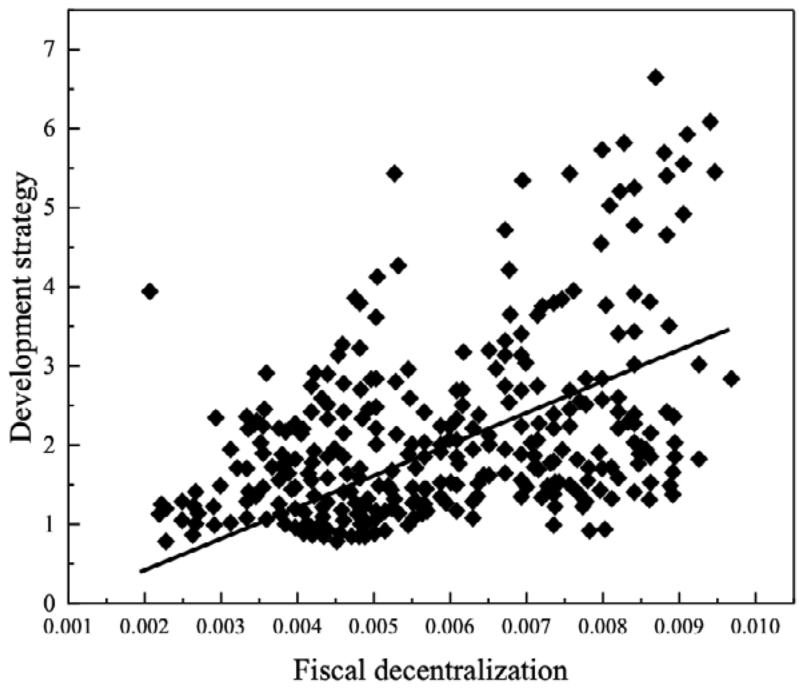

Figure 2. Scatter plot of fiscal decentralization and development strategies

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From the perspective of scatter chart 2, fiscal decentralization is positively correlated with the development strategy, and its correlation coefficient is 0.502, indicating that the higher the degree of fiscal decentralization, the higher the degree to which the local development strategy follows its comparative advantage. Further, from the perspective of the nuclear density map of fiscal decentralization and development strategy in the eastern, central and western regions of China, as shown in Figures 3 and 4.

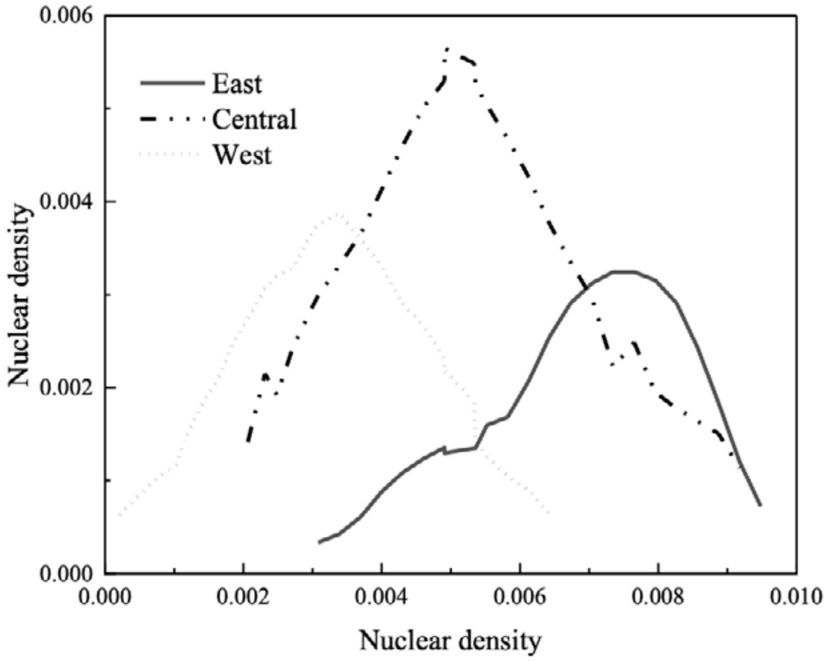

Figure 3. The nuclear density of fiscally decentralized sub-regions

In Figure 3, the degree of fiscal decentralization in the eastern region is generally higher than that in the central and western regions, with the average being 0.722 in the eastern region, 0.468 in the central region and 0.389 in the western region.

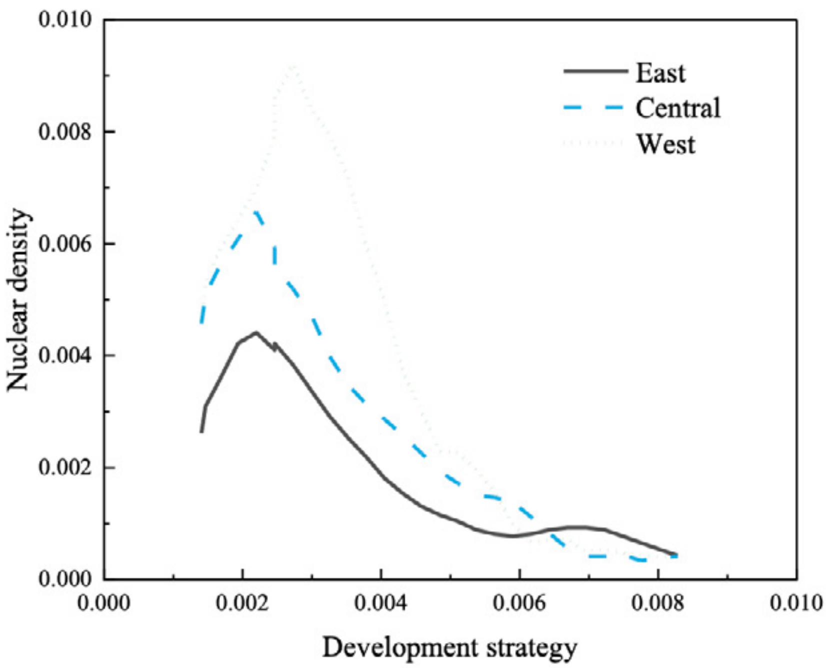

Figure 4. The subregional nuclear density of development strategies

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In Figure 4, the distribution of the TCIR index in the eastern region is generally biased to the central and western regions, that is to say, the development strategy in the eastern region is less distorted than in the central and western regions, and on average, the eastern region is 0.243, the central region is 0.007, and the western region is 0.005. It can be seen from this that the basic characteristic facts can support the theoretical expectations of this paper.

3. REGIONAL ENVIRONMENTAL POLLUTION COMPENSATION STANDARD DESIGN

3.1. COMPENSATION STANDARD SYSTEM DESIGN PRINCIPLES

Due to the variety and complexity of the factors for evaluating the ecological environment pollution level, when designing the ecological environment pollution level index system, it is necessary to select the indicators that cause ecological environmental pollution from multiple aspects and multiple angles to meet the systematic assessment and comparison [34]. The specific design principles have the following aspects:

1. Comprehensiveness. Comprehensively and objectively reflect the pollution status of the ecological environment. The designed index system must be able to reflect the degree of ecological environmental pollution from all aspects, which is directly related to the quality of the entire system.

2. Scientific. The indicator system must be based on science and fully reflect the internal relationship between ecological environmental pollution and various indicators. The methodological science of determining the weight of indicators and the grading of early warnings ensure the authenticity and objectivity of the system;

3. Operability. The selected indicators should have reliable sources and ensure the availability of data, the established indicator system is concise and easy to operate and understand, and the internationally common names, concepts and units are adopted as far as possible, which is conducive to the actual operation of relevant personnel.

3.2. DETERMINATION OF THE WEIGHT OF THE INDICATOR SYSTEM

Environmental pollution refers to the phenomenon that human beings directly or indirectly emit substances or energy that exceed their self-purification capacity into the environment, thereby reducing the quality of the environment and adversely affecting the survival and development of human beings, ecosystems and property [35]. Since

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this article mainly discusses the ecological pollution compensation standard, industrial enterprises in the external discharge of pollutants by the traditional view mainly include air pollution, water pollution and solid waste pollution, so in the design of the ecological environment pollution level evaluation index system, this paper combined with the above indicators design ideas and original, to comprehensively and objectively reflect the ecological environment pollution status, according to the "China Environmental Statistics Yearbook" disclosed pollutant emission data [36], design the following three types of pollutant indicators: air pollution indicators, Indicators of water pollution and indicators of solid waste pollution.

Due to the different roles of the above index factors in the index system, the degree of impact on ecological environmental pollution is different, to distinguish their differences, certain mathematical methods should be used to determine the weight values of each evaluation index. The reasonableness or non-validity of the weight determination of the indicators is directly related to the accuracy and meaning of the evaluation results. This paper adopts a subjective and objective empowerment method that combines the analytic hierarchy method with the entropy method. The analytic hierarchy method is a combination of qualitative and quantitative, systematic, hierarchical analysis method, so that people's thinking process is hierarchical, layer by layer comparison of relevant factors and layer by layer to test whether the comparison results are reasonable, to provide a convincing quantitative basis for analytical decision-making. However, in recent years, the analytic hierarchy method has been constantly questioned by the excessive subjectivity of the weight, so this paper uses the entropy weight method to determine the weight based on the analytic hierarchy method, and finally averages the weight values obtained by the two methods to obtain a more scientific and reasonable weight value. Regarding the emergence of entropy law, first of all, the German physicist Clausius introduced the concept of "entropy" into the field of thermodynamics in 1855 to describe the degree of chaos in the thermal system, and then developed into "information entropy" by Shannon, the founder of information theory in the United States, to quantify the size of the amount of information described, and then the social sciences began to apply "entropy" to the process of determining weights in multi-objective decision-making, and the academic community generally defined the method of determining the weight as the entropy law [37]. The entropy weight method is determined according to the size of the amount of information reflected by the evaluation object, which has accuracy and objectivity and has been well applied in various research fields. The ecological environment pollution level index system is shown in Figure 5.

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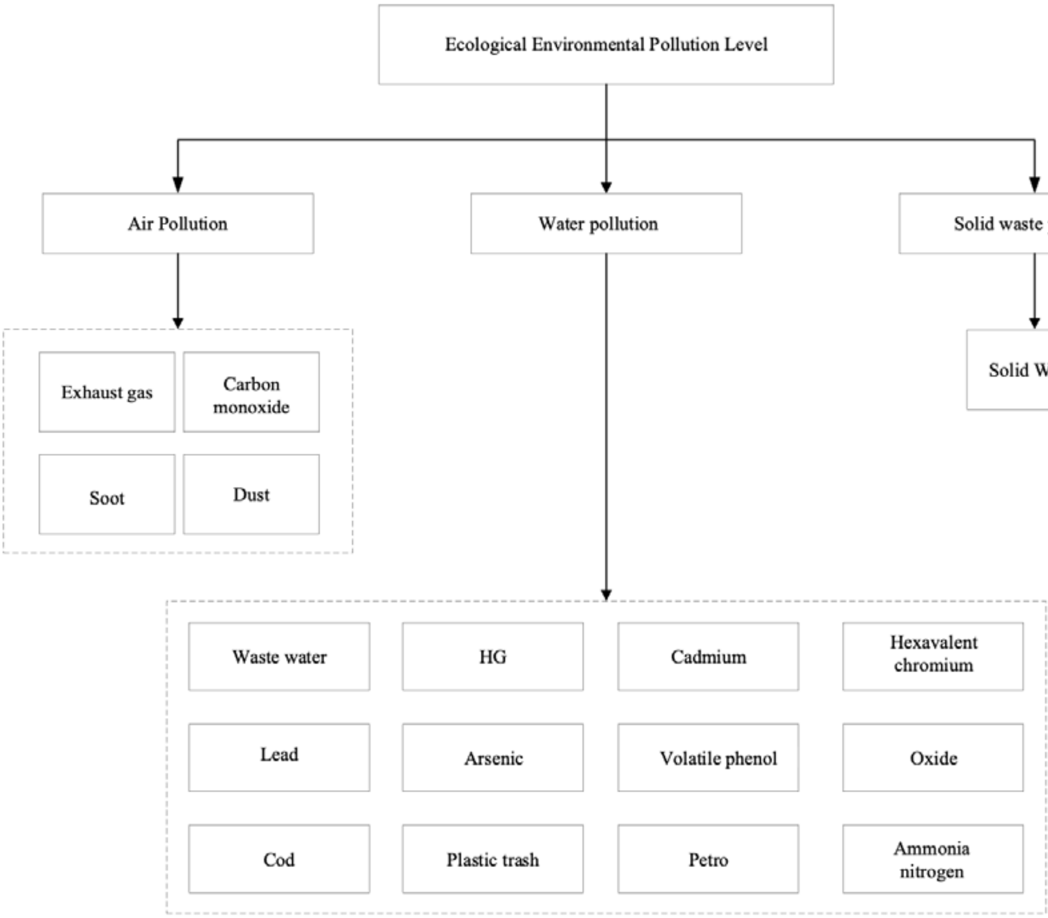

Figure 5. Ecological environment pollution level index system

In Figure 5, the influencing factors of ecological environmental pollution caused by unnatural factors are analyzed, and the indicators of air pollution, water pollution and solid waste pollution are extracted. The design of ecological and environmental pollution level indicators involves multidisciplinary applications such as atmospheric science, ecology, economics, management, accounting, and mathematical statistics. Mainly from the perspective of the influencing factors of the ecological pollution rating evaluation index system design and compensation standards, the design of market-oriented ecological pollution compensation standards is theoretically analyzed, and the comprehensive evaluation model and panel regression model are used to conduct technical analysis of the design of market-oriented ecological pollution compensation standards.

To illustrate the basis for judging the importance of the indicators, this paper first takes a 1--9 scale according to the scale method proposed by TL. Saaty, as shown in Table 1, and uses a_{ij} to represent the comparative results of the i factor relative to the j factor, then $a_{ij} = \frac{1}{a_{ji}}$, and establishes the judgment matrix between the levels of the 16 factors currently considered in the ecological environment pollution level evaluation index system. This is shown in Table 2.

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Table 1. Saaty scale method

Scale	Meaning
1	The influence of factor i is the same as that of factor j
3	The influence of factor i is slightly stronger than that of factor j
5	The influence of factor i is stronger than that of factor j
7	The influence of factor i is obviously stronger than that of factor j
9	The influence of factor i is absolutely stronger than that of factor j
2,4,6,8	The influence of the i-th factor relative to the j-th factor is between the above two adjacent levels

Table 2. Judgment matrix table

A	B_1	B_2	B_3
B_1	a_{11}	a_{12}	a_{13}
B_2	a_{21}	a_{22}	a_{23}
B_3	a_{31}	a_{32}	a_{33}

Hierarchical single sorting is the process of determining the degree of influence of the lower factors on a factor in the upper layer, using weights to express the degree of influence, calculating the maximum eigenvalue of the matrix λ_{max}, and its corresponding normalized feature vector $k = (k, k_2, \ldots, k)$, and the eigenvector $\sum k_j = 1$ is the index weight.

When determining the order of a matrix is large, it is often difficult to construct a matrix that satisfies consistency. However, judging the matrix should deviate from the consistency condition by a degree, for this reason, it is necessary to identify whether the judgment matrix is acceptable, which is the connotation of the consistency test. Definition of consistency indicator $CI = \frac{\lambda_{max} - n}{n - 1}$, randomness indicator RI and the degree of the judgment matrix, in general, the larger the order of the matrix, the greater the probability of random deviation of consistency, which can be obtained by looking up the table. In general, when the consistency ratio is $CR = \frac{CI}{RI} < 0.1$, the judgment matrix is considered to pass the consistency test, otherwise it does not have a satisfactory one-RI consistency. From this, we calculate the weight results of each level of the indicator.

Total sorting is performed layer by layer from top to bottom on a single-sort basis. According to the weighted combination of the weighted results of each level of

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indicators calculated above, the weighted values of the comprehensive evaluation indicators $k = (k_1, k_2, \ldots, k_{16})$ and $\sum_{j=1}^{16} k_j = 1$ are obtained.

This paper assumes that the evaluation matrix of the entropy weight method is $X = (x_{ij})_{m \times n}$, where the evaluation object is $m(0 < i < m)$, which represents the evaluation index $n(0 < 1 < n)$, and x_{ij} represents the original value of the j index of the i evaluation object. The calculation step is divided into three steps.

Step 1: standardize the processing, the formula is:

$$y_{ij} = \frac{x_{ij} - \min_i \left(x_{ij}\right)}{\max_i \left(x_{ij}\right) - \min_n \left(x_{ij}\right)} \tag{1}$$

Where, $\max_i(x_{ij})$ and $\min_i(x_{ij})$ represent the maximum and minimum values of the j indicator in the i evaluation object, respectively.

Step 2: calculate the entropy of the indicator, the expression is:

$$r_{ij} = y_{ij} / \sum_{j=1}^{n} y_{ij} \tag{2}$$

$$e_j = -\frac{1}{\ln m} \sum_{i=1}^{m} r_{ij} \ln r_{ij} \tag{3}$$

Step 3: Determine the entropy weight t_j of the indicator:

$$t_j = \left(1 - e_j\right) / \sum_{j=1}^{n} \left(1 - e_j\right) \tag{4}$$

On the one hand, although the process of determining weights by the analytic hierarchy method has the advantages of clarity of hierarchy and the combination of quantitative and qualitative, the analytic hierarchy method will inevitably cause the subjectivity of the index weights through artificial scoring by experts when constructing the two-two comparison judgment matrix. On the other hand, the entropy weight method is determined according to the size of the amount of information reflected by the evaluation object, which has accuracy and objectivity and has been well applied in various research fields, which can well avoid the weakness of the analytic hierarchy method.

From the perspective of the victim entity of ecological environmental pollution, the severity of ecological environmental pollution is subjective; From the technical point of view of ecological environmental pollution, the severity of ecological environmental pollution is objective, so considering the characteristics of both subjectivity and

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objectivity of ecological environmental pollution, before evaluating the ecological environment pollution level, the setting of the weight of ecological environmental pollution indicators also adopts the subjective and objective empowerment methods combining the analytic hierarchy method and the entropy rights method, see Table 3. The calculation formula is:

$$\omega_j = \left(k_j + t_j\right)/2 \tag{5}$$

$$j = (1,2,\ldots,16) \tag{6}$$

Table 3. Weight setting of ecological environment pollution level evaluation index

Pollution classification	Index system	Index weight w_j
Air pollution	Waste gas (100 million standard cubic meters)	w_1
	Sulfur dioxide (10000 tons)	w_2
	Smoke and dust (10000 tons)	w_3
	Dust (10000 tons)	w_4
Water pollution	Waste water (10000 tons)	w_5
	Mercury (ton)	w_6
	Cadmium (ton)	w_7
	Hexavalent chromium (ton)	w_8
	Lead (ton)	w_9
	Arsenic (ton)	w_{10}
	Volatile phenol (ton)	w_{11}
	Cyanide (ton)	w_{12}
	Chemical oxygen demand (ton)	w_{13}
	Petroleum (ton)	w_{14}
	Ammonia nitrogen (ton)	w_{15}
Solid waste pollution	Solid waste (ton)	w_{16}

3.3. SYSTEM EVALUATION AND POLLUTION LEVEL DIVISION

After determining the weights of each ecological environment pollution index, it can be used, and certain technical methods can be synthesized on the ecological environment pollution level index system, and the evaluation is combined, and the weights of the ecological environmental pollution evaluation indicators can be determined through the subjective and objective empowerment method. Therefore, it is objective, accurate and simple to quantitatively evaluate the pollution level of the

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ecological environment. This paper adopts a comprehensive evaluation model, which takes the following form:

$$P_j = \sum_{j=1}^{16} \omega_j y_{ij} \tag{7}$$

Among them, $P(0 < i < m)$ is the comprehensive evaluation index of the ecological environment pollution level of the polluting entity in the i year, and $\omega_j(0 < j < 16)$ is the weight of the j evaluation index, y_{ij} has the same meaning as above.

Obviously, by such processing, it is possible to make $0 \le p \le 1$. Since China does not yet have a comprehensive rating evaluation standard for air pollution, water pollution and solid waste pollution, this paper considers the two extremes of ecological pollution when formulating evaluation standards. When the polluting entity has no pollutant discharge, the ecological and environmental status is excellent, and the comprehensive evaluation index is 0 at this time. When the total amount of pollutants discharged by polluted entities is large, causing extreme damage to the ecological environment and production and life, the degree of ecological environmental pollution will be very serious, and the comprehensive evaluation index is 1 at this time. We will be the worst degree of ecological environmental pollution grade set as P_1, the comprehensive evaluation index set as $\left(P_{n-1},1\right]$, the lightest degree of ecological environmental pollution grade set as R_n, the comprehensive evaluation index set as $\left[0,P_1\right)$, of which the specific value of $P(i = 1,2\ldots,n-1)$ can be determined according to the above comprehensive evaluation formula and combined with a large number of sample data values, so we will divide the ecological environmental pollution into n grades according to the comprehensive evaluation index, and according to the development of the situation and the effect of measures, the evaluation results are dynamically adjusted, and the ecological environmental pollution can be upgraded or degraded. This is shown in Table 4.

Table 4. Comprehensive evaluation index and ecological environment pollution level

A comprehensive index value of evaluation index	Ecological environment pollution level	Severity of ecological environment pollution
$P_{n-1} < P \le 1$	R_1	Very poor (very serious)
$\vdots$	R_2	Poor (severe)
$P_1 \le P < P_2$	$\vdots$	$\vdots$
$0 \le P < P_1$	R_n	Excellent (slight)

3.4. THE STANDARD MODEL OF ECOLOGICAL POLLUTION COMPENSATION

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3.4.1. VARIABLE AND SAMPLE SELECTION

To facilitate the determination of the ecological pollution compensation standard from the economic perspective, it can be assumed that in the case of a certain income of the injured economic entity, the environmental cost of the economic entity caused by the ecological environment pollution must be reflected in the decline in the total profit of the injured economic entity, for this reason, the total profit of the injured economic entity is taken as the dependent variable, and the ecological environment pollution level of the polluting entity determined above is taken as the independent variable, and the corresponding control variables need to be selected due to a large number of other influencing factors of the change in the total profit of the affected economic entity. The specific situation of the control variable needs to be determined by the specific research object and combined with the relevant financial theory, such as the selection of the corresponding control variables of the industry and the enterprise will be completely different.

Based on the above-mentioned classification of ecological and environmental pollution levels, considering that China's environmental economic statistics have just started, and environmental and economic data are seriously lacking, so to expand the sample size, make the estimation results accurate, consider the panel data established by collecting market-oriented ecological pollution standards, and the data source can conduct field research and investigation by selecting representative, long span time, and a certain number of polluted areas (such as downstream or downwind areas) polluted objects (such as land) and units (such as listed enterprises).

Table 5. variable design and explanation

Variable	Mark	Interpretative statement
dependent variableTotal profit of the affected economic entity	PROFIT	Total profits of economic entities in each year within the sample time span
Explanatory variable Pollution grade index of pollutant discharge entity	P	The Eco-environmental pollution grade index of pollutant discharge entities can be obtained according to the above comprehensive evaluation model. If there are many pollutant discharge entities, in order to avoid too many variables, the average value of Eco-environmental pollution index can be taken according to the pollutant discharge entities
control variable Other major variables affecting the total profits of the affected economic entities	Controis	The specific situation of control variables depends on the specific research object and the theory of related disciplines. For example, the selection of corresponding control variables for industries and enterprises will be quite different

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3.4.2. PANEL REGRESSION ANALYSIS

Through the above analysis, the following panel regression model is established in this paper to investigate the degree of influence of the ecological environment pollution level index of polluting entities on the total profits of the affected economic entities:

$$PROFIT_{it} = \alpha_{it} + \beta_{it}P_{it} + \gamma_{it}\ Controls_{it} + \varepsilon_{it} \tag{8}$$

Where $i = 1,2,\cdots,n$ represents the number of cross-sections and $i = 1,2,\cdots,m$ represents a total of m time series from year 1 to year m. $PROFIT$ is the total profit of the injured economic entity in the m year to the 1st year, P is the ecological and environmental pollution level index of the polluting entity from the 1st to the m year, and $Controls$ is a series of control variables. In addition, before performing panel data regression analysis, it is necessary to consider many problems such as variable collinearity, heteroscedasticity, sequence correlation, and cross-section correlation.

3.4.3. ECOLOGICAL POLLUTION COMPENSATION STANDARDS

Will make the sample data into the panel regression model, the unknown parameters, get the upper hand area) (upstream basin drainage entity (P) discharge pollutants reduced after the ecological pollution poses a disadvantage to rank index per unit area (downstream) suffer entity (E) economic harm the pollution of ecological compensation standard pollution (that is, the marginal cost) calculation formula:

$$EC = \frac{\partial(PROFIT)}{\partial P} = \beta \tag{9}$$

The recovery cost calculation formula is as follows:

$$P_0 = 10^{-5} \times D/\left(C_i - C_0\right) \tag{10}$$

Where, P_0 is the recovery cost, and the unit is 100 million yuan /t; D is the sewage treatment cost, and the unit is yuan /t; C_i is the COD concentration of inlet water, and the unit is mg/L; C_0 is the COD concentration of outlet water, and the unit is mg/L.

The calculation formula of the ecological compensation standard of water source based on water environmental capacity is:

$$P = P_0(M - M_0) \tag{11}$$

It is believed that the external impact of ecological pollution acts can be regarded as a pollution right, the property rights of the parties to the ecological pollution acts can be clearly defined, and the ecological pollution compensation standards are determined by the virtual "ecological pollution rights trading market" formed by the two

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parties, and the numerical size needs to be measured in combination with the amount of pollutant discharged by the polluter exceeding the standard and the economic value loss of the injured party. In the future market-oriented ecological pollution compensation practice, the two sides can also bargain for some of the differences until the price acceptable to both sides is reached, so that the "visible hand" of the government is gradually replaced by the "invisible hand" of the "ecological pollution compensation" market.

According to the ecological pollution compensation standard from the economic perspective, if ecological environmental pollution occurs, the amount of ecological pollution compensation V_{ij} under the economic perspective is calculated according to the following steps:

1. Judge the ecological environment pollution grade $R_j(j = 1,2,\cdots,n)$, and the specific value P;

2. Panel regression analysis was used to determine the marginal cost of ecological environmental pollution suffered by the affected economic entity, and the specific value was EC;

3. According to the above criteria, determine the economic loss $V_{ij} = \beta_{ij}P_j$ of the affected economic entity caused by ecological environmental pollution, namely, obtain the compensation amount of regional environmental pollution from the perspective of new structural economics.

4. RESULTS AND ANALYSIS

In this paper, we take the Zhangwei South River Basin as an example, the Zhangwei South Canal water system originates from the Taihang Mountains, is one of the five major river systems in the Hai River Basin, flows through the five provinces and cities of Jin, Hebei, Henan, Lu and Tianjin, with a basin area of 38,000 km. Among them, the upstream mountainous area is 25,000 km, the middle and lower reaches of the plain area are 13,000 km, the Zhangwei South Canal is composed of two major tributaries of the Zhanghe River and the Weihe River, the two rivers are called the Wei Canal after the confluence of Xuwancang in Guantao County, Hebei Province, and are divided into the South Canal (the mainstream of the Haihe River) and the Zhangwei New River (into the Bohai Sea) through the Sinu Temple hub, and the important water source protection areas of the Zhangwei South Water System are the Zhangwu Reservoir (AY) of Anyang City, the Water Source Area of Hebi City (HB), the Qingzhang River Hebei Water Source Area (QZ), the Yuecheng Reservoir (YC), and the Qingzhang Dongyuan Water Source Area (QZD). Most of these water source protection areas are located upstream of the river basin, shouldering the responsibility of providing excellent water quality, sacrificing some development opportunities, and in the case of providing excellent water quality, the downstream should make ecological compensation for these areas to compensate for the loss of upstream

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areas; However, the overuse of water resources and the disorderly discharge of sewage by some upstream water-using units will cause serious water pollution accidents, sacrificing the right to use water resources downstream, and using compensation measures based on the perspective of new structural economics to discuss regional environmental pollution, the main body of ecological compensation can be clarified and provide a basis for the formulation of ecological compensation standards.

Based on the actual data collected, the main water source areas of the basin are analyzed, as shown in Table 6. The environmental capacity of the main drinking water source protection area in the sub-basin of the Zhangwei South Canal was calculated, and the results are shown in Figure 6.

Table 6. The main water source areas of the Zhangwei South River Basin

Water source area	Length of reach (m)	flow (m^3/s)	Current Speed (m/s)	COD degradation coefficient (1/d)
Anyang Zhangwu reservoir	5	4	0.1	0.25
Hebi water source area	48	3.2	0.2	0.25
Qingzhang River Hebei water source area	45	0.82	0.27	0.25
Yuecheng Reservoir	51.2	0.3	0.19	0.5
Qingzhang Dongyuan water source area	103.5	0.1	0.14	0.25

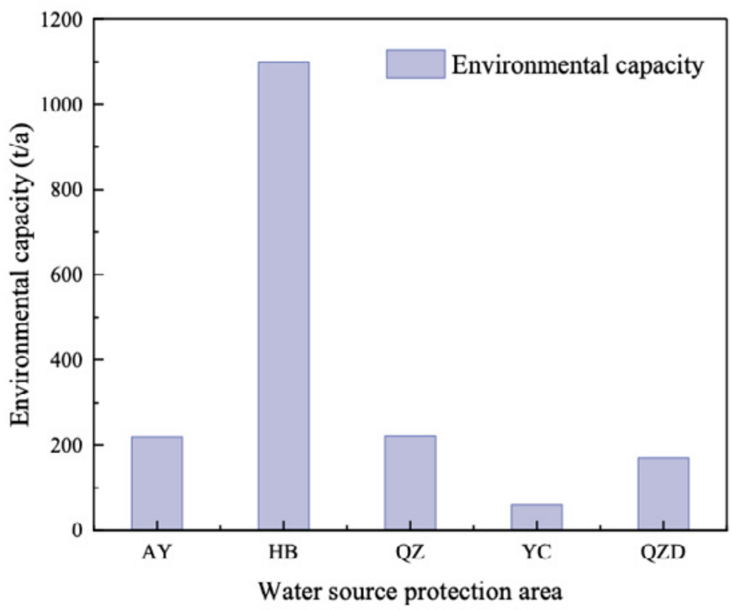

Figure 6. The environmental capacity of the main drinking water source protection area in the Zhangwei South Basin

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Figure 6 shows the COD emissions of pollutants in each water source area after the investigation and data collation, of which the emission of COD in the Yuecheng Reservoir Water Source Protection Area (YC) is the smallest, reaching only 98t/a, indicating that the water resources in the water source area are well protected, the emission of COD of Zhangwu Reservoir (AY) in Anyang City is 205t/a, the emission of COD in the North Water Source Area (QZ) of Qingzhanghe River is 208t/a, and the emission of Qingzhang Dongyuan Water Source Area (QZD) is 194t/a. The COD emission of the drinking water source area (HB) in the water source area of Hebi City was the largest, reaching 1088.1t/a, indicating that the water resources in the water source area were excessively wasted. Ecological problems are essentially environmental problems, and the accounting of ecological compensation standards should also be based on environmental cost accounting to promote the harmonious and unified development of social economy and natural ecology.

The treatment cost of major urban sewage treatment plants in China is 1.29 yuan / t, the COD concentration of inlet water is 253.79 mg / L, and the COD concentration of effluent is 22.03 mg / L. Bringing the data into the formula yields that the recovery cost P_0 is 100 million yuan/t.

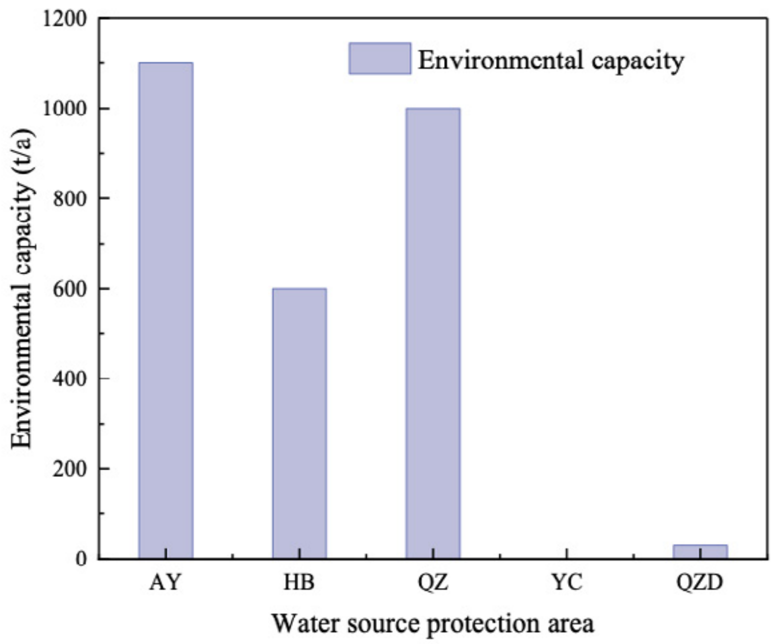

Figure 7. COD emissions by water source area

If the result is positive, that is, there is still a surplus of environmental capacity, the downstream should be compensated for the excellent water quality provided upstream; If the remaining environmental capacity is negative, that is, the upstream water does not meet the specified water quality standards, the downstream needs to carry out water ecological restoration measures to meet the water quality standards, so the upstream should compensate the downstream accordingly.

Among them, M is the water environment capacity of the functional area, the unit is mg, and M_0 is the total pollutant discharge. From the previous calculations, the

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recovery cost of water resources P_0 is 5.57×10^{-5} billion yuan /t, and the data is brought into Equation 11 to obtain the ecological compensation standard of each water source (a negative number indicates that the pollutant emission exceeds the water environment capacity, and the upstream pays the corresponding cost). The results are shown in Figure 8.

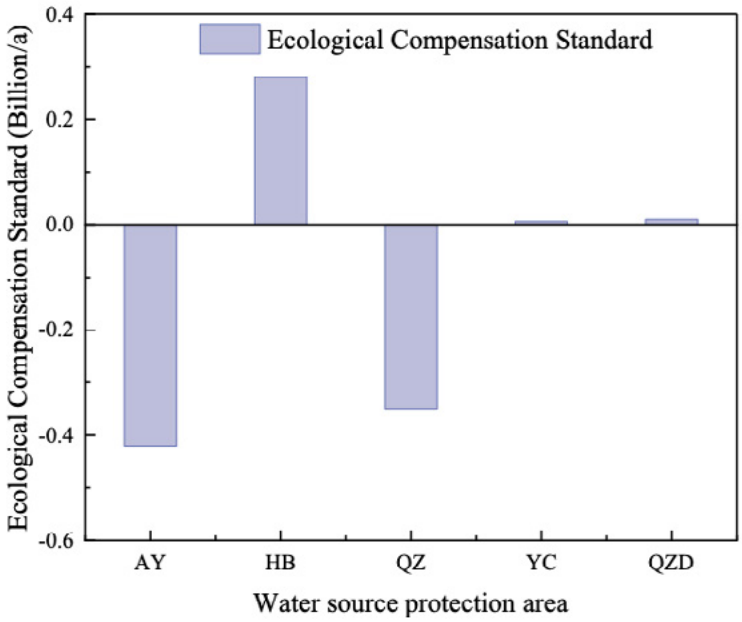

Figure 8. Ecological compensation standards for each water source area

The impact of polluting substances discharged by enterprises and units in Hebi City Drinking Water Source Area, Yuecheng Reservoir Water Source Area and Qingzhang Dongyuan Shanxi Conservation Area is within the scope of water environment capacity, and there is still a surplus water environment capacity, and the downstream upstream compensation is not necessarily used to compensate for the provision of excellent water quality, and the ecological compensation costs downstream to the upstream of Hebi Drinking Water Source Area, Yuecheng Reservoir Water Source Area and Qingzhang Dongyuan Shanxi Conservation Area are 282,310,000 yuan and 620,000 yuan /a, respectively.

According to the 2021 water environment monitoring of Anyang City, due to the discharge of a large amount of domestic sewage and industrial wastewater along the river, the water quality in the jurisdiction shows a deterioration trend of different degrees, and the water quality of the main rivers and reservoirs in Anyang City, the water quality of class II-III water that meets the national standard is very small, and the overall quality is poor. Combined with the research in this paper, the upstream drinking water source area of Zhangwu Reservoir in Anyang City needs to compensate 4.53 million yuan downstream for the implementation of measures such as downstream sewage treatment and water ecological restoration.

The demand for water for the socio-economic development of the Qingzhang River Basin is increasing, and industrial wastewater and urban domestic sewage are directly

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discharged into the river without treatment, resulting in river water pollution. The amount of water entering the upper reaches of the Qingzhang River has been greatly reduced, and the pollutants entering the river have greatly exceeded the pollution absorption capacity of the river, resulting in the serious deterioration of the water quality of the Qingzhang River, which has caused great hidden dangers to the safety of drinking water quality, and the implementation of ecological compensation measures, the upstream of the drinking water source area of the Qingzhang River in Hebei needs to compensate 3.88 million yuan downstream for water quality and water ecological restoration.

5. DISCUSSION

On the one hand, this paper empirically studies and designs the market-oriented ecological pollution compensation standards of China's industry. Its research paradigms and methods can provide useful reference and experience basis for further testing the common corporate pollution compensation standards at the micro level, especially in the future, when the environmental accounting information disclosure mechanism of listed companies in China is sound, it is more feasible. On the other hand, this paper takes the market-oriented ecological compensation standard of the upper and lower reaches of the Zhangwei South River Basin in China as a case for testing, but in fact, there is also an inter-provincial pollution compensation problem in the Boundary of Jiangsu, Zhejiang and Zhejiang and Shanghai in the Taihu Lake Basin, and the availability and length of the data are still to be studied. Of course, the research in this paper still needs to be deepened, for example: expanding pollutant indicators, which can incorporate pollutants issued by new national regulations such as PM2.5 into the atmospheric ecological pollution compensation standard system; broadening the compensation object, which can include the health and economic losses of residents in the downwind area of the industrial zone and the downstream of the river basin; exploring the compensation implementation mechanism, giving the existing compensation standards interval values, and introducing game mechanisms to lay a reliable foundation for the implementation of ecological and environmental pollution compensation in the future.

6. CONCLUSION

With the rapid development of the social economy, the continuous consumption of natural resources, and the increasingly prominent ecological and environmental problems, the awareness of the damaged people on ecological compensation has been further strengthened, requiring the adoption of reasonable ecological compensation standards to achieve sustainable social and economic development. To control and coordinate the relationship between economic benefits and environmental resources, realize the synchronous optimization of environmental benefits, social benefits and economic benefits, and promote the harmonious unity of economic

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development, social progress and environmental protection. In this paper, by designing ecological pollution compensation indicators and constructing a quantitative model, this paper discusses the principles, influencing factors, methods and calculation steps of the formulation of market-oriented ecological pollution compensation standards from the theoretical level. Through the panel regression model, an empirical study on the design of ecological pollution compensation standards in China's industrial industry and a case study on the design of compensation standards in the Zhangwei South River Basin were carried out. The conclusion is as follows:

1. From the perspective of new structural economics, the sub-regional nuclear density of fiscal decentralization is 0.722 in the eastern region, 0.468 in the central region, and 0.389 in the western region. The sub-regional nuclear density of the development strategy: 0.243 in the eastern region, 0.007 in the central region and 0.005 in the western region. This indicates that the higher the degree of fiscal decentralization, the higher the degree to which local development strategies will follow their comparative advantages.

2. According to the treatment cost of major urban sewage treatment plants in China is 1.29 yuan / t, the COD concentration of inlet water is 253.79 mg / L, and the COD concentration of effluent is 22.03 mg / L. The ecological compensation value of each water area is calculated. The comprehensive evaluation index of unit ecological environmental pollution will significantly cause damage to the real economy in the downwind area (downstream watershed), and the market-oriented ecological pollution compensation standard and compensation amount can be determined by the marginal cost of pollution.

3. The ecological compensation costs upstream of the drinking water source area of Hebi City, the water source area of Yuecheng Reservoir and the downstream of Qingzhang Dongyuan Shanxi Nature Reserve are 282,310,000 yuan and 620,000 yuan/a, respectively. The upstream of the drinking water source area of Zhangwu Reservoir in Anyang City needs to compensate 4.53 million yuan downstream for the implementation of measures such as downstream sewage treatment and water ecological restoration. The upstream of the drinking water source area of Qingzhanghe River Hebei needs to compensate 3.88 million yuan downstream for water quality and water ecological restoration.

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/15/

IMAGE CHARACTERISTICS OF RURAL ECOLOGICAL CULTURE UNDER RURAL VITALIZATION POLICY

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ABSTRACT

The construction of ecological culture is a major issue concerning the national economy and people's livelihood. In order to clearly recognize the image characteristics of rural ecological culture development based on the rural revitalization policy background and achieve the harmonious development of rural economic operation, this paper, a case study on the image characteristics of rural ecological culture under the rural revitalization policy is performed, and an in-depth analysis of ecological culture is performed with respect to natural ecology and social ecology of culture. Then, the results of in-depth analysis and case study indicate that cultural ecology has the typical characteristics of heritability, variability and diversity, and that, the development of rural ecological culture in Changzhou is relatively good in connection to natural resources, construction resources and human resources, in which Liyang contributes the most to ecological culture in Changzhou, accounting for 40%. In view of the above, the research results provide a certain reference value for policymaking under the rural revitalization strategy.

KEYWORDS

Rural revitalization; Ecological culture; Rural development; Ecological protection; Cultural image characteristics

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1. INTRODUCTION

The unbalanced development is mainly reflected in the unbalanced development of urban and rural areas, and the underdevelopment is mainly reflected in the underdevelopment of rural areas. The implementation of the rural revitalization strategy is to solve the problems of unbalanced development of urban and rural areas and insufficient development of rural areas in the country [1-3], which is an objective choice for China to achieve prosperity, democracy, civilization, harmony and beauty [4].

Building an ecological civilization is crucial to the implementation of the rural revitalization strategy [5-6]. The promotion of ecological culture in the new era needs to be carried out and needs to be combined with the rural revitalization strategy [7] to continuously meet people's demand for a high-quality life and a beautiful ecological environment. The construction of rural ecological culture is both the main content of the rural revitalization strategy [8] and the goal of its pursuit [9]. Paying great attention to the construction of rural ecological culture is of great significance to promote the rural revitalization strategy and achieve the goals and tasks [10].

Current social development has greatly facilitated people's lives, but it has also resulted in negative impacts on mainstream culture [11] and the proliferation of information. This, in turn, has created an imbalance in ecological culture and increased the problems of ecological cultural governance. Ecological culture is typically characterized by heritability, variability, and diversity [12]. Grasp the characteristics of rural ecological culture under the rural revitalization policy, to grasp the study of rural ecological culture governance [13]. It is of great significance to govern the imbalance of rural ecological culture and rebuild a good ecological culture system. It creates a good environment conducive to the development of ecological culture and promotes the harmonious and healthy development of rural ecological culture [14].

Areas that have not been affected by urbanization are considered to have the highest value in terms of protecting physical factors [15-17], while areas strongly affected by urbanization are considered to have the highest value in terms of protecting social factors [18-19]. The literature [20] constructed an evaluation index system based on the Chinese rural water situation [21-22]. In the literature [23], three secondary indicators and 18 tertiary indicators were selected [24], and the Delphi expert consultation method and hierarchical analysis were used to weight each indicator [25] to build the evaluation system [26]. Based on the current situation of Beijing's rural ecological environment, the literature [27] analyzed the shortcomings of Beijing's rural areas based on the construction of ecological habitat, ecological industry and ecological culture [28], and proposed measures and prospects to promote the construction in Beijing's rural areas. Strengthening rural ecological environmental protection is conducive to sustainable economic and social development and cultural construction in Beijing. The literature [29] analyzed the relationship between the vision of rural revitalization and the complex natural-cultural-

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economic system, taking the rural areas in southern Jiangsu, where urban-rural integration and agricultural modernization are rapidly developing, as an example, and studied the problem of rural ecological construction and its causes from three aspects: planning vision, planning methods, and planning contents [30]. Further, different types, dimensions, and levels of planning strategies are proposed to guide the practice of rural ecological construction in southern Jiangsu and to achieve the goal of rural revitalization. To sum up, rural ecology is an important research target both at home and abroad, and rural areas are viewed from various perspectives, and with economic development, rural conditions are gradually emphasized. Therefore, this paper proposes a kind of research on the imagery characteristics of rural ecological culture under the rural revitalization policy. Through analyzing ecological culture characteristics from multiple perspectives, the construction of rural ecological culture under the background of rural revitalization strategy is constructed. The ideas and concepts of rural ecological culture construction and development are implanted into the minds of the grassroots. Recognize the importance of rural ecological culture construction and sustainable economic development. Promote the comprehensive development of rural spiritual civilization and guarantee economic development and ecological culture construction.

2. ECOLOGICAL CULTURE CHARACTERISTICS

As an inseparable part of social development, culture develops in harmony with other aspects of society, forming the external order of culture [31]. At the same time, culture itself is an organic whole, and the harmonious development of the elements within culture constitutes the ecological order within the culture. A good and orderly external ecological order of culture is an important reason for the development of culture and the harmonious development of the whole society. A good and orderly internal ecological order of culture is the inherent foundation for the sustainable development of culture and maximization of its functions. Only when the internal and external ecological order of culture is in an orderly state of development can culture and society develop healthily [32].

2.1. HEREDITY OF ECOLOGICAL CULTURE

The development process of any cultural ecosystem is a process of inheritance and development, and the corresponding characteristics of cultural ecology are the heritability and variability of cultural ecology. With the development of the times, after a long period of baptism, some cultural factors are inherited, while other cultural factors that do not adapt to the development of the social environment will be eliminated or broken, thus producing new cultural factors, and this process is the inheritance and variability of cultural ecology. There are two main ways of cultural-ecological inheritance, one is to complete the genetic process through information transmission, and the other is to complete the genetic process through education [33]. Inheritance through information carriers includes cultural achievements in material form created by previous generations, as well as non-material cultural traditional concepts. For example, language, religion, customs, moral concepts, political system, legal system, marriage concept, thinking habits, etc. These systems and concepts greatly influence people's social activities and have a subtle influence on them, so they are more likely to be passed down. Therefore, these concepts and systems are relatively stable factors in the development of cultural ecology [34]. Education has been playing a role in the inheritance of cultural ecology since the birth of human beings in primitive societies, but education has different expressions in different social periods.

2.2. VARIABILITY OF ECOLOGICAL CULTURE

Cultural transmission occurs in the process of human socialization because the social environment changes more quickly and frequently than the natural environment. It leads to changes in ecological culture that are also more drastic than those in biology, just as changes in species accumulate to a certain degree, and new species are produced [35-37]. When ecocultural variation accumulates to a certain degree, it is accompanied by the disappearance of the old ecoculture and the creation of a new one.

Ecological culture has variability, which provides the basis for its self-renewal. The variation of ecological culture is a dynamic development process. Just as the law of development of anything is a unity of progress and twists and turns, the development trend of new things is bound to be resisted and stifled by old things. The development of ecological culture is not smooth, but tortuous. Therefore, advanced culture must continue to develop and innovate to adhere to its direction of advancement and maintain its advanced nature. It is also necessary to follow the general laws of cultural development and create an open and good atmosphere for cultural innovation and development, rather than conservatism and complacency. Advanced culture should take the monoculture as the leader and vigorously develop multiple cultures. Only by consciously resisting the decaying roots of cultural dross, cutting off undesirable roots and absorbing reasonable factors from other cultural ecosystems, can we maintain our advancement in the process of mutation. Do not be conservative, not be complacent, and actively innovate.

2.3. ECOLOGICAL AND CULTURAL DIVERSITY

The diversity of cultural ecology has the same impact on human society as biodiversity has on the biological world. Just as biological genetic diversity facilitates genetic renewal and biological evolution, cultural ecological diversity facilitates the healthy and diverse development of cultural ecosystems around the world.

Ecological culture is diverse, and countries and peoples around the world have developed unique ecological culture systems in the long history of development. At the same time, it has added color to the world's rich and colorful culture. Countries

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with advanced cultures have formed their eco-cultural systems and produced their distinctive types of eco-culture in the course of historical development, which is a very important link that must be inherited and developed for future cultural development in the world. Various ecological cultural systems have made important contributions to the development of world culture. We should advocate ecological and cultural diversity, and adhere to cultural diversity and our cultural traditions. Therefore, in building a harmonious culture, we should maintain cultural diversity and adhere to the characteristics and openness of the nation. Internally, we should achieve the protection of ethnic culture, especially the diversity of minority languages, religious beliefs and folk customs. Externally, we should maintain openness, absorb the essence of foreign cultural achievements while maintaining the nation's characteristics, and continuously develop and build our own national culture.

3. CONSTRUCTION OF RURAL ECOLOGICAL CULTURE IN THE CONTEXT OF A RURAL REVITALIZATION STRATEGY

3.1. CONNOTATION OF ECOLOGICAL CULTURE

Scholars' connotations and definitions of cultural ecology mainly include: cultural ecology refers to the interaction between human culture and behavior and the social environment. All components of human culture are an interactive whole, and the result of this interaction makes human culture evolve and develop continuously. It is the way and state of interaction and interaction between various specific cultural forms and certain social and cultural systems within a certain period and is the organic unity of various factors that affect the survival and development of culture, including both the natural and social ecology of culture.

Each part of human culture is an interactive whole, an ecosystem similar to a natural ecosystem. In this system, different cultural elements, cultures and their habitats interact, interdepend on each other and nourish each other, constantly exchanging information and energy to maintain the homeostatic continuity of society. Ecoculture is a cultural system composed of various cultural elements, in which various cultural factors are interlinked, constrained and dependent. Ecological culture cannot be separated from the ecological environment, which is important in the emergence, development and evolution of ecological culture. Its interior is constantly changing and in a dynamic state of flux. Its exterior is stable and continuous. Ecoculture is culture in a specific environment, and the differences in cultural habitats are an important reason for the survival of cultural diversity.

3.2. PATH SELECTION OF RURAL ECOLOGICAL CULTURE CONSTRUCTION IN THE CONTEXT OF A RURAL REVITALIZATION STRATEGY

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3.2.1. CHANGE IDEOLOGY AND BUILD A SPIRITUAL CIVILIZATION

Cognition influences thinking and thinking determines action. The construction of rural ecological culture starts from the thoughts and spirits of the grassroots people. Through education, training and daily propaganda, we should implant the thoughts and concepts of rural ecological culture construction and development into the minds of the grassroots people, raise people's attention to rural ecological culture construction through direct and indirect communication, make people realize the important role of rural ecological culture construction and sustainable economic development, and encourage them to participate in rural ecological culture construction.

Villagers who have been living in rural areas for a long time lack the opportunity to receive education and the awareness of receiving education. It should not only pay attention to the investment and development of rural ecological environment and infrastructure but also the development of rural cultural and recreational activities to meet the cultural needs of the people. Secondly, we should also increase the investment and construction of rural fitness equipment and fitness places to promote the overall development of rural spiritual civilization.

3.2.2. STRENGTHEN THE SUPPORT OF SCIENCE AND TECHNOLOGY AND DEVELOP THE ECOLOGICAL ECONOMY

Industry drives the economy and economic development of rural areas. The construction of rural ecological culture should be based on the characteristics of local development, the scientific and reasonable industrial layout of the construction area, realize the perfect combination of economic and ecological benefits, improve the development of rural green agricultural products, enhance the core competitiveness of rural ecological agricultural products, form special industries, create regional brands and develop the local ecological agricultural economy.

The goal is a development mechanism coordinated with the integrated development of urban and rural areas, and the new ecological countryside is a development model supported by science and technology. Accelerate the independent innovation and application of science and technology to form a new pattern of rural, agricultural and farmer-style development. First, agriculture and rural areas supported by science and technology are a development model of production, consumption, recycling and reproduction, the whole development link is clean and sanitary without pollution, fully realizing the harmonious development of rural economic operation and ecological environment. Second, the production and consumption in the process of rural life. The popularization of high-tech industrial products will make people's lives more convenient, and the production and use in the whole process of life more civilized. Third, the construction of ecological culture is a long-term project, which

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cannot be separated from the long-term persistence of publicity and promotion personnel. It is necessary to play the correct guiding role of science and technology promoters, adopt green products that have a positive effect on ecological rural construction, and promote the production and application of green technology.

3.2.3. STRENGTHEN INFRASTRUCTURE CONSTRUCTION AND IMPROVE THE LIVING ENVIRONMENT

The construction of rural ecological culture should adhere to people-oriented, respect the laws of nature, conform to nature and protect nature. Deepen the system of harmonious coexistence of humans and land to improve and optimize the human living environment. Rural land resources are limited. We should adhere to economic development and protective development so that the harmony and beauty of nature are in line with the concept of tranquil ecological civilization. The relevant departments should carry out the construction of rural ecological culture at the same time, do a good job of planning the construction of rural housing ecological culture, scientific and reasonable use of rural land space, correct the current situation of rural deficiency, strengthen the management of rural environmental health so that rural areas are full of rural civilization and ecological habits of livable life.

Sustainable development is an important concept in the construction of rural ecological culture, and protective development of resources and infrastructure construction should focus on protecting ecological civilization and the environment. State capital investment faces many difficulties, which brings great obstacles to rural economic development. The main purpose of rural ecological construction is to change the situation of backward rural infrastructure, unregulated environmental management and uncoordinated economic development, to help the majority of rural farmers and people to embark on the road of economic development, to seek economic development benefits for the people and to promote harmonious rural development. To reduce the harm to the environment in a scientific way of development, to achieve the purpose of protecting the ecological environment, to form a benign development of resources and environment.

3.2.4. BUILD A REGULATORY MECHANISM AND IMPROVE THE EVALUATION SYSTEM

The new round of rural development planning should take ecological livability as the core, and during the planning and construction process, the entry of enterprises harmful to the environment should be avoided, and those causing pollution should be corrected, rectified, or even stopped. The harmonious development of rural economy and ecology needs a perfect environmental evaluation system to ensure that there is a basis for supervision and evaluation in the process of rural ecological culture

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construction so that the rural ecological environment can be improved comprehensively.

The construction and development of ecological rural areas require not only input and effort in the process but also supervision in all aspects of the whole process. Therefore, it is necessary to improve the supervision mechanism of rural construction. First of all, supervision in the implementation process first needs a rules-based supervision system and implementation norms. Modern ecological civilization in the new countryside should be based on local characteristics and people's habits of living and should be planned by local conditions and scientific layout so that economic development and rural planning can be coordinated and harmonized. Secondly, the problems that are difficult to adjust during the construction process should be solved by legal means, and the corresponding restraint mechanism should be established and improved from the legal level so that the grassroots government can provide the basis and laws for rural environmental governance and protection. Finally, the improvement of the system is the primary link, and the implementation is the key. Strictly abide by laws and systems to protect the rural ecological environment. In the process of supervision and law enforcement, the ecological protection awareness of the whole society should be cultivated to effectively guarantee orderly economic development and ecological construction.

4. RESULTS AND ANALYSIS

We take the villages in Changzhou as an example. Among the villages in Changzhou, there is one national historical and cultural village - Jiaoxi Village, two provincial historical and cultural villages - Shazhang Village, Yangqiao Village, and one Chinese traditional village - Yangqiao Village. Changzhou is rich in rural cultural resources, with unique natural resources, rich architectural resources and strong local characteristics.

The villages in Changzhou are mainly located in urban areas, Wujin, Jintan and Liyang, and are mainly represented by the existing Qing Dynasty and Republican architectural forms. At present, there are dozens of villages in Changzhou, including Jiaoxi Village, Yangqiao Village, Wei Village, Zhaiqiao Village, Yuxiang Village, Tangqiao Village, Minghuang Village, Xiaohe Village, Wansui Village, Xiajixi Village, Mahang Shangdian Village, Caoqiao Village, Furong Shuangmiao Village, and Daixi Village, Ma'an Village. In Jintan, there are Dongpu Village and Lushubagua Village. In Liyang City, there are Longweigu Village, Shagang Village, Shenxi, Qicun and Jiming Village.

4.1. OVERVIEW OF CULTURAL RESOURCES OF CHANGZHOU VILLAGES

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4.1.1. NATURAL RESOURCES

Natural resources of traditional villages generally refer to the environmental resources around traditional villages during their formation, such as topography, landforms, mountains, rivers, farmland, forests, vegetation and other natural resources. Wujin Jiaoxi Village is surrounded by mountains such as Shunshan, Phoenix Mountain, Qinwang Mountain, Heshan Mountain, Shiyan Mountain and other mountain ranges stretching incessantly, and Shun River on the east side, connecting the Yangtze River and Taihu Lake. In this village, the Longxi River winds through and is built along the river in the surrounding streets. Yangqiao Village is located on the shore of West Taihu Lake, and the waters of West Lihe Lake, East Taihu Lake and West Taihu Lake flow through the village in turn.

Figure 1. Rural ecological nature, architectural development

4.1.2. BUILDING RESOURCES

The village construction resources in Changzhou mainly refer to street and alley architecture, ancient bridges and ancient roads, and high mountain architecture. Street and lane architecture is generally the general layout and structural form of the village, consisting of blocks, alleys, ancient buildings, traditional dwellings and so on. There are five streets and thirteen alleys in Jiaoxi village, with streets about 300 meters long from east to west and 50 meters long from north to south, hundreds of which were built in the Qing Dynasty and the People's Republic of China. Up to now, there are about 27,000 square meters of traditional buildings of the Ming and Qing dynasties and the Republic of China in the territory of Yangqiao village, and more than

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1,000 meters of stone berms are well preserved. Now there are 5 old streets and 6 ancient bridges.

4.1.3. HUMANISTIC RESOURCES

The villages in Changzhou have rich humanistic and historical cultural resources, such as celebrity resources, folklore, ritual culture and other intangible cultural heritage. The traditional folklore of Yangqiao includes the Yangqiao temple fair, traditional dances such as "Mendacity" and "36 lines", traditional art of Yangqiao paper twisting, traditional sports, acrobatics of fixing wheelbarrows, traditional skills of Su Dongpo "red friend wine" brewing, Yangqiao head boat making and so on. In Dongpu village of Jintan district, there are front fish lanterns and silk string gongs and drums; in Wansui village of Wujin district, there are Wansui monkey lanterns; in Liyang city and Shagang village, there are temple fairs, public hall open doors, horse lanterns and lion dances.

Figure 2. Rural eco-humanistic development

4.2. EXAMPLE ANALYSIS

Changzhou villages have rich tourism resources, such as ancient buildings, traditional houses and folk customs, which continue the development of villages, inherit local folk customs, reflect distinctive regional cultural characteristics and have

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high tourism value. The villages in Changzhou are located in the water town of Jiangnan, with the typical regional style of "small bridges, flowing water and people's homes". With people's enthusiasm for rural cultural tourism, traditional villages have certain tourism values as they integrate the traditional culture and unique style of beautiful countryside. The scientific and reasonable development of villages is conducive to realizing their economic value and obtaining good economic benefits. A large number of traditional villages in Changzhou are located in rural areas with backward economic development and almost no development. Relying on their rich natural resources, architectural resources and historical and cultural resources, their scientific and reasonable development can improve residents' income, raise their living standard, increase employment opportunities and realize their economic value.

According to the research on the characteristics of rural ecological cultural imagery, it is clear that the characteristic elements of its cultural imagery expression are multifaceted, but with unique characteristics. Such as the evolution, inheritance, habits and other cultural characteristics of each village. The above natural resources, architectural resources, and human resources are divided, with rivers, farmland, and vegetation as secondary indicators of natural resources, roads, bridges, and ancient buildings as secondary indicators of architectural resources, and celebrity resources, living and cultural habits, and cultural literacy as secondary indicators of human resources. Each item is 10 points, and the total is 100 points, as shown in Table 1.

Table 1. Classification indicators of cultural imagery characteristics in rural Changzhou

Resource	Type	Characteristic situation	Wujin/Fraction	Jintan/Fraction	Liyang/Fraction
Natural resources	River	Quality of river water	9	7	9
	Farmland	Farmland soil quality	8	7	9
	Vegetation	Vegetation cover	9	6	9
	Air environment	Environmental Quality	8	5	9
Building resources	The way	Road quality	7	4	8
	Bridge	Bridge support	8	5	8
	Ancient building	Conservation of ancient buildings	7	4	9
Human Resources	Celebrity Resources	Influence	6	4	7
	Living and cultural habits	Popularity	8	6	9
	Cultural literacy	Literacy strength	8	5	9
Total score			78	53	86

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Table 1 shows that the cultural imagery characteristics of Changzhou's three main regions, Wujin, Jintan and Liyang, can be analyzed by dividing each resource carefully.

From the data in the table, we can see that the overall score of Jintan is low, especially in architectural resources, the score is mostly 4-5, especially in the protection of ancient buildings, the score value is 4. The overall score of architectural resources lowers the score of the whole region, so it can be concluded that the natural resources, architectural resources and human resources of traditional villages are organically combined into a whole, and the relationship between various resources should be considered as a whole, and they should not be separated for one-sided protection and development. Architectural resources such as traditional houses, ancient buildings and alpine roads are the material carriers of traditional village cultural resources. They constitute the organic whole of traditional village cultural resources together with the immaterial carriers of traditional village cultural resources such as folk culture. In the protection and development of traditional village cultural resources, we should pay attention to both tangible material cultural resources and intangible material cultural resources, thus forming a complete combination of tangible and intangible.

Among them, the overall ecological and cultural imagery characteristics score of Wujin is 78, while the lowest score of Jintan is 70 and the highest score of Liyang is 82, which means that Liyang has higher ecological and cultural aspects and the development is better maintained. Protecting and inheriting these traditional rural cultural imagery makes the history and culture of traditional villages deeply rooted in people's hearts and realizes the sustainable development of traditional village resources. In the development of cultural resources of traditional villages, sustainable economic development should be taken as an important grasp, and short-term economic benefits should not be pursued unilaterally to achieve sustainability.

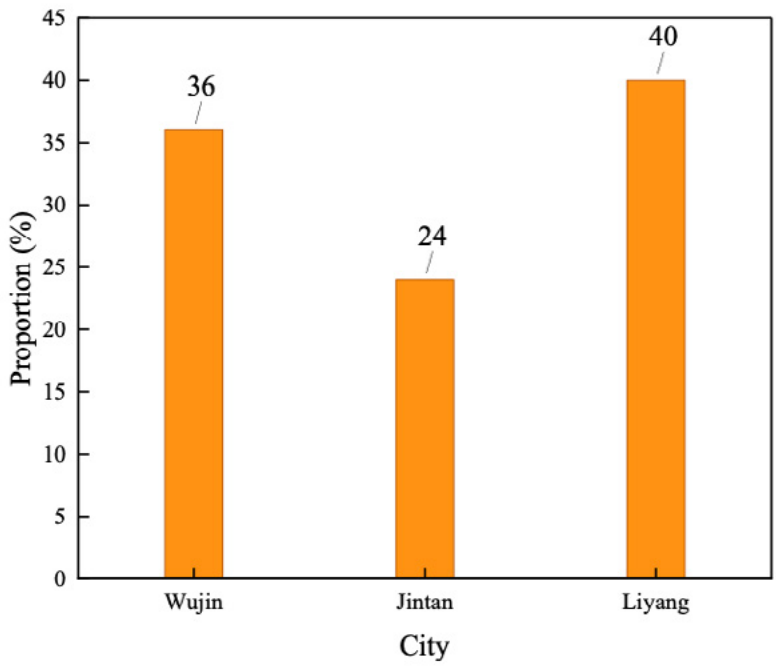

Figure 3. The proportion of ecological and cultural imagery features in the three regions

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It can be seen from Figure 3 that Wuzhen accounts for 36%, Jintan accounts for 24% and Liyang accounts for 40% in the three regions, thus learning that Liyang has the best development level under the rural revitalization policy and adds a splash of color to Changzhou's rural ecological culture. Jintan needs to encourage publicity more the next time, improve ecological culture in all aspects, maintain ecological balance when protecting and developing traditional villages, follow ecological laws, consider the carrying capacity of the local natural environment, achieve sustainable development of material and cultural resources in traditional villages, and make Changzhou's overall development level improve.

5. DISCUSSION

The purpose of ecological and cultural conservation is to create an ecosystem that is conducive to healthy and sustainable cultural development. Rural ecological and cultural conservation is to protect the constituent elements of folk culture and its habitat, as well as the inner operating mechanism that promotes the normal operation of rural ecological culture under rural revitalization, i.e., to protect the culture and its check and balance relationship with its survival habitat. While continuously coping with the natural ecological environment, we have built a unique rural ecological culture. To build a rural ecological culture reserve, we must accurately understand the characteristics of the formation of rural ecological culture, so that the construction of a rural ecological culture reserve can be targeted and effective.

6. CONCLUSION

With the acceleration of urbanization, the natural economic and social relations under the traditional culture are broken. The relatively stable landscape structure of ancient villages precipitated by history is rapidly changing. Changzhou's villages are based on ecological protection, and most traditional villages are located in ecological civilization demonstration areas. They embody unique and distinctive rural characteristics, possess rich tangible and intangible cultural heritage, and are an important part of the cultural heritage development project. It becomes more necessary and urgent to study the landscape characteristics of traditional villages in Changzhou and explore their cultural heritage.

1. By analyzing the unique culture contained in natural resources, architectural resources and human resources in the development of Changzhou's rural ecological culture, we can understand the characteristics of the resources and environment in the formation of Changzhou's rural ecological culture, and then provide reference for the preservation and development of rural ecological cultural resources under the policy and promote the implementation of rural revitalization strategy.

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2. Through natural resources, architectural resources and human resources, scores were assigned to the rural ecological and cultural imagery characteristics of three regions in Changzhou, among which Wujin's evaluation score was 78, Jintan's 53 and Liyang's 86, indicating that Liyang's overall ecological and cultural imagery characteristics developed best under the rural revitalization policy.

3. The proportion of the three regions is divided, from which we can see that Wujin accounts for 36%, Jintan accounts for 24% and Liyang accounts for 40%, Liyang contributes the most to the ecological culture of Changzhou, but we cannot ignore the other regions, we have to take a comprehensive and balanced development.

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COUPLED SYNERGISTIC DEVELOPMENT OF THE SPORTS INDUSTRY AND URBAN PARK ECOLOGICAL ENVIRONMENT

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ABSTRACT

The quality of sports and leisure has received the attention of local sports departments. The construction of sports parks has become a new hot spot to enhance the image of the city and develop sports. Therefore, this paper studies the coupled and synergistic development of the sports industry and urban park ecology. First, the current situation of urban sports parks in China is analyzed. Then the affiliation numerical method was introduced into the evaluation of park ecology. Finally, we calculate the acquisition index and evaluation and use it to analyze the ecological and environmental effects of plant communities. The results showed that in Manduhai Park, Hohhot, the temperature change of plant communities first rose and then slowly decreased, with the highest temperature at 4 pm and the lowest at 8 pm, and the cooling rate was 3.34%~5.05%. The relative humidity was highest at 8:00 a.m. and lowest at 4:00 p.m., with a humidification rate of 1.82% to 12.18%. Wind speed is the highest at 12:00 noon and the lowest in the morning and evening; the human body feels the best comfort in the morning at 8:00, and feels uncomfortable around 12:00 and 16:00, with a variation range of 71.77±2.73 to 73.19±2.54; the research found that 42% of the visitors chose leisure and sports activities; followed by 39% for entertainment and games, and 12% for cultural activities again. Thirty-one percent of the visitors were satisfied with the leisure and sports facilities, 31% thought they were average, 28% reached only basic satisfaction, and 10% were not satisfied with the leisure and sports facilities.

KEYWORDS

Sports industry; Urban Park; Ecological environment; Coupled synergistic development; Satisfaction

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1. INTRODUCTION

Currently, China is facing a period of change in the transformation of its economic system and social structure [1]. In this process, the Chinese "progressive" reform, which starts from shallow to deep, from easy to difficult, and "crossing the river by feeling the stones", has now entered a critical stage [2-3]. However, although China's economy has achieved world-renowned success, the ecological and environmental problems faced by the country have become extremely serious. This, coupled with the comparative advantage of resource endowments between regions and the unevenness of economic development, has led to the blind pursuit of economic aggregates among localities at the expense of the ecological environment [4-5]. The green space of the city residents is squeezed by the profit space of the businessmen. If the government plays a market role in providing ecologically beautiful recreation areas, it will allow people to enjoy the tranquility brought by nature, which is bound to have a significant improvement in the psychological condition and quality of life of the nation [6].

Therefore, the emergence of urban sports parks caters to the needs of modern cities and urban residents. It not only has the functions of a general park, but also can combine green space and sports organically, providing more fun-filled sports activities, and good opportunities for urban residents to exercise [7-10]. Of course, with the development of sports, green and ecological development is the general trend. Modern people go to the gym to exercise, go to the gymnasium to play ball, just to "spend money to buy health", but it shows that people pay more and more attention to their physical and mental health [11]. With the progress of the times, people further pursue personalized leisure and recreation, and sports and fitness environments, and want to pursue the highest level of harmony between humans and nature. However, at present, the ecological environment of Chinese urban sports parks is a prominent problem, resulting in the phenomenon of "cold doors" in Chinese sports parks [12-13].

To change this dilemma, the ecological value of urban sports parks should be reconceptualized and affirmed, and the theme of "sports" should be strengthened. The future development of urban sports parks should be examined from a "human-centered" ecological perspective [14-15].

There are more studies related to recreational sports parks at home and abroad. For example, literature [16] verified the feasibility of transforming parks into sports parks by combining the actual situation of parks around the world and elaborating the design scheme of sports parks by combining specific parks from the perspective of landscape design. The literature [17] takes the perspective of benign industrial development to build sports parks based on leisure tourist attractions to promote the benign interaction between tourism and sports industries, as well as the development of both. The literature [18] proposed the basic requirements and design principles for healthy exercise spaces, argued that healthy exercise spaces should not be too large, and developed the minimum land area required for exercise areas. The literature [19] argued that there are fewer research results about exercise places and environments for community residents. And in community sports practice, the top three places for the distribution of physical activity sites are parks, community venues and street corners. In the literature [20], through ecological principles, the construction of the Nanhai National Fitness Sports Park was carried out with sports facilities as the core content, creating a theme park where green space and sports places are integrated, with a perfect overall functional system, integrating sports, fitness and leisure. Researchers believe that expanding green fitness and leisure activity space in the process of urbanization is an important task for sustainable urban development. The literature [21] addresses the current problem of the single function of community parks, repositioning their functions and reconfiguring their resources to strengthen the function of community parks for physical exercise, and making some suggestions on the setting of programs, the cost of operation, and the opening hours. The literature [22] analyzed the evolution of the system, mainly from the perspective of historical evolution. It also proposed the concept of a community park leisure ecosystem and confirmed the existence of a community park leisure ecosystem dominated by leisure activities in community parks through case studies. The literature [23] found that moderate recreational sports can reduce symptoms of depression and anxiety, improve self-image, social skills, and have a beneficial effect on both mental health and cognitive function. The literature [24] studied the relationship between park recreational sports and the physiological and psychological health of older adults. The study found a direct relationship between park recreational exercise and lower systolic blood pressure. The literature [25] states that although there is a long-term relationship between recreational sports and health, the mechanism of the effect of leisure on health remains unclear and more empirical results are needed to prove that the type of leisure has a significant positive correlation with health. A comparison between the two parks in Nijmegen and Amsterdam in the literature [26] concluded that the main forms of sports and classes of people active in different parks are different, but people expect to resolve these conflicts through cultural integration and use this public space equally. Based on the aforementioned national and international literature, it can be seen that the fastest-growing research related to the field of leisure is currently: tourism, sports and health. In addition to continuing to expand and deepen the research areas of parks, recreation, and tourism, more attention is also being paid to the relationship between leisure and health and the impact of leisure culture [27-28]. The study of leisure sports and sports parks in China has stepped into a multidisciplinary and multi-faceted research level, including the attention of researchers from various disciplines such as kinesiology, landscape architecture, and economics, and it can be said that sports and leisure research, has gradually become a very popular research topic [29-30].

This paper addresses the coupled synergistic relationship that currently exists between urban sports and park ecology. The numerical method of affiliation is substituted in the research process, and finally, the index and evaluation are obtained by calculation, and the ecological and environmental effects of plant communities are analyzed in this way. Meanwhile, this paper takes Manduhai Park in Hohhot as the research object, and analyzes the characteristics of daily changes in meteorological

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factors of its park's plant community, the characteristics of changes in human comfort, and the satisfaction of the park's leisure and sports facilities, to realize the research on the coupling and synergistic development of urban sports and park ecology.

2. ANALYSIS OF THE CURRENT SITUATION OF URBAN SPORTS PARKS IN CHINA

A total of 39 urban sports parks are investigated in this paper, among which 19 are directly named as sports parks, while others are equipped with sports facilities in certain areas. These 39 urban sports parks basically represent the construction and development of urban sports parks in China as shown in Table 1.

Table 1 (part I). Construction and development of urban sports parks in China

Park name	Jiande City Gantan Sports and Fitness Plaza	Quzhou Citizen Fitness Park	Ledu County Sports Park	Guiyang Baiyun Park	Wenfeng Garden, Duyun City	Korla Riverside Sports Park	Urumqi Sports Park	Manduhai Park, Hohhot	Hengyang West Lake Park	Pingluo County Sports Park
Park area /m²	133333	840000	500000	430000	176267	3000	55300	180000	190000	100000
The area of sports facilities / m²	22667	9980	200000	400000	10000	1500	18400	1126	30932	60000
Number of sports that can be carried out	16	12	7	10	28	20	7	20	20	12
Number of social sports instructors	37	15	5	8	12	20	25	8	50	8
Annual number of people participating in physical fitness / million	36	12	712	29	100	14	25	65	100	10
Park fees	Free	Free	Free	Free	Free	Free	Free	Free	30Yuan	Free
Number of activities per year	25	50	10	30	10	10	20	25	50	10
Site facility maintenance system	Exist	Exist	Exist	Exist	Exist	Exist	Exist	Exist	Exist	Exist
Major fitness injury	No	No	No	No	No	No	No	No	No	No

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Table 1 (part II). Construction and development of urban sports parks in China

Park name	Dongguan Sports Park	Tianjin Wangchuanchang Sports Park	Qinhuangdao Forest Sports Park	Yantai Sports Park	Lanzhou Sports Park	Yichang Binjiang Park	Beach Fitness Scenic Spots on Both Sides of the Yangtze River	Chengdu Repulse Bay Swimming Pool	Beidaihe Olympic Avenue Park	Happy Mountain Forest Park
Park area /m²	189600	60000	306667	1328000	60000	170000	1000000	72000	155600	13333333
The area of sports facilities / m²	60000	30000	41898	300000	35164	2000	120000	15000	38000	33333
Number of sports that can be carried out	12	12	8	12	13	15	12	8	18	20
Number of social sports instructors	5	30	10	32	31	40	43	200	36	5
Annual number of people participating in physical fitness / million	30	90	1	150	30	45	157	200	2	35
Park fees	1Yuan	0.3Yuan	Free	Free	5 Yuan	Free	Free	20 Yuan	Free	10 Yuan
Number of activities per year	30	10	10	20	126	6	10	20	24	30
Site facility maintenance system	Exist	Exist	Exist	Exist	Exist	Exist	Exist	Exist	Exist	Exist
Major fitness injury	No	No	No	No	No	No	No	No	No	No

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Table 1 (part III). Construction and development of urban sports parks in China

Park name	Sun Yat-sen Mausoleum White Horse Stone Carving Garden	Wanlv Garden	Wenchang Park	Dunhua Beishan Forest Sports Park	Jilin City Paotaishan Sports Park	Stalin Park, Daoli DistrictHarbin	Nantong Sports Park	Galaxy Sports Park	Xiushan History and Culture Park	Mawu Road Park, Jianshan District
Park area /m²	350000	724880	20533	300000	105000	65000	8000	7600	7600	90000
The area of sports facilities / m²	15000	20300	3000	56000	3000	20000	60000	4000	18000	4000
Number of sports that can be carried out	10-20	10	8	1	4	50	25	5	13	0
Number of social sports instructors	14	20	10	5	4	96	60	10	18	0
Annual number of people participating in physical fitness / million	200	40	30.5	20	0.3	300	120	11	12.8	300
Park fees	10 Yuan	Free	Free	Free	Free	Free	Free	1 Yuan	15 Yuan	Free
Number of activities per year	50	0	25	40	10	9	60	6	16	0
Site facility maintenance system	Exist	Exist	Exist	Exist	Exist	Exist	Exist	Exist	Exist	Exist
Major fitness injury	No	No	No	No	No	No	No	No	No	No

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Table 1 (part IV). Construction and development of urban sports parks in China

Park name	Beijing Chaoyang Park	Longtan Park, Chongwen District, Beijing	Quanzhou Puxi Riverside Sports Park	Baoji Weihe Park	Anhui Bengbu City Park	Ma'anshan Xishan Lake Park	Minhang Sports Park	Zhongshan Park, Shahekou District, Dalian City	Taiyuan Fenhe Park	
Park area /m²	2887000	492000	5320000	1485	69000	1400000	839160	113000	3000000	
The area of sports facilities / m²	170000	30922	139333	1260000	10000	6000	333000	15000	570000	
Number of sports that can be carried out	10	28	12	19	15	16	46	10	16	
Number of social sports instructors	9	196	3	42	19	32	45	80	15	
Annual number of people participating in physical fitness / million	80	10	20	480	70	300	42	175	300	
Park fees	5 Yuan	2 Yuan	Free	Free	Free	Free	Free	Free	Free	
Number of activities per year	1000	25	12	13	300	3	120	12	50	
Site facility maintenance system	Exist	Exist	Exist	Exist	Exist	Exist	Exist	Exist	Exist	
Major fitness injury	No	No	No	No	No	No	No	No	No	

Through a survey of 39 cities that issued questionnaires, China has a total area of 34,816,300 m^2 of sports facilities, with an average of 696,300 m^2 per park. these areas include sports field areas, water areas, path areas, etc., due to the inconsistent caliber of parks in reporting area indicators, as well as misrepresentation. Therefore, this data can only be a reference data. According to the statistics of the 2000 and 2010 China Mass Sports Survey, 87% of the morning and evening practice points for mass sports activities in China are located in urban parks. The data from 20 urban sports parks surveyed in this paper show that the parks with the most sports programs in China can carry out more than 40 sports programs. For example, Stalin Park in Daoli District, Harbin, and Minhang Sports Park, Shanghai, can carry out 49 and 46 sports and fitness programs, respectively [31]. Among the 39 urban sports parks investigated in this paper, 15 parks can carry out 11-15 sports and fitness programs, accounting for 34% of the overall number. 14 parks can carry out 16-20 physical fitness programs, accounting for 31% of the overall. The sum of the two is 65%, so most sports parks in China can carry out 11-20 physical fitness programs [32].

3. PARK ECOLOGY BASED ON SUBORDINATE DEGREE NUMERICAL METHOD

3.1. INDEX CALCULATION AND EVALUATION

The ambient air quality index (GB3095-2012), the grading evaluation standard of forest ambient air negative ion concentration, and the human comfort level classification standard established by the China Meteorological Administration are used as evaluation criteria [33]. Among them, the human comfort index I_{CHB} is calculated by the following formula.

$$I_{CHB} = (1.8t + 32) - 0.55\left(1 - 0.01H_r\right)(1.8t - 26) - 3.2\sqrt{v} \quad (1)$$

In the above equation, t denotes the average temperature; H_r denotes the relative humidity; v denotes the average wind speed, m/s.

3.2. STUDY OF ECOLOGICAL AND ENVIRONMENTAL EFFECTS OF PLANT COMMUNITIES

The ecological and environmental effects of plant communities were evaluated by using the affiliation function value method in fuzzy comprehensive evaluation [34]. The affiliation function value was calculated as follows.

$$U\left(X_i\right) = \left(X_i - X_{\min}\right) / \left(X_{\max} - X_{\min}\right) \quad (2)$$

If the indicator is negative, the calculation formula is

$$U\left(X_i\right) = 1 - \left(X_i - X_{\min}\right) / \left(X_{\max} - X_{\min}\right) \quad (3)$$

Where $U\left(X_i\right)$ denotes the affiliation function value of the ecological effect of sample site i, X_i denotes the measured value of an index of sample site i, $X_{\max}$ and $X_{\min}$ denote the maximum and minimum values of an index of the sample site, respectively. The mean value of the affiliation function of each index of the selected sample site is used as a criterion to determine the ecological effect of the sample site, and the larger the mean value, the better the ecological effect of the sample site [35].

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3.3. DATA PROCESSING

Microsoft Excel was used to count and analyze the monitoring data; Origin 2019 was used to draw correlation charts; SPSS 25.0 was used to conduct correlation analysis (Pearson correlation test) and principal component analysis; the affiliation function value method was used to calculate the integrated ecological and environmental effects affiliation function values [36-37].

4. RESULTS AND ANALYSIS

This paper takes Hohhot City Manduhai Park, with latitude and longitude (40°42'N, 111°42'E), located in Saihan District, Hohhot City, Inner Mongolia Autonomous Region, as the research object, which also serves the functions of forest germplasm resources preservation, ornamental recreation, scientific research and teaching. It has an altitude of 1056m, covers an area of 22hm^2, and has a temperate continental climate, with an average annual temperature of 5.8°C and an annual rainfall of 300~450mm. There are more than 500 species of plants in the garden, belonging to 53 families and 122 genera, including coniferous species, broad-leaved species and sandy plants.

In August 2021, a clear and breezy day was selected for 5 d of continuous field monitoring. The monitoring time was from 8:00 am to 18:00 pm, with 2h intervals, and 6 times a day, and the meteorological factors, atmospheric particulate concentration (C_{APM}), negative air ion concentration (C_{NAI}) and human comfort (I_{CHB}) were monitored simultaneously at a total of 6 sample sites in the park. The sampling height was about 1.5 m. The meteorological factors of each plant community were measured by a KestrelNK4500 portable meteorological instrument, and the average values were taken three times. The TurnkeyDustmate dust monitor was used to measure the TPS, PM_{10}, $PM_{2.5}$ and PM_1 concentrations at each site, and after the instrument readings were stabilized, the data were read from four directions, southeast and northwest, respectively. After repeating each direction 3 times, the final average value was taken.

4.1. CHARACTERISTICS OF DAILY CHANGES IN METEOROLOGICAL FACTORS OF PLANT COMMUNITIES

Six sample sites in the park were selected, S1, S2, S3, S4, S5, and CK, and the meteorological factors (temperature, relative humidity, and wind speed) were collected from these six sites, and the daily variation characteristics of plant community meteorological factors (temperature, relative humidity, and wind speed) were compared and analyzed, as shown in Figure 1.

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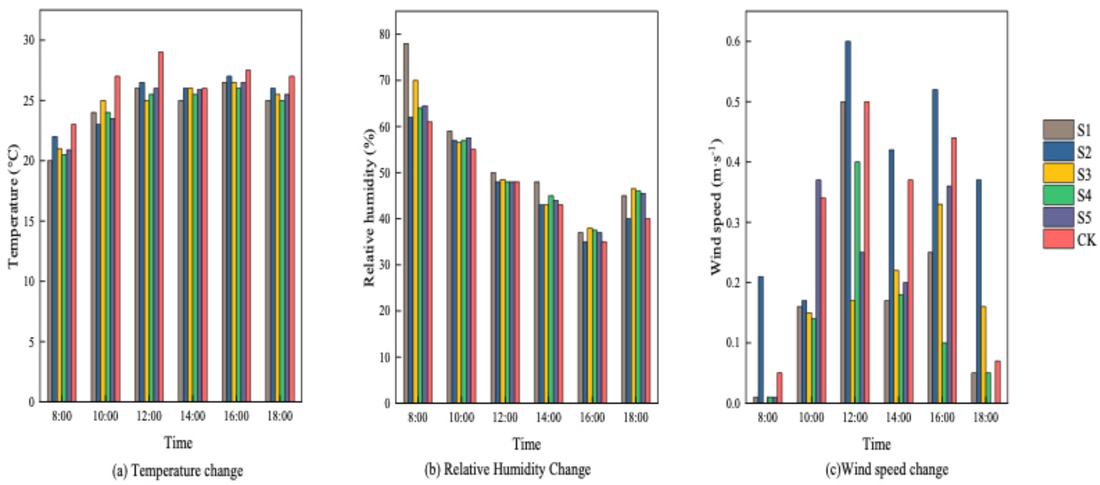

Figure 1. Daily variation of meteorological factors in plant communities

1. Temperature. As can be seen from Figure 1(a), the temperature of each plant community varied in a similar trend during the day, rising first and then slowly decreasing. The peak temperature occurred at around 16:00 and the lowest at around 8:00. The average daily temperature of each sample site was significantly lower than that of the control site, with a cooling rate of 3.34% (sample site S2) ~ 5.05% (sample site S1). This may be related to the simple plant community structure, low depression, poor shading effect and weak transpiration in sample plot S2, which eventually led to higher temperature in the sample plot.

2. Relative humidity. As shown in Figure 1(b), the relative humidity of each plant community peaked at about 8:00 and was lowest at about 16:00. The trend of daily average relative humidity was basically the same, and the change curve was "V" shaped. The average daily relative humidity of each plant community was significantly higher than that of the control site, with the humidification rate ranging from 1.82% (sample site S2) to 12.18% (sample site S1). This is mainly because the depression degree of sample plot S1 is larger than that of sample plot S2, the air convection is weakened and transpiration is more obvious. The diffusion of water vapor within the plant canopy was affected, the rate was reduced, and the rate of humidification was increased.

3. Wind speed. From Figure 1(c), it can be seen that the wind speed variation trend of each plant community is different, and the wind speed mostly peaks at 12:00 in the day, and the wind speed is the lowest in the morning and evening. The wind speed variation curve of sample site S2 fluctuated the most and S4 fluctuated very little. Most of the sample sites had lower average daily wind speed than the control site, which proved that the trees, canopy and branches in the green space had a certain effect of shading and reducing the wind speed. The wind speed of S2 was higher than that of the control site, which is presumed to be due to the relatively small degree of depression in the green

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area and the weak shading effect of trees, resulting in enhanced air convection.

4.2. PLANT COMMUNITY I_{CHB} DAILY CHANGE CHARACTERISTICS AND EVALUATION

After collecting human comfort from a total of six sample sites in the park, the daily change characteristics of human comfort of these plant communities were compared and analyzed, as shown in Figure 2.

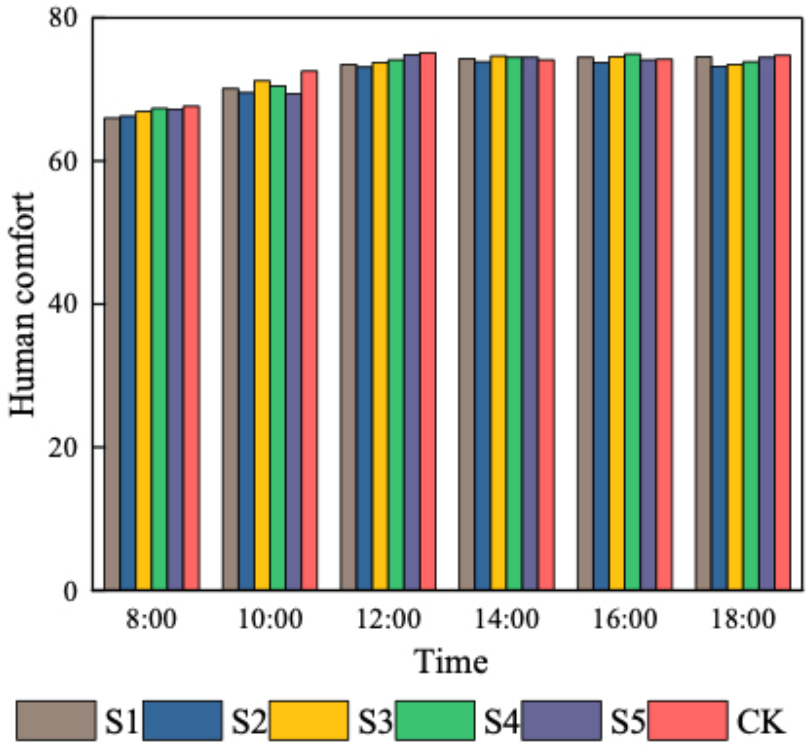

Figure 2. Daily variation of plant community

From Figure 2, we can see that the change trend of I_{CHB} in each place is similar, and the change curve is inverted "V" shape. The comfort level was best in the morning at 8:00 a.m., uncomfortable around 12:00 a.m. and 16:00 a.m., and more comfortable at other times. The daily average I_{CHB} variation ranged from 71.77±2.73 to 73.19±2.54. The daily average I_{CHB} of the plant community was significantly lower than that of the control site, i.e., the park green space could effectively improve I_{CHB} with the highest improvement rate of 1.94%.

According to the human comfort scale, the daily average I_{CHB} in the tree garden was in the VI range, i.e. "slightly hot". At around 8:00, all sample plots I_{CHB} were in the "comfortable" range. At around 10:00, some of the sample sites I_{CHB} were in the "comfortable" range, while the rest of the sample sites I_{CHB} were in the "slightly hot" range. After 10:00, all the sample areas I_{CHB} continued to rise, and most of the sample areas I_{CHB} were in the "slightly hot" range, and very few sample areas were

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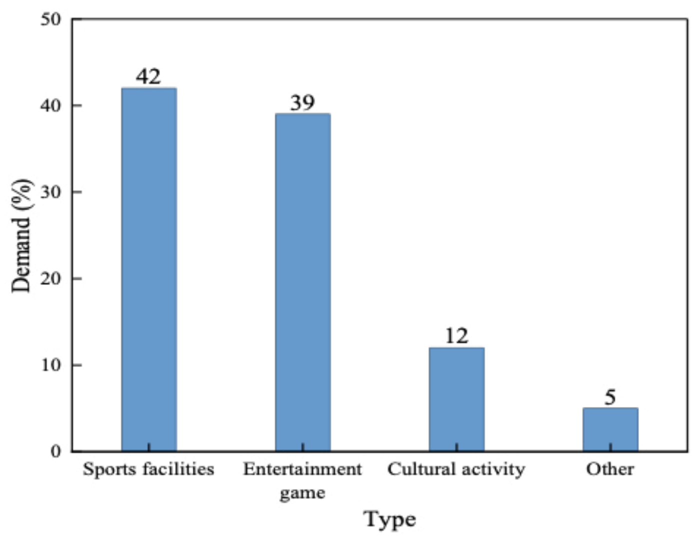
uncomfortable. From 16:00 to 18:00, I_{CHB} decreased slowly, and most of the sample sites were in the "slightly hot" range. Therefore, recreational activities in the tree garden were not recommended from 10:00 to 16:00. The duration of physical comfort in each site lasted 8.5-10h during the day, which was about 1.5h longer compared to the control.

4.3. SURVEY ON SATISFACTION WITH PARK LEISURE AND SPORTS FACILITIES

The collected literature was analyzed, screened and judged, and a questionnaire was created for local visitors based on a field study of the current situation of sports and leisure in Manduhai Park in Hohhot. The questionnaires were consulted several times with experts in sports event planning, organizational research, and environmental protection research. Based on the feedback from the pre-survey respondents, the questionnaire was revised, supplemented and integrated before being finalized and developed. The results showed that the correlation coefficient of each option of the questionnaire was ≧ 0.8 and the reliability of the questionnaire was significant. At present, a total of 500 questionnaires were distributed and 429 were collected. Among them, 382 questionnaires were valid, and the effective recovery rate was 76.4%. The data collated shows that in terms of age distribution, the elderly (over 60 years old) are the main visitors to Manduhai Park in Hohhot. They have more leisure time, and the park provides them with a good environment for human interaction and eliminates the feeling of emptiness at home.

The demand situation of park visitors for park facilities and their satisfaction with park leisure and sports facilities are plotted as shown in Figure 3.



(a) Demand for leisure and sports facilities in parks

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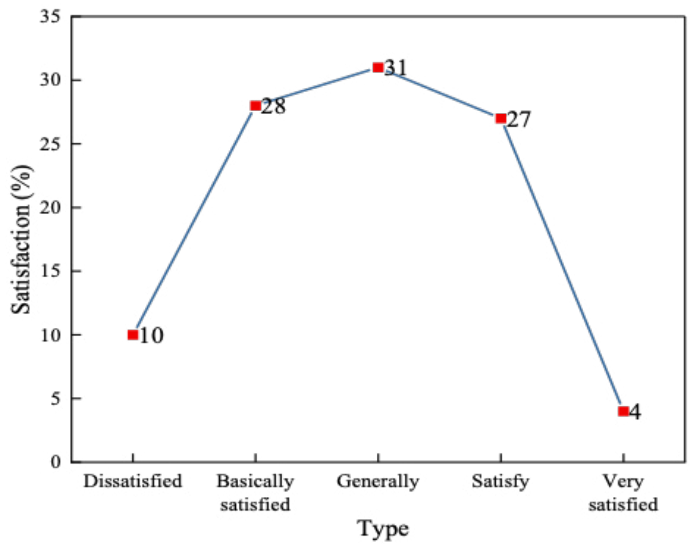

(b) Satisfaction with park leisure and sports facilities

Figure 3. Demand for and satisfaction with leisure and sports facilities in parks

The data collated and analyzed in Figure 3(a) shows that the highest proportion of visitors chose leisure and sports activities at 42%, followed by recreational games at 39%, and then cultural activities at 12%. Additional activities according to the needs of visitors can extend their stay in the park and improve the utilization rate of the park.

In Figure 3(b), it can be seen that 31% of the 382 questionnaires are satisfied with the leisure and sports facilities in Hohhot Manduhai Park, 32% of the visitors think the leisure and sports facilities are average, 28% of the visitors are only basically satisfied with the leisure and sports facilities, and 10% of the visitors are not satisfied with the leisure and sports facilities. This degree shows that the existing leisure and sports facilities, can't meet the requirements of people to sports and leisure parks to the maximum extent, so in terms of leisure and sports facilities update and the needs of visitors, the park managers should be strengthened.

5. DISCUSSION

At present, sports and leisure projects are reflected in the ecological environment of urban parks. On the one hand, visitors can choose their favorite sports and leisure facilities in the parks and play sports to strengthen their bodies. On the other hand, the continuous optimization of the ecological environment of urban parks also attracts a lot of have to come to the parks to view the garden scenery. The combination of sports and leisure projects and the ecological environment of the park has largely achieved their coupled synergistic development.

If we want to further strengthen the coupled and synergistic development of the two, we need to use the foundation of resource integration, start from ecology, culture and economy, deeply strengthen the material infrastructure, and coordinate and

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integrate ecology, culture and economy, to realize the purpose of promoting culture with ecology, promoting economy with culture and protecting ecology with economy. Consolidate existing ecological resources and develop recreational sports programs based on them. Using the existing recreational sports resources of the National Forest Park as a model, we enhance the ecological resources of the watershed and mountains to promote the common development of recreational sports programs. Use media publicity and sports event programs to enhance the public's awareness of ecological recreational sports. Based on the existing ecological resources, create leisure sports with ethnic cultural characteristics and develop ethnic sports for leisure without intruding into the main connotation of ethnic culture. Introducing ethnic culture in the form of leisure sports, pulling ethnic exchanges, promoting regional economic prosperity, building the material basis of leisure sports in China's ecological cities, and arousing the awareness of mass participation.

6. CONCLUSION

This paper takes Hohhot Manduhai Park as the research object, and analyzes the daily change characteristics of meteorological factors of plant communities, daily change characteristics of human sensory comfort of plant communities, and the results of a satisfaction survey of leisure and sports facilities in the park in Hohhot Manduhai Park, and obtains the following conclusions.

1. As for the daily variation characteristics of plant community meteorological factors, the temperature change of the plant community first rose and then slowly decreased, with the highest temperature at 4:00 pm and the lowest at 8:00 pm, and the cooling rate was 3.34%~5.05%. This may be related to the simple plant community structure, low depression, poor shading and weak transpiration in sample plot S2, which eventually led to the increase in temperature in the sample plot. The relative humidity was highest at 8:00 a.m. and lowest at 4:00 p.m. The rate of humidification was 1.82%~12.18%, which was mainly because the depression of sample plot S1 was larger than that of sample plot S2, air convection was weakened, transpiration was more obvious, water vapor diffusion within the plant canopy was affected, the rate was reduced, and the rate of humidification increased. The wind speed was highest at 12:00 noon and lowest in the morning and evening. The average daily wind speed of most of the sample sites was lower than that of the control sites, which proved that the trees, canopies and branches in the green areas had a certain effect of shading and weakening the wind speed. The wind speed at sample site S2 was higher than that at the control site, presumably because of the relatively small depression in the green space and the weak shading effect of trees, resulting in enhanced air convection.

2. Regarding the daily variation of plant community human comfort characteristics, the best human comfort was found at 8:00 in the morning, and discomfort was felt around 12:00 and 16:00. The variation of human sensory

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comfort ranged from 71.77±2.73 to 73.19±2.54, and the park green space could improve the highest rate of comfort by 1.94%. Therefore, from 12:00 to 16:00, sports and recreational activities are not recommended in the tree garden.

3. Regarding the results of the survey on satisfaction with leisure and sports facilities in parks, the survey found that 42% of visitors chose leisure and sports activities. The next entertainment game accounted for 39%, and again cultural activities accounted for 12%. It can be seen that most of the visitors come to urban recreation and sports parks mainly for recreation and sports activities, indicating that visitors pay more attention to their health issues. Thirty-one percent of the visitors were satisfied with the leisure and sports facilities, 31% thought they were average, 28% reached only basic satisfaction, and 10% were not satisfied with the leisure and sports facilities. The main reason for this situation is that the sports facilities in city parks have not been updated according to modern popular sports over time, and the lack of routine maintenance of the facilities has resulted in serious weathering of the sports facilities and human damage by visitors, making many of the sports facilities unusable.

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ENVIRONMENTAL AND ECOLOGICAL PRESERVATION-ORIENTED TOURISM DEVELOPMENT OF THE INTANGIBLE CULTURAL HERITAGE OF GUANGXI, YUNNAN AND GUIZHOU ETHNIC MINORITIES

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ABSTRACT

The intangible cultural heritage of ethnic minorities in Guangxi, Yunnan and Guizhou is born and grows essentially basing local environmental protection. Doubling efforts in protecting the ecological environment is the key to enabling the live transmission of such non-material cultural heritage. To better preserve the environment in places inhabited by ethnic minorities, this paper probed into and verified the live transmission tourism development of the intangible cultural heritage of ethnic minorities in Guangxi, Yunnan and Guizhou, in virtue of the evaluation system built applying the dimensionless method. The results suggested that tourism development has improved the ecological environment of ethnic minority villages. Digitally, the utilization rate of clean energy and resource exceeded 85% and 76.8%, while the vegetarian coverage and afforestation area reached 45% and 137.4 hectares respectively. That made level 5 the impact of the intangible cultural heritage tourism development of ethnic minorities on the corresponding ecological environment, enabling joint development.

KEYWORDS

Ecological protection; Environmental protection; Intangible culture; Heritage tourism; Tourism development

INDEX

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1. INTRODUCTION

With UNESCO's efforts to construct a complete system of world heritage and to include intangible cultural heritage into the category of world heritage, intangible cultural heritage has increasingly become a hot issue in practice [1-2]. In this discussion, tourism development has become the focus of attention, with some in favor and some against it. For example, at the World Congress on Safeguarding Intangible Cultural Heritage held in Suzhou, some scholars opposed the tourism development of intangible cultural heritage [3-4]. In today's rapid development of tourism, it is of great practical significance to drive the protection and inheritance of intangible cultural heritage by the development of tourism, and it has become an inevitable trend [5-6]. How to integrate intangible cultural heritage into the tourism attraction, and carry out scientific planning and development to solve the contradiction between them is an important issue worthy of in-depth study [7-8].

In recent years, there has been a dramatic increase in the number of applications for ICH in China, with a total of 45 ICH selected for inclusion in the United Nations ICH program and 1,382 selected for inclusion in the national ICH program until 2022 [9-10]. When the ICH is applied, the local tourism industry also goes to glory, on the one hand, the country wants the public to recognize the cultural value of the ICH, and on the other hand, the local government also wants to spread its proud cultural capital to gain profit [11-12]. However, the development of cultural heritage tourism has subconsciously affected the transmission and protection of NRMs [13]. Take the NRM projects in Guangxi, Yunnan and Guizhou minority regions as an example, although the local economy is not developed the people are simple, as the province with the largest number of minority groups in China, including many minority groups such as Zhuang, Yao, Miao, Dong and Huijing. Due to the backward economy, the local people also have a more traditional ideology, and some cultures and ideas have rich characteristics although they are closed [14-17]. However, with the development of the economy, driven by material interests, the simple local people lack awareness of the protection of NRMs, and the government has not introduced perfect protection measures, many NRMs are distorted and lose their original flavor in the process of tourism development [18].

Intangible cultural heritage is an intangible, living flow of cultural resources inherited by specific regions and ethnic groups from generation to generation using oral transmission. It is a unique, living, flowing cultural memory and historical witness [19-20]. Guangxi, Yunnan and Guizhou are multi-ethnic areas, and each ethnic minority has formed unique ethnic villages during their long historical development and created numerous intangible cultural heritages of ethnic minorities in this special geographical environment [21-22]. Strengthening the living heritage of the intangible cultural heritage of ethnic minorities is an important task to promote the traditional culture of ethnic groups and build villages with ethnic characteristics. The cultural ecological reserve reduces the multi-level and multi-faceted intangible cultural heritage tourism development and inheritance groups to specific cultural spaces from the natural and human ecological environment and does holistic protection. This is an innovative concept and innovative initiative for tourism development and protection [23-25].

The regional characteristics of the intangible cultural heritage of Guangxi, Yunnan and Guizhou minorities play a significant role in their tourism development, and the regional flavor and rhythm can be better reflected. From the literature [26], the test results showed that the cognitive, affective and cultural experiences of cultural heritage tourism destinations positively influenced the environmental behavior of tourists. The literature [27] analyzes the coupling relationship between tourism resources and intangible cultural heritage to explore models for revitalizing or developing intangible cultural heritage. It also provides a useful reference for the integration of intangible cultural heritage and tourism development planning in other regions. The literature [28], through a study of the main motivations for tourism in South Tyrol, fascinates tourists with tangible and intangible aspects of South Tyrolean culture, such as architecture, traditional lifestyles, activities, customs, dress and language. The role played by cultural sustainability for the region has succeeded in preserving traditions, including aspects such as traditional language dialects and Latin. In literature [29], the first phase aimed to collect evaluation indicators affecting ICH skill learning and used semi-structured in-depth interviews to support these data. In the second phase, the convergence of value indicators influencing ICH skill learning was completed through questionnaires and statistical analyses. Factor analysis was conducted using SPSS software. Validation analysis was performed using Amos software for SEM (structural equation modeling). The literature [30] shows the temporal evolution of the gastronomic heritage literature parallel to the UNESCO cultural heritage initiative. The results show that most articles link gastronomic heritage to the sustainability of tourism destinations, with European case studies focusing more on sustainability than Asian studies. The contents and themes studied in the above literature are relatively focused, and the research mainly includes various aspects such as the value of NRM conservation management and conservation measures, the impact of tourism development on NRM, the staging and authenticity of NRM tourism, and the initial dynamics of NRM tourism [31-34].

The intangible cultural heritage of Guangxi, Yunnan and Guizhou ethnic minorities is the crystallization of the wisdom of the people in their production life for thousands of years, with a long history and deep cultural heritage. It is passed down from generation to generation, formed in a certain natural and cultural background, has a unique living soil and cultural ecological space, and is a living culture attached to a special individual or group, a specific region or space. This paper constructs a tourism development model based on the current situation of the intangible cultural heritage of Guangxi, Yunnan and Guizhou minorities, and uses the dimensionless method to construct an evaluation system to study the environmental and ecological protection of intangible cultural heritage tourism development of Guangxi, Yunnan and Guizhou minorities. The aim is to achieve a win-win situation in the joint development of the intangible cultural heritage of Guangxi, Yunnan and Guizhou minorities and ecological protection. In this way, the sustainable development of the intangible cultural heritage of Guangxi, Yunnan and Guizhou minorities can be achieved and the intangible cultural heritage of the minorities can be prolonged in its original ecosystem.

2. ENVIRONMENTAL AND ECOLOGICAL PROTECTION OF INTANGIBLE CULTURAL HERITAGE TOURISM DEVELOPMENT MODEL

2.1. CURRENT SITUATION OF THE INTANGIBLE CULTURAL HERITAGE OF GUANGXI, YUNNAN AND GUIZHOU MINORITIES

Located in the hinterland of southwest China, Guangxi, Yunnan and Guizhou is a multi-ethnic area and each minority group has formed distinctive villages with different styles during their long-term production and living process. Among the 345 "Villages with Minority Characteristics in China" announced by the National People's Committee, Guangxi, Yunnan and Guizhou have 167 villages with minority characteristics, accounting for 48.4% of the total number of villages. The distinctive minority villages are rich in the intangible cultural heritage of minority groups. For example, the Lusheng stomping tang in Yubu Village, Buling Tun, Xiangfen Township, Rongshui Miao Autonomous County, Liuzhou City, Guangxi Province, the A-xi jumping moon in Hongwan Village, Xiyi Township, Takeo Village Committee, Mile County, Yunnan Province, and the Duzhu floating in Datong Township, Ethnic Village, Zunyi City, Chishui City, Guizhou Province. The following table shows several batches included in the national list [35].

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Table 1. List of the intangible cultural heritage of ethnic minorities in Guangxi, Yunnan and Guizhou

Category	Project name (declared unit)
Folk literature	Miao guge (Huangping County), Kedao (Shibing County), Yang Asha (Miao and Dong Autonomous Prefecture), Zhulang niangmei (Rongjiang County), Miao Jiali (southeastern state of Guizhou Prefecture)
Folk music	Dong dage (Liping County), Dong pipa song (Rongjiang County, Liping County), Miao folk song (Miao flying song) (Leishan County), Lusheng music (Dong Lusheng, Miao Mangtong Lusheng) (Danzhai County)
Folk dance	Miao Lusheng dance (Jinji dance, Long-shirt dragon dance, Rolling mountain pig) (Leishan County, Danzhai County, Guiding County), Wooden drum dance (Anti-row Miao wooden drum) (Tai County), Copper drum dance (Leishan County)
Traditional drama	Dong opera (Liping County)
Folk art	Miao embroidery (Leishan County), Dong embroidery (Jinping County)
Traditional handicraft	Miao batik technique (Danzhai County), Miao Lusheng making technique (Lei County), Miao silver forging technique (Leishan County), Miao brocade weaving technique (Majiang County, Leishan County), Maple printing and dyeing technique (Majiang County), Xijang thousand-house miaozhai hanging foot building construction technique (Leshan County)
Traditional Medicine	Miao medicine (bone and snake injury therapy, Jiujie tea medicine production process) (Leishan County, southeastern state of Guizhou Miao and Dong Autonomous Prefecture), Dong medicine (passing yellow medicine production process) (southeastern state of Guizhou Prefecture), Buyi medicine (Yi liver herb production techniques) (Guiding County)
Traditional Folklore	Miao sister festival (Taijiang County), Dong sama festival (Rongjiang County), Miao dokki dragon boat festival (Taijiang County), Miao new year festival (Danzhai County, Leishan County), Dong new year (Rongjiang County), Miao drum collection festival (Rongjiang County, Leshan County), Song festival (48 Zhai song festival) (Tianzhu County), Moon festival (Liping County), Miao rock-cutting custom (Rongjiang County), Dong costume (southeastern state of Guizhou Prefecture), Statute custom (Dong Model Covenant) (Liping County)

2.2. TOURISM DEVELOPMENT MODEL OF THE INTANGIBLE CULTURAL HERITAGE OF ETHNIC MINORITIES IN GUANGXI, YUNNAN AND GUIZHOU

For the situation of intangible cultural heritage resources of ethnic minorities in Guangxi, Yunnan and Guizhou, a tourism development model is designed from the following six aspects, as shown in Figure 1.

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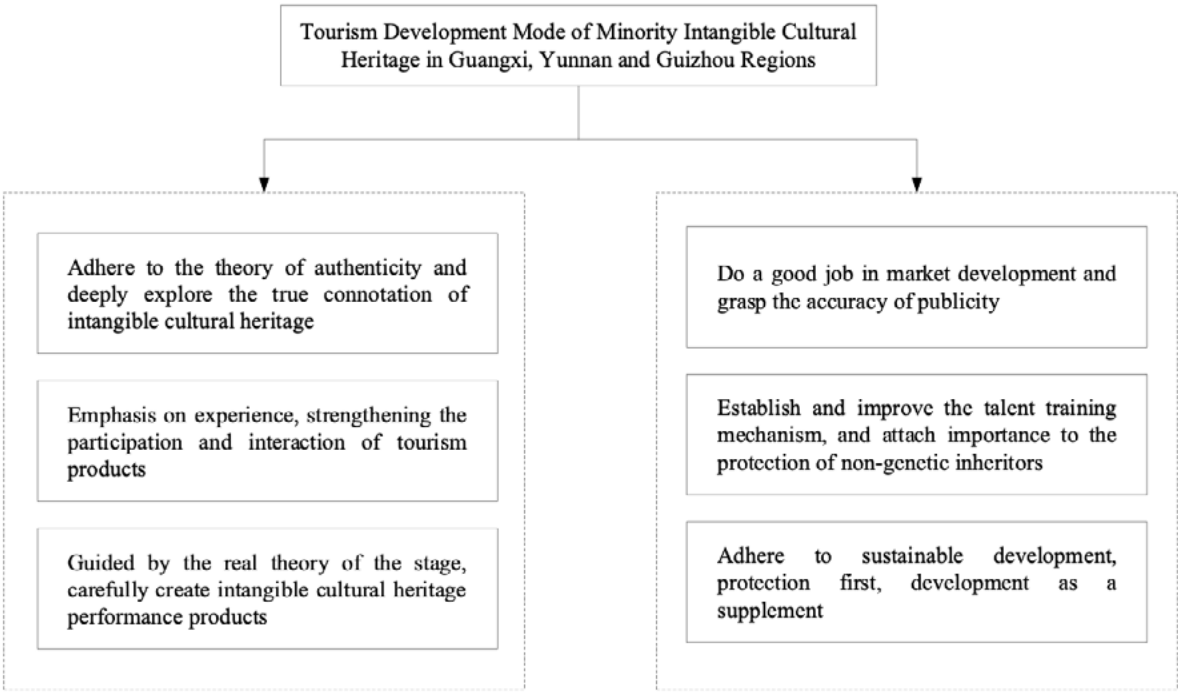

Figure 1. Tourism development model of the intangible cultural heritage of ethnic minorities in Guangxi, Yunnan and Guizhou regions

Adhere to the theory of authenticity and deeply explore the true connotation of intangible cultural heritage. In the process of continuous development and change of human civilization, unique living habits and lifestyles make each nationality accumulate different national cultural heritages due to different characteristics of their natural social and ecological environments, forming the cultural diversity of intangible cultural heritage [36]. Guangxi, Yunnan and Guizhou are both large ethnic minority provinces, and their ethnic intangible cultural heritage has the advantage of ethnic cultural uniqueness and diversity, but in the process of tourism development, the intangible cultural heritage of ethnic minorities faces many opportunities and challenges. Its ethnic and cultural uniqueness and diversity reflect the unique human capacity for innovation and the solid foundation for group interaction and never-ending human well-being. The intangible cultural heritage of ethnic minorities must strictly follow the principle of comprehensive and authentic protection. In the process of tourism development, only by adhering to the theory of "authenticity" and tapping the real connotation can the vitality and attractiveness of the tourism products of the intangible cultural heritage of ethnic minorities be consistent with the pursuit of the original development trend while pursuing the original tourism ecology. Only with real and unique local characteristics can we bring tourists high-quality satisfaction and help establish tourism brands.

Focus on experience and strengthen the participation and interactivity of tourism products. Guangxi, Yunnan and Guizhou minority intangible cultural heritage tourism development, add experiential links. Instead of limiting tourists to just taking pictures in tourism activities, they should also allow them to join them and experience them to truly meet the needs of different tourists. Developers can implement targeted

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marketing strategies in their development, study the demand experience of tourists, improve the type of tourism experience, and carry out marketing programs from the country, culture and other aspects. Rich product structure and excellent product quality can enhance the core competitive advantage of tourism products in the tourism era and obtain better and wider economic benefits.

Craft non-traditional performance products with stage authenticity theory as a guide. Stage authenticity theory" on the one hand can avoid the impact of tourists on the fragile local culture and ecosystem, avoid cultural changes and a series of problems, and maintain the traditional cultural origin and integrity. On the other hand, to meet the experience of tourists from other places in real life, the traditional culture, folk customs, and lifestyle in tourist destinations are kept in their connotation on an authentic basis [37]. And through artistic processing and creation, it creates tourism performing arts products that tourists can see and hear. Interact with visitors at the front desk to make them feel that what they see and experience is real, and then create a tourism experience. On the one hand, reduce the demonstration effect brought by visitors to the destination community. On the other hand, the pride of the local population is aroused, and new elements of traditional crafts, dances, costumes, etc. are added to the tourism product so that it can continue in a new and continuous form and be accepted by modern tourists. The application of "staged authenticity theory" to the development of actual performances helps to minimize the impact of cultural commercialization, maintain the objective authenticity of the original culture, and achieve sustainable and healthy development.

Do a good job of market development and grasp the precision of publicity. Guangxi, Yunnan and Guizhou are multi-ethnic provinces with rich and unique cultural charms. Expand product marketing and market segmentation of customers through clear market positioning of tourists. Targeted design of tourism projects and active guidance of residents to participate in the preservation, and thus tourism development. In cooperation with tourism developers, operators and government, and residents, we will attract a large number of tourists and experts and scholars curious about the country's culture to visit and study here through powerful and well-known domestic and foreign travel agencies and tourism reception departments.

Establish a sound talent training system and pay attention to the protection of non-genetic inheritors. First, through the development of the corresponding system, establish and improve the retention, attract outstanding tourism talent protection incentive mechanism for the protection of Guangxi, Yunnan and Guizhou minority intangible cultural heritage development services to provide manpower support, adhere to the principle of local talent and tourism professionals are given priority to hire and do a good job protection work. Secondly, the source of protecting art and culture is to protect the heirs. It is necessary to strengthen the importance of inheritance protection, provide financial support, actively establish cultural heritage, strengthen social education and school education, raise the social value of the status of the heirs, and make more people more aware of the protection of non-heritage.

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Adhere to sustainable development, protection as the main, and development as a supplement. To achieve the sustainable development of tourism, protection should be the first task, not only limited to the protection and development of external culture, but more importantly, the protection of its living environment, especially for its history, culture and emotional information should be strengthened to protect. Tourism resources and the environment are closely linked, and the healthy development of tourism will be seriously affected if either of them is destroyed.

3. TOURISM DEVELOPMENT MODEL IMPACT EVALUATION INDICATORS

The first target layer indicators of the evaluation index of the ecological environment of ethnic minority villages are comprehensive evaluation indicators. The second layer of domain layer indicators is classified as evaluation indicators. The third layer of sub-indicator layer indicators are single evaluation indicators. We decompose the categorical indicators in the minority village ecological environment evaluation index system into several sub-indicators, to form a well-structured recursive structure. So far, we have constructed an index system of 5 aspects and 10 individual indicators of the ecological environment of minority villages. As shown in Table 2.

Table 2. Framework table of impact evaluation index system

Target layer	Domain Layer	Sub-indicator layer
Ecology	Air quality	Air pollutant prevention and control in Ethnic Minority Villages
		Clean energy utilization in ethnic minority villages
	River and lake water quality	Sewage and wastewater treatment in ethnic minority villages
		Drinking water safety in ethnic minority villages
	Soil quality	Soil improvement in ethnic minority villages
		Soil pollution prevention and control in ethnic minority villages
	Greening level	Vegetation coverage of ethnic minority villages
		Forest planting and protection in minority villages
	Garbage disposal	Centralized garbage removal and harmless treatment in minority villages
		Scientific classification and resource utilization of garbage in minority villages

Each evaluation index in the ecological environment evaluation index system of minority villages reflects the construction status of the ecological environment of minority villages from different sides, but to reflect the overall status of the ecological environment construction of minority villages, it is necessary to make a

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comprehensive assessment of the above evaluation indexes. The factors (dimensions) affecting the ecological environment level x are the following five, air quality, water quality of rivers and lakes, soil quality, greening degree, and garbage disposal. They are denoted by English small letters x_1, x_2, x_3, x_4, x_5 respectively. That is, $x = (x_1, x_2, x_3, x_4, x_5)$.

Air quality mainly examines two factors: prevention and control of air pollutants in ethnic minority villages and clean energy use in ethnic minority villages. They are denoted by English small letters x_{11}, x_{12} respectively. That is, $x_1 = (x_{11}, x_{12})$.

The water quality of rivers and lakes is mainly examined by two factors: sewage treatment in minority villages and drinking water safety in minority villages. They are represented by English small letters x_{21}, x_{22} respectively. That is $x_2 = (x_{21}, x_{22})$.

Soil quality mainly examines two factors: soil improvement in minority villages and soil pollution prevention in minority villages. They are denoted by English small letters x_{31}, x_{32} respectively. That is, $x_3 = (x_{31}, x_{32})$.

The degree of greening mainly examines two factors: the vegetation coverage of minority villages and the planting of trees and forestry in minority villages. They are denoted by English small letters x_{41}, x_{42} respectively. That is, $x_4 = (x_{41}, x_{42})$.

Waste treatment mainly examines two factors: centralized waste removal and harmless treatment in minority villages and scientific separation and resource utilization of waste in minority villages. They are represented by English small letters x_{51}, x_{52} respectively. That is, $x_5 = (x_{51}, x_{52})$.

Let the sample point data of the factors (dimensions) affecting the ecological environment - the secondary index of the statistic be x, then we specify its calculation formula as:

$$x\begin{cases} 1, \text{ when } x_i = 2 \\ 2, \text{ when } 10 < \sum_{i=1}^{5} x_i \leq 20 \\ 3, \text{ when } 20 < \sum_{i=1}^{5} x_i < 30 \\ 4, \text{ when } 30 \leq \sum_{i=1}^{5} x_i < 40 \\ 5, \text{ when } 40 \leq \sum_{i=1}^{5} x_i \leq 50 \end{cases} \tag{1}$$

According to the above model, the quantitative evaluation criteria of the ecological environment construction of minority villages are set. When $x_m = 1$, it means the ecology of the minority village is poor. When $x_m = 2$, it means the ecological environment of the minority village is poor. When $x_m = 3$, it means that the ecological environment of the minority village is average. When $x_m = 4$, the ecological environment of the minority village is good. When $x_m = 5$, the ecological environment of the minority village is very good.

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4. RESULTS AND ANALYSIS

Seven ethnic minority villages in the Guangxi, Yunnan and Guizhou ethnic areas were randomly selected and the constructed intangible cultural heritage tourism development model was applied. Using the designed impact evaluation index system, the ecological and environmental impacts of the development model on different villages were examined, and the obtained evaluation results are shown in Figure 2.

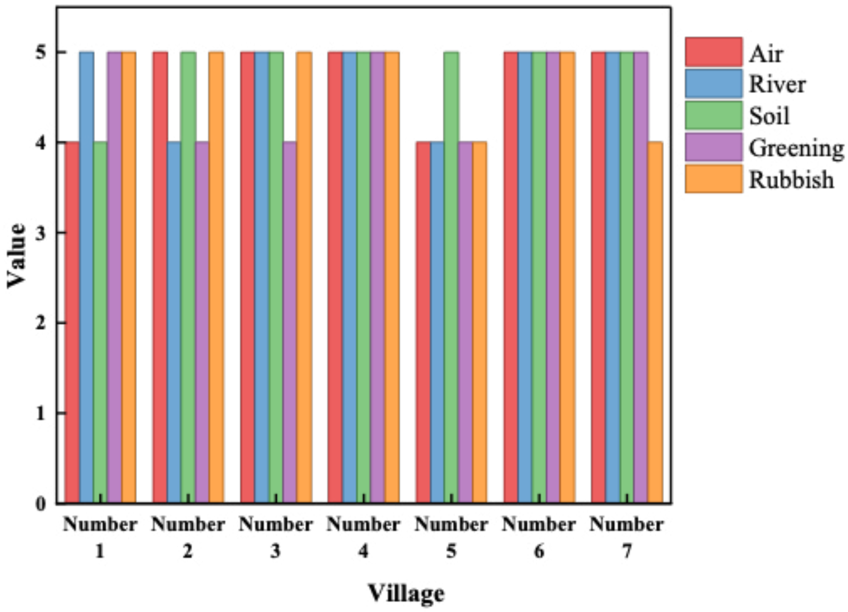

Figure 2. Schematic diagram of the impact assessment of the tourism development model of the intangible cultural heritage of Guangxi, Yunnan and Guizhou minorities on the ecological environment

According to the quantitative evaluation standard of the ecological environment of minority villages, it is clear that the ecological environment of village No.1 is well constructed. The survey found that the village actively builds a "green farmhouse park", gives full play to the geographical advantage of leaning on the mountain and facing the river, strengthens various infrastructure construction, and provides diversified convenient services for tourists. The vitality and attractiveness of intangible cultural heritage tourism products of ethnic minorities are in line with the trend of tourism development while pursuing the original tourism ecology. Since the quantitative evaluation levels of air, river, soil, greenery and garbage of the ecological environment of this village cottage reached 4, 5, 4, 5 and 5 respectively. Therefore the ecological environment level of this village cottage reached a high standard.

The ecological environment of village No. 2 is better constructed. The survey found that the village is solidly promoting precise poverty alleviation and precise poverty eradication. With the development of special tourism as the focus, we actively create a famous tourism village, ecological village, and cultural village. In particular, the county and township leaders attach great importance to ecological and environmental

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protection work. Through the use of clean energy, environmental pollution is reduced and energy utilization is improved. And the villagers are guided to use chemical fertilizers, pesticides and mulch scientifically. This minimizes the possibility of pollution to the village's ecological environment and makes the village's ecological environment construction effective. According to the quantitative evaluation standards of the ecological environment of the minority villages, the quantitative evaluation levels of air, river, soil, greenery and garbage of the village ecological environment have reached 5, 4, 5, 4 and 5 respectively.

The ecological environment of village No. 3 is very well built. The survey found that the village and the surrounding villages are jointly building a pilot project of rural revitalization, "Qing Hua Field Complex", and strengthening infrastructure construction around the project, designing tourism projects and actively guiding residents to participate in the protection of the intangible cultural heritage of ethnic minorities, to develop tourism and make the village look significantly better. In recent years, the village has also achieved good results in the creation of national unity and progress, with a simple and beautiful countryside and a harmonious village. According to the quantitative evaluation standards of the ecological environment of the minority villages, the quantitative evaluation levels of air, river, soil, greenery and garbage of the village's ecological environment are 5, 5, 5, 4 and 5 respectively.

The ecological environment of village No. 4 is very well constructed. The survey found that the village, as a well-preserved village with Tujia characteristics within Wufeng County, has received strong support from the county and township governments for its development. By continuously improving the village infrastructure, protecting the unique ethnic culture, and promoting rural tourism, the village has initially formed a benign development situation in which industrial revitalization and ecological environment construction synergize and promote each other. And we insist on sustainable development, mainly protection, supplemented by development, to promote the sustainable development of intangible cultural heritage tourism of ethnic minorities. According to the quantitative evaluation standards of the ecological environment of the minority villages, the quantitative evaluation levels of air, river, soil, greenery and garbage of the village ecological environment are 5, 5, 5, 5 and 5, respectively.

The ecological environment construction of village No. 5 is better. The survey found that in recent years, Lichuan City vigorously promote new urbanization and the pace of village and town integration construction accelerated. The village cottage is 18 kilometers away from the urban area, 318 National Highway through the village, and is located in the Tenglong Cave scenic area and Enshu Grand Canyon tourist highway node. The construction of roads to the village, communication, water supply and drainage facilities, and increasing the renovation of dilapidated houses, make it very convenient for tourists to travel, entertain and shop. The quantitative evaluation grades of air, river, soil, greenery and garbage of the village's ecological environment are 4, 4, 5, 4 and 4 respectively. Therefore, the ecological environment of the village is in good condition.

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The ecological and environmental construction status of village No. 6 is very good. The survey found that the village has renovated the facades of some of the dwellings to create a tourist attraction. So that its overall appearance can be beautified. Continuously improve the village sanitation public facilities, with sorted garbage cans, and increase the number of garbage removal. Arranging a person in charge of the care, to realize the centralized treatment of wastewater and garbage. The construction of tourism facilities is actively improved to enhance the tourist experience of visitors. According to the quantitative evaluation grade standard of the ecological environment of the minority villages, the quantitative evaluation grades of the village ecological environment of air, river, soil, greenery and garbage are 5, 5, 5, 5 and 5 respectively.

The ecological environment construction status of village No. 7 is relatively good. The survey found that the village plants tea to increase land water storage, improve the soil environment of the land, to create a green mountain forest overall appearance, the village relies on the tea industry as the leading vigorously promote the development of rural tourism resources, has achieved certain economic benefits. At present, the tea industry has a good radiation-driven ability, relying on the geographical advantage of the mountains and rivers, to drive the development of the village tourism economy. According to the quantitative evaluation standards of the ecological environment of the minority villages, the quantitative evaluation levels of air, river, soil, greenery and garbage of the village ecological environment are 5, 5, 5, 5 and 4, respectively.

5. DISCUSSION

The development history of the minority villages has undergone a unique baptism of human history. Therefore, the history, culture and local characteristics of minority villages are unique, and in the process of their development and construction, they should also maintain local characteristics, combine local cultural heritage and natural environment, and protect the original local landscape. We integrate new ideas and thoughts based on the existing minority cultures to make the environment of minority villages more beautiful and culturally rich. The ecological environment needs to work not only on ecological and environmental protection but also on the cultural environment to provide more nourishment for the spiritual life of the villagers. This makes their cultural identity and pride grow. The purpose of this paper is never to stop at the construction of the index system itself, but to extend the application of this index system to the ecological environment construction of minority villages. The purpose of this paper is to apply this index system to the ecological environment of minority villages and to realize the development of intangible cultural heritage tourism under ecological environment protection.

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6. CONCLUSION

This paper analyzes the current situation of intangible cultural heritage of Guangxi, Yunnan and Guizhou minorities and constructs a tourism development model to protect the ecological environment. The model was constructed by using the dimensionless method of mathematical statistics to verify the impact of the tourism development model of the intangible cultural heritage of Guangxi, Yunnan and Guizhou minorities on the ecological environment, and the following conclusions were drawn:

1. Realizing the development of intangible cultural heritage tourism of Guangxi, Yunnan and Guizhou minorities in the context of environmental and ecological protection. Relying on the cultural connotation and characteristic landscape of ethnic minorities, we plan beautiful villages according to local conditions and deeply explore and use local ecological and environmental protection knowledge to improve the ecological environment of ethnic minority villages. So that the ecological evaluation level of villages No. 3, No. 4 and No. 6 maintains a high level with a grade of 5.

2. By adhering to the people-centered concept and giving full play to the role of villagers in the construction of the ecological environment of minority villages, we create a good atmosphere in which everyone cares about the environment and everyone participates in environmental protection. To enhance the comprehensive function and environmental level of minority villages, to explore and utilize local ecological knowledge, to protect the ecological environment of minority villages in a multifaceted and coordinated manner, to use resources rationally and to improve the utilization rate of resources, so that the ecological environment of villages No. 2 and No. 5 is better constructed with a grade of 4.

3. By constructing the ecological environment evaluation index system of minority villages, we adhere to the people-centered concept and enhance the comprehensive function and environmental level of minority villages. To make the vitality and attractiveness of intangible cultural heritage tourism products of ethnic minorities consistent with tourism development while pursuing the original tourism ecology. It makes the ecological environment of village No. 1 better and makes the ecological environment evaluation grade 5.

4. In the process of tourism development, we insist on the theory of "authenticity" to explore the real connotation, so that the vitality and attractiveness of intangible cultural heritage tourism products of ethnic minorities will be consistent with the original development trend while pursuing the original tourism ecology. Based on the ecological environment construction status of No. 7 village, the ecological evaluation level is maintained at 4. Continue to promote the construction of the ecological environment of minority villages, so that the ecological protection of minority villages and the tourism of minority intangible cultural heritage can be developed together.

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/18/

ECOLOGICAL CONSTRUCTION AND ENVIRONMENTAL MANAGEMENT IN LARGE AND MEDIUM-SIZED CITIES IN THE CONTEXT OF INDUSTRY-CITY INTEGRATION

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ABSTRACT

To maintain the ecological environment and protect the sustainable development of natural resources, this paper proposes a study on ecological construction and environmental management in large and medium-sized cities in the context of city-industry integration. The spatial layout, environmental capacity, and environmental quality are clearly deficient in the situation related to the integration of industrial and urban areas. Analyze the problems of ecological construction and environmental management in governance, construct an index system for the coordinated development of ecological and environmental systems, and measure the coupled and synergistic dispatch of cities and ecological environments. Eliminate dimensions, variable changes and values so that benefit and cost metrics are consistent. The information entropy of each index is calculated by using the original information of the objective environment, and the weights are determined after standardizing them to obtain a comprehensive index of the development level of urbanization and the ecological environment system. The coupling coordination model is used to measure two or more system linkage indicators, reflecting the degree of coordination of the interactive coupling of economic growth and the ecological environment. The analysis of the results shows that the ecological development of urbanization is steadily increasing, and the level of ecological development has grown to 0.7291 and the level of urbanization development has increased to 0.8950 over time, with a good degree of coordination of coupling.

KEYWORDS

Industry-city integration; Ecological construction; Environmental management; Coupling model; Correlation index

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1. INTRODUCTION

With the gradual advancement of China's ecological civilization construction, environmental management issues are becoming increasingly prominent. Strengthening environmental management and ensuring ecological civilization have become important strategic slogans for the economic and social development of many integrated industrial cities [1]. The key is to solve the outstanding problems of the ecological environment, improve the quality of the environment, improve the utilization rate of resources [2], and promote the harmonious development of humans and resources. In recent years, environmental management has made great progress and the Central Environmental Protection Inspectorate has achieved good results in various places [3], but there are still many problems to be solved. Only by continuously improving the level, we can make a city of ecological civilization better and better.

"The 14th Five-Year Plan period will be a period when the main and secondary contradictions in ecological environmental protection in China will be transformed, and it will be a period when the stage differences [4-5]. While further promoting development, it will become the main line of ecological civilization construction in this period to achieve ecological and environmental protection [6]. For regions with a high degree of industry-city integration, the construction of ecological civilization faces great challenges due to the high intensity of land development, high population density, large unit footprint, and high emissions [7-9].

Compared with the separation of industry and city, the integration of industry and city is a development concept proposed in the context of China's transformation and upgrading [10-11]. "Promoting cities with industries, promoting industries with cities, and integrating industries and cities" is a new idea and a new tool to solve the problem of urban functional zoning in the context of new urbanization [12-13]. National-level new districts are regional economic growth poles and new engines [14]. At the same time, it is also a specific practical exploration under the integration of industry and city. The industrial-city integration and the construction of new zones integrate industry and urbanization rationally. People-oriented and comprehensive development is an inevitable choice to adapt to the development of the times [15-16]. The management and policies of the new district should support the development strategy from the perspective of environmental construction to achieve the guidance of the blueprint and meet the needs of the healthy development of the new district with the integration of industry and city, which is an important way to implement green development [17-18].

Based on this, ecological construction and environmental management are the key objectives of concern for urban development. The literature [19] has conducted small-scale agriculture through opportunistic farming [20-23], and integration of natural landscape elements in the field [24-25]. The literature [26] discusses various modeling approaches to predict ecosystems and responses to human interventions [27], including mechanical models and so on. The literature [28] quantified the condition of

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grasslands from 2001 to 2014. The effect of SISGC on grassland conditions was estimated [29]. SISGC significantly improves grassland conditions; however, the effectiveness of SISGC is somewhat offset by other socioeconomic and climatic factors [30]. The above literature examines the relevant ecosystems or environmental management, but only one aspect is analyzed, which is not sufficiently comprehensive.

Therefore, based on the relevant data on urbanization and the ecological environment in a medium-sized city from 2011 to 2020, this paper analyzes the correlation mechanism between urbanization and the ecological environment of the city. And with the help of the coupling and coordinated development model, the coupling and coordinated scheduling of the above two indicators in the city in the past 10 years are measured, which provides a decision-making reference for ecological construction and environmental management.

2. IDEAS OF ECOLOGICAL CONSTRUCTION IN THE AREA OF CITY-INDUSTRY INTEGRATION

"China's overall economic scale will continue to expand. Industrialization, urbanization and agricultural modernization will continue to advance, and the contradiction between scale expansion and ecological environmental protection will be further highlighted [31]. As ecological environmental protection and pollution prevention enter the "deep water" area, it will be increasingly difficult and promote emission reduction in key industries. The main problems faced by the general city-industry areas are:

The spatial layout is unreasonable. The intensity of land development is close to 70%, and the early industrial development planning did not fully consider ecological and environmental protection factors. This has led to the interweaving of industrial parks and residential areas, resulting in conflicts between enterprises and groups and hidden environmental safety hazards. In addition, the proportion of industrial land is high, and the image of monotonous industrial parks is prominent. Under some regulations, the problem of sloppy utilization of industrial enterprises and use not in line with planning is more prominent.

The environmental capacity is seriously insufficient. The scale of industry is large, and the emission intensity of COD, ammonia nitrogen and volatile organic compounds per unit land area is high per unit land area. Overall, the problems of serious stock pollution, ecological cost overdraft, and environmental carrying capacity near the upper limit are more prominent. High-tech industries are the main emission sources of COD and ammonia nitrogen industries in the region [32]. "After the 13th Five-Year Plan period, the lack of alternative sources of total pollutant emission reduction has become an important bottleneck limiting industrial development.

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Environmental quality is unstable. 2019 concentrations of NO_2, PM2.5, ozone and PM10 have not yet reached secondary standards. The region will face combined PM2.5 and ozone pollution, and it will be more difficult and costly to continuously improve air quality. The rivers in the area are all used for passenger water and rely heavily on gates to control the flow of the river network. It also faces problems of poor water quality for visitors and weak self-purification of water bodies.

Key areas are in urgent need of breakthroughs. Hazardous waste disposal suffers from insufficient treatment capacity, category mismatch, low disposal and resource levels, etc. The amount of hazardous waste generated by the projects under construction has exceeded the existing disposal capacity, and there are about 6 enterprises with an annual hazardous waste volume of less than 10 tons, making it difficult to find a suitable disposal method for commissioning. The closure and relocation of key industries such as electroplating, and the redevelopment and utilization of the land left behind by enterprises and the industrial land "retreating from two to three" still need to strictly prevent environmental risks [33].

The task of supervision is complex and arduous. Environmental protection personnel in the area account for only 7% of the city's environmental protection personnel, but the per capita supervision target is about twice as large as the city's. In the new situation, environmental protection policies are getting stricter and stricter, and the requirements for personnel to supervise environmental protection are getting more and more difficult. It is difficult to cover every corner of the entire region with the existing supervision model alone.

3. ECOLOGICAL CONSTRUCTION AND ENVIRONMENTAL MANAGEMENT

3.1. THE IMPORTANCE OF ENVIRONMENTAL MANAGEMENT IN THE CONTEXT OF ECOLOGICAL CONSTRUCTION

The construction of ecological civilization is based on green development of economic and social development, taking a sustainable development path that respects nature, protects the environment and conserves resources. Environmental management refers to the use of administrative, legal, scientific and technological, educational and propaganda means to achieve the purpose of environmental protection and to realize the goal of environmental protection through planning, organizing, coordinating, controlling and supervising. Although China is vast and rich in natural resources, it is still a developing country with a large population, and there are many problems in the utilization of resources and environmental protection. Through the construction of ecological civilization, strengthening environmental management, scientific management of the environment and scientific use of

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resources, accelerating the construction of a new type of urbanization, promoting the construction of the Belt and Road.

3.2. PROBLEMS ENCOUNTERED IN ENVIRONMENTAL MANAGEMENT IN THE CONTEXT OF ECOLOGICAL CONSTRUCTION

The current urbanization process is accelerating and the urban population is increasing significantly. The contradiction between people's pursuit of material life and a quality living environment and the current waste of urban resources and poor living environment is intensifying. The low level of urban waste disposal, serious air pollution, water pollution and noise pollution exist simultaneously, which have a great impact on people's life. From the perspective of environmental management, the main problems are as follows.

1. Lack of perfect management system and management institutions

Although China has promulgated the "Ten Articles on Atmosphere" and "Ten Articles on Water". However, a more scientific, comprehensive and specific system is needed for environmental management to solve the increasingly complex environmental protection problems. In addition, our regulatory agencies are not perfect. In the face of cross-regional pollution such as river pollution and air pollution, we also lack cross-regional environmental protection agencies, the overall nature of environmental protection is not enough, and the division of authority and responsibility is not clear.

2. Public participation is too low

"The city belongs to you and me, protecting the environment depends on everyone". Although such a slogan is well known, neither the managers nor the public have done a good job. China has imperfect laws and lacks detailed regulations [34], managers are prone to slackness in their work and lack effective publicity and education for public participation. In terms of environmental protection, the quality of Chinese citizens is still relatively low. Many people still have the habit of littering and spitting, not to mention getting them to actively participate in environmental public welfare activities.

3. High cost of environmental management

In recent years, although the state has introduced fiscal and tax policies to support environmental protection and increased the financial budget for environmental protection, the funds are still far from enough compared to the current environmental protection efforts. Although some cities intend to make achievements in environmental protection, the high cost of environmental management and the lack of funds for environmental protection have led to difficulties in environmental management.

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4. THE COUPLING MECHANISM OF URBANIZATION AND ECOLOGICAL ENVIRONMENT

4.1. SETTING WEIGHTS

The coupling mechanism of urbanization and the ecological environment was analyzed in a medium-sized city as an example [35]. And the coupling and synergistic dispatch in this city were measured with the help of the coupled coordinated development model.

The basic principles of model-based index selection and formulation include scientificity, comprehensiveness and operability, and the research results are verified by evaluating the interaction between urbanization and ecological environment. According to the coupling and coordination mechanism, we combine theoretical analysis and use methods such as frequency statistics of indicators. The index systems are selected, and the evaluation indexes of the urbanization-ecological environment system are finally constructed.

Since this coefficient does not explain the raw data related to the selected indicator system, it is necessary to standardize the indicator system before quantitative analysis. To eliminate the effects of dimensionality, variables own changes and values, so that the benefit and cost indicators are consistent. First, let map X through $\min - \max$ standardized to the value in the interval $[0,1]$. The formula for this is:

$$Y_t^i = \begin{cases} x_{it} - x_{it}\min\left(x_{it}\max - x_{it}\min\right) & \text{Positive indicator normalization} \\ x_{it}\max - x_{it}/\left(x_{it}\max - x_{it}\min\right) & \text{Inverse indicator normalization} \end{cases} \tag{1}$$

In Equation (1), it is the original value of the ith index of the city, i.e., the value after data normalization. It represents the ith index of the urbanization and ecosystem index system in year t. $i = 1,2,3,4,\ldots$. Zero values may appear after data normalization. Therefore, 1 is added to the whole standardized data to make it still meaningful.

4.2. CALCULATION OF THE WEIGHT OF THE METRIC

The concept of entropy originates from thermodynamics and is a measure of the uncertainty of the system state [36]. Information is a measure of the order of an information-theoretic system. They have the property of being equal in absolute value but opposite in sign. Therefore, we can use the raw information of the objective environment. In this paper, we calculate the information entropy of each index by the entropy method, further, analyze the correlation between the indexes and determine the index weights. The entropy calculation formula with E_j as the jth index is as follows.

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$$Ej = K \sum_{i=1}^{m} \left[\left(Y_{ij} / \sum_{i=1}^{m} y_{ij} \right) \cdot \ln \left(\sum_{i=1}^{m} Y_{ij} \right) \right] \tag{2}$$

In Equation (2), K is a constant, $K = 1/1n(m)$, $E_j \in (0,1)$ that is, the maximum value of E_j is 1. Therefore, d_j can be defined as the degree of consistency of the contribution of each index system under the attribute j. $d_j = 1 - E_j$, is set as the weight value, then the weight of each index system is calculated as follows.

$$W_j = (1 - Ej)/ \sum_{j=1}^{n} (1 - Ej) \tag{3}$$

The above raw index data were standardized [37] to determine the index weights. On this basis, the integrated index was calculated using the layer-by-layer weighted summation method. The calculation formula was as follows.

$$U_{1,2} = \sum_{i=1}^{m} Y_{it}^{1} \cdot W_j \tag{4}$$

In Equation (4), U_1 and U_2 denote the integrated index development level respectively.

4.3. COUPLING COORDINATION DEGREE DEVELOPMENT MODEL

4.3.1. COUPLING DEGREE ANALYSIS OF URBANIZATION SYSTEM AND ECOLOGICAL ENVIRONMENT SYSTEM

If it is set to t year, then we get U_1 and U_2 respectively, then the following functions are used for the coupling degree analysis:

$$C = 2 \left[U_1 U_2 \right] \theta / U_1 + U_2 \tag{5}$$

In the above Equation, the coupling degree value $C[0,1]$, is set to 0.5, and the coupling degree C value is proportional to the coupling degree.

4.3.2. ANALYSIS OF THE COUPLING AND COORDINATION DEGREE MODEL OF URBANIZATION SYSTEM AND ECOLOGICAL ENVIRONMENT SYSTEM

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Because the development levels have their different degrees of difference, and the calculated weight values of both subsystems are relatively low, this paper thus introduces the model, which can better reply to the coordination degree of the interactive coupling, and the function is shown as follows:

$$\begin{cases} D = (C \cdot T)^{1/2} \\ T = \left[U_1 + U_2\right]/2 \end{cases} \tag{6}$$

The coupling degree is combined with the comprehensive development level of urbanization development and ecological environment system to calculate the coupling coordination degree of the system $D(t)$, i.e. $D(t) = (C \times T)1/2$. Where, $T = \left[U_1 + U_2\right]/2$ indicates the comprehensive development level of the urbanization system and ecological environment system in year T. The specific index division and value criteria are shown in Table 1.

Table 1. Criteria for dividing the level of coupling and coordination

D value range	Coordination level	External performance
0＜*D*≤0.3	Low coordination coupling	The development of urbanization has little impact on the ecological environment system, and the environmental carrying capacity is large
0.3＜*D*≤0.5	Moderately coordinated coupling	The level of urbanization development continues to improve, the ecological environment is gradually destroyed, and the carrying capacity of the ecological environment system becomes smaller
0.5＜*D*≤0.8	Highly coordinated coupling	The development of urbanization, the restoration of the ecological environment system
0.8＜*D*≤1	Extremely coordinated coupling	The level of urbanization development and the development of the ecological environment system have entered a stage of coordinated and orderly coupling

5. RESULTS AND ANALYSIS

We obtained the index weights by calculation based on the city's 2016, 2018, 2019 and 2020 statistical yearbooks and the city's 2011-2020 statistical bureau data. Then the city's urbanization and ecological environment development level is got by formula (4), and then its coupling coordination degree and coupling development stage is obtained by the coupling degree coordination calculation formula (6). The calculation results are in Table 2, the development trend in the past ten years is obtained as shown in Figure 1.

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Table 2. Coupling coordination degree and type from 2011 to 2020

Year	Level of urbanization U_1	Ecological environment development level U_2	Coupling coordination D	Coordination level
2011	0.0286	0.3300	0.1793	Low coordination coupling
2012	0.2294	0.3923	0.3108	Moderately coordinated coupling
2013	0.1331	0.5203	0.3267	Moderately coordinated coupling
2014	0.2474	0.3441	0.2957	Low coordination coupling
2015	0.3412	0.3673	0.3543	Moderately coordinated coupling
2016	0.4449	0.3771	0.4110	Moderately coordinated coupling
2017	0.5724	0.4271	0.4997	Moderately coordinated coupling
2018	0.7373	0.6619	0.6996	Highly coordinated coupling
2019	0.7922	0.6586	0.7254	Highly coordinated coupling
2020	0.8950	0.7291	0.8120	Extremely coordinated coupling

From the data in Table 2, we can see that the level of urbanization development in 2011 is low at 0.0286, while the level of ecological environment development is relatively high at 0.3300, and the development is unbalanced. So that the environmental carrying capacity is large, and the coupling coordination degree is 0.1793, showing a low coordination coupling stage. From 2012 to 2013, the two developed staggered. The level of urbanization continues to improve, the ecological environment is gradually destroyed, and the carrying capacity becomes smaller. The coupling coordination degrees are 0.3108 and 0.3267, respectively, showing a moderate coordination coupling stage.

And in 2014, with the rapid development of urbanization, the development of the ecological environment was hindered, so the coupling coordination degree of the two dropped to 0.2957 again, showing a low coordination coupling stage. After 2014, due to the continuous advancement of the urbanization process, including the improvement of education level, and the increase of people's awareness of environmental protection, the ecological environmental protection and governance capabilities have been greatly improved. The coupling coordination degree has also increased year by year, gradually rising from 0.3543 in 2015 to 0.7254 in 2019, indicating that the coupling stage has changed from basic advanced to high coordination, and will reach an extremely coordinated coupling stage of 0.8120 in 2020.

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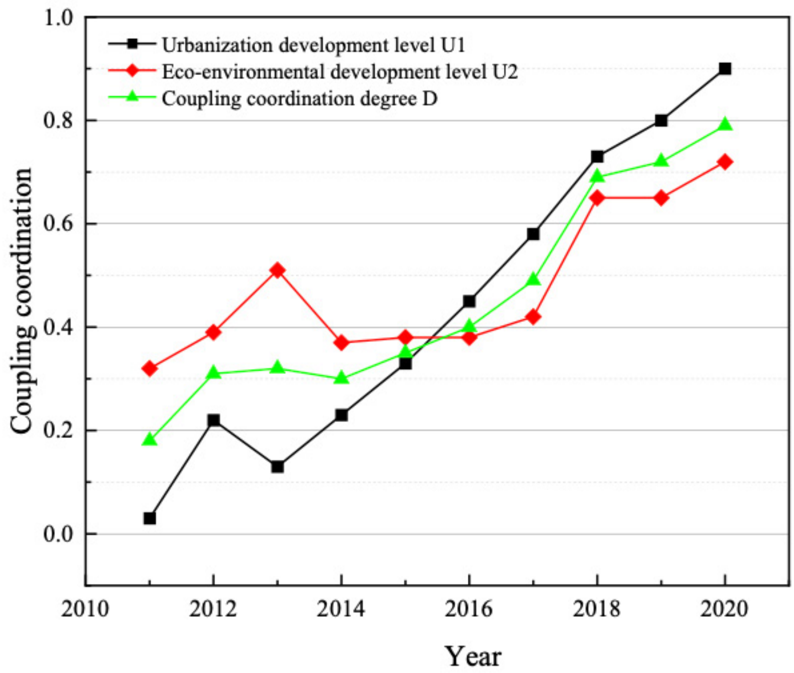

Figure 1. Development trend of coupling urbanization and ecological environment, 2011-2020

We can see from Figure 1 that the overall trend is up, except for 2013-2014, which was a declining phase; the ecological environment development level has certain fluctuations, and the overall trend is increasing. In terms of coupling coordination, the overall trend is rising, then falling and then rising. The level of ecological development of the city needs to be improved, the level of urbanization needs to be further enhanced, and the coordination between the two needs to be strengthened. In 2012, resulting in a decline in coupling, the development of urbanization was affected and showed a downward trend. After 2013, urbanization flourished, which brought certain pressure to development and made the level of development decrease. The steady growth of urbanization promotes the development of high-tech industries. From 2015 to 2017, it showed a rapid upward stage. With the continuous improvement of urbanization, the ecological environment is gradually destroyed and the carrying capacity becomes smaller, which makes the coordination degree between the two low. In general, although the urbanization construction has been continuously strengthened and environmental governance has been continuously strengthened, dialectically from the perspective of the comprehensive level, the overall ecological environment is relatively low, resulting in a low degree of coordination between the two, which is still in the Moderately coordinated coupling phase. From 2017 to 2018, due to the development of technology, the environmental governance capacity has been greatly improved, and the development level has been significantly improved.

Based on the above data, we can propose some environmental management strategies for the city. First, we suggest that the city government should strengthen the governing concept of ecological city construction and make great efforts to promote the innovation of environmental governance systems and mechanisms. It should fully coordinate the development, and insist on development in the protection and

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protection in the development. Second, improve top-level design and top-level thinking based on development ideas and the current situation of the city. Determine the overall goals, roadmap and timeline, and refine environmental goals in terms of environmental quality, environmental regulation, and public participation. To combine the research results of urban vision planning and development strategic planning, carefully compile ecological construction and environmental protection planning. Effectively maintain the authority of the plan, study and formulate annual implementation plans, clarify the responsible subjects, and strictly implement the assessment. In the implementation of ecological and environmental special planning insist on finding aspects that are difficult to achieve, especially seize the air pollution, drinking water, mountains and lakes, fumes and noise and several other outstanding issues that affect the quality of the environment and the satisfaction of the public. In the planning and implementation of the project in step-by-step arrangements to solve, to accelerate the green development in full swing, the construction of a beautiful city to provide strong support. Strengthen publicity and education, improve the public's awareness of environmental protection and law-abiding, and cultivate a good atmosphere focused on environmental credit. Consciously assume social responsibility from the legal system mandatory to the rule of law compliance, to achieve environmental pollution information disclosure, strengthen the treatment of pollution to meet emission standards, and vigorously implement clean production, through emission reduction and pollution control. Implant everyone's participation in environmental protection in the hearts of citizens and encourage public participation in ecological construction and environmental protection work. Encourage independent media coverage to further strengthen public opinion monitoring. To achieve a strong promotion of the two core elements of information disclosure and public participation in environmental governance, and to guarantee residents' right to informed environmental supervision.

6. DISCUSSION

In the context of urbanization, the integration of industry and cities has greater power and thus positive and negative effects. One must limit the negative effects of industry on the integration of industry and cities. One of the key measures is to promote industry-city integration based on ecological construction. While promoting industry-city integration, ecological construction should be promoted and environmental management systems should be strengthened. To make the speed, scale and intensity of industry-city integration adapt to the evolutionary process of ecological environment carrying capacity and ensure that the development of industrial and urban integration is always within the ecological environment appendix value. Integrating population, resources and environment, promoting the integration of industry-city and ecological civilization, and realizing the respective functions and overall functions are the keys to the integration of industry-city and ecological civilization. Make the integration of industry and city and ecological civilization

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construction promote each other, and promote and coordinate each other in time, function and development speed.

7. CONCLUSION

Building an ecological city and optimizing the environmental governance system is to meet the people's demand to have a better life. It is an objective requirement to promote the construction of ecological civilization by the law and a strategic need to achieve sustainable development under the new normal. This paper further analyzes how to carry out reasonable environmental management based on the construction of an ecological construction system of a city in the context of industry-city integration. To provide a reference and the optimization of the environmental governance system in the region.

1. The urbanization development of the city has been greatly improved. Except for the period from 2012 to 2013 when the urbanization development level decreased due to the decrease in the proportion of industrial output value, the urbanization development level in general tends to be in a stable and increasing stage in the last ten years, from 0.0286 in 2011 to 0.8950 in 2020.

2. Except from 2013 to 2014, when the level of ecological and environmental development decreased due to the smaller carrying capacity of the ecosystem, the level of ecological and environmental development, in general, tends to be a stable and increasing stage in the last decade, from 0.3300 in 2011 to 0.7291 in 2020.

3. From this urban and ecological environment coupling development degree curve we can see that the urbanization development level, and ecological environment development level in Xiangyang city are all in the rising stage during 2011-2013. During the period 2013-2014, the level of urbanization development of the city has increased and its ecological development level has decreased, while the coupled development degree of the two is in a decreasing stage. During the period 2014-2020, all three of them are again in an increasing stage.

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THE ROLE OF INCOME SMOOTHING ON FINANCIAL PERFORMANCE INDICATORS

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ABSTRACT

The primary objective of this study is to determine whether income smoothing procedures have an impact on the financial performance of return on assets (ROA) and return on equity (ROE). Data for this study came from a sample of banks that are listed on the Iraq Stock Exchange. The research sample consists of banks listed between 2015 and 2019 on the Iraq Stock Exchange. The model estimate is done using the panel data approach. Five banks match the required requirements, and the samples were chosen using a purposive sampling technique. This study employs Miller's model to distinguish between banks that used income smoothing and banks that did not, as well as certain statistical techniques to examine the data. Two indices of financial performance—return on assets (ROA) and return on equity (ROE). Were used to compare the performance of smooth and non-smooth income banks and the variations in the influencing variables that influence each. The findings of this study demonstrate that return on assets (ROA) and return on equity (ROE) have a considerable impact on income smoothing procedures, while variable volume has a significant positive impact as well. In this study, we observed statistically significant differences between banks with and without smooth income in terms of their returns on assets (ROA) and returns on equity (ROE). We found a statistically significant positive relationship between bank size, financial success, and income smoothing in our study.

KEYWORDS

Income smoothing, financial performance, Banking sector, Miller's model, and emerging economy.

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1. INTRODUCTION

Income smoothing is a type of earnings management that management use across several periods to display a constant level of profit flow. To attain the level of earnings anticipated by the market or analyst, management may often employ income smoothing to lessen earnings volatility over a given time [1] By setting aside a portion of income during prosperous times and increasing reported income during periods when it falls short of expectations, the volatility of income can be reduced. Several factors might affect a company's income-smoothing procedures. Profitability is one of the key elements that affect income smoothing. A company's profitability, which is a gauge of its level of managerial effectiveness, is its capacity to make profits over a period [2]

Income smoothing is frequently impacted by a number of factors, including financial performance. This practice is a typical method of managing profits. The managers implement the income smoothing approach, which involves boosting or reducing reported income to reduce its volatility. Creating reserves or earnings from the unreported amounts of earnings in good years to cover the low financial performance years is the procedure of income smoothing. The smooth revenue the company reports in its financial statements for each period is a sign of a strong corporation, and investors and management favor this characteristic since it demonstrates the firm's strong performance [3]. One of the elements that motivate behavior income smoothing is financial performance. This practice is a common technique for managing profits. The managers use an income smoothing approach that involves changing the reported income either increasing or recreating to reduce its volatility. The creation of reserves or profits from unreported earnings in strong years to offset the low financial performance years is the practice of income smoothing.

Smooth revenue in the financial statements for every period is a sign of a strong company, and investors and management favor this feature since it indicates strong company performance [3]. Management is responsible for creating the financial statements. As a result, agency theory claims that management knows more about the firm than the firm owner. So, managers have the freedom to take a variety of alternative measures to adjust different accounting procedures in a way that serves the interests of the business. This is what motivates managers to undertake income smoothing, whether they realize it or not [4]. To satisfy the interests of the firm owner or the manager of the firm itself, management activities to smooth out income are typically based on this. Managers use income smoothing to minimize the tax burden paid and/or raise stock prices or company value to satisfy the interests of business owners. while satisfying the requirements of management itself, meaning getting payment or keeping his job [5]. By examining income smoothing practices as one of the forms of management intervention in the accounting measurement and disclosure process and their impact on the financial performance indicators of banks, the findings of this study add to the body of knowledge about firms' income-smoothing behavior.

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As well as the significance of researching the techniques employed by management for income smoothing practices and their effect on enhancing the financial performance of banks, as well as the significance of employing the (Miller model) in identifying and diagnosing income smoothing practices.

The purpose of this study is to investigate the connection between financial success and income-smoothing strategies. This paper's main goal is to demonstrate how, in the context of earnings management, income smoothing procedures have an impact on the significance of earnings value and financial performance. On these topics, a prior study has been conducted. Yet, other studies have shown contradictory findings. The goal of this study is to increase the accuracy of achieving the best reflective outcome by evaluating a model for income smoothing screening techniques.

This paper is organized as follows: the next section is followed by a discussion of reviews of the literature to develop the research hypotheses. Next, the research method and data-collecting process are described, followed by a discussion of the empirical results. The paper ends with a conclusion.

2. LITERATURE REVIEW

2.1. INCOME SMOOTHING

According to agency theory, a firm is a legal agreement between the party in charge of managing a resource and the owner of the resource. When the principal assigns the agent to action and gives them the power to make decisions, an agency relationship may develop. [6]. in a relationship based on agency, the principal expects the agent to represent his interests. The main objective of the agent's activities, regulations, and tactical decisions is to maximize his welfare. Agents, on the other hand, might work against the interests of the principal since they have their interests. According to agency theory, management, and principals' competing interests have an impact on how earnings are managed. By relocating employees, managers may enhance their well-being. It's possible for managers to want to artificially boost company performance. The manager's position will rise through expanding the business, accelerating its growth, or improving performance. The objective is to strengthen employment security from the possibility of dismissal and secure jobs, bonuses, and pay increases [7].

The goals of management activities for income smoothing often revolve around advancing the interests of the business's manager or owner. Managers smooth out profits to lower tax liabilities and/or boost stock prices or company value to fulfill the objectives of business owners. However, to keep his job or fulfill the needs of management itself, such as receiving a salary [5]. By replacing the revenue from a poor year with that from a good year, income smoothing attempts to equalize the swings in income that are associated with particular years. Similarly to this, moving losses or spending from time to time can alter income volatility. For instance, a

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corporation may lower discretionary costs in a given year to boost current profitability but do so at the risk of raising discretionary costs in the next year [8]

The accounting and finance literature has been interested in the topic of income smoothing for many years. Most studies viewed income smoothing as "immoral" due to the "cheating" and "misleading" that went on because it was done by any firm's management. [9]. Proponents claim that one of the incentive accounting practices known as "income smoothing" is modifying and manipulating swings in a company's earnings at specific high points. There are two feelings that apply to the management of earnings. The first is more prevalent and rejects income management, but in the second case, stakeholders define such actions as management according to their preferences [10]. Actions to smooth out income are typically taken for a variety of reasons, such as lowering taxes or avoiding pressure from employees to raise salaries or pay. To draw in investors, creditors, and other outside parties, company management might also take steps to obtain the desired profit position in the income statement. This is due to the dysfunctional behavior of income smoothing, which seeks to increase investors' perceptions of the company's worth [11]

2.2. FINANCIAL PERFORMANCE

A financial ratio is a technique used to describe the connection between two types of financial data in mathematical terms. According to [12], the purpose of performance measurement is to compare business performance and management to the company's goal or target. It is also true that a company's financial standing may affect how well it operates. As a result, financial statements are crucial diagnostic tools for knowledge management. A company's financial position and operating results are stated in its financial statement at a specific period of time. According to research done by [13], firms with a habit of achieving past period earnings are more likely to engage in income-smoothing earning management methods, and as a result, earning management practices are highly correlated with company success. that there is a link directly connecting earnings management to business performance [14].

Also, it found that there is a substantial inverse association between the degree of earnings management and the performance indicators for firms [15]. As a result, the literature study offers enough proof that there is a considerable connection between effective earnings management techniques and company success. The financial performance focuses on factors directly related to financial reports and includes a variety of measures, but financial leverage and profitability ratios, such as return on assets (ROA) and return on equity, are beneficial for investors to invest in the capital market and minimize high tax payments (ROE), The two ratios that will be utilized in this study and connected to the examination of the financial statements of the performance of the firm are:

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Return on Asset (ROA)

The capacity of the firm to turn a profit from sales, total assets, and own capital is known as profitability. Users of financial statements should be highly familiar with profitability ratios since they provide information about a firm's potential to create profits. A higher profitability ratio indicates better management of the organization [16]. When the return on asset (ROA) is positive, it may be used to determine if the firm can make money from the total assets utilized in operations [17]. If the return on assets (ROA) is negative, it might indicate that the company's activities do not generate a profit (loss) [18].

Return on Equity (ROE)

According to [19] .ROE evaluates the company's shareholders' returns, including both preferred and common stockholders. ROE has evolved into one of the factors that investors use to assess a company's stock price since it directly affects a company's intrinsic worth [20]. If a corporation has no debt, both its ROA and ROE will be equal. There is a similarity between ROA and ROE. Yet, ROE will surpass ROA if the firm has financial leverage [21]. Debt will enhance the company's cash flow and its asset base [22].

3. HYPOTHESIS DEVELOPMENT

The research supports the presence of managers' incentives to smooth compensation based on agency theory. Even when it is not in the best interest of shareholders, the separation of ownership and control encourages managers to manage earnings to serve their interests [23], [24] and [25] for example, examined the impact of income smoothing and earnings quality on the financial performance of pharmaceutical companies quoted on the Nigerian Stock Exchange from 2006 to 2014. The current study focuses on the financial performance and income smoothing of banks listed on the Iraqi Stock Exchange. The profitability ratio return on assets (ROA) affects income smoothing. A high profitability ratio is one of the reasons to undertake income smoothing since it demonstrates the company's capacity to generate profits in the future, and management might manage the earnings using that knowledge [26] .This study's primary goal is to investigate how income smoothing affects the financial performance of banks that are listed on the Iraqi Stock Exchange with a focus on the relationship between profitability and financial performance. Out of the three variables studied, two hypotheses may be made based on the theory of variables and the findings of previous research, and all of the hypotheses are as follows:

H1: Income smoothing has a significant impact on the financial performance indicators, represented by the return on assets (ROA)

H2: Income smoothing has a significant impact on the financial performance indicators, represented by the return on equity (ROE)

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4. METHODOLOGY

This study is an example of explanatory research, which uses hypothesis testing to explain the causal link between variables. Identify cause-and-effect correlations between the variables by designing this research. Secondary data is what was used. The study's data are from the Bank of Iraq's 2015–2019 financial report statistics.

4.1. POPULATION AND SAMPLE

All commercial banks registered on the Iraqi Stock Exchange between 2015 and 2019 make up the study's population. Purposive sampling, which has regularly resulted in published audited financial accounts, is used to collect samples. Quantitative data and secondary data, specifically data in the form of figures obtained from observation data on financial ratios from financial statements collected from various points in time and data collected from those registered with the Iraq Stock Exchange in the years 2015 to 2020, are the types and data sources used in this research.

4.2. DEFINE OPERATIONAL VARIABLES

Income smoothing is the independent variable in this research. Several studies describe the models used to measure income smoothing practices, [27] and [28] but for this study, we picked the Miller model since it is the most recent model for doing so, is simple to use, and can easily be obtained the data needed to utilize it. to assess income-smoothing techniques. Miller (2007) introduced the ratio of the relationship between the change in working capital as an element subject to manipulation and the cash flow from operating activities as an element not subject to manipulation because current assets and liabilities are the constituent elements of working capital (current assets - current liabilities).

The dependent variable is a variable that will be tested for the effect on the independent variable. In this research, the dependent variables used are ROA (Y1) and ROE (Y2) Below are the measurements of the variables. Table 1 presents the measurement of the used variables .

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Table 1. Variable Measurement

Variables	Measurement
Income smoothing (X)	So-called the Miller Ratio, it can be used to detect manipulation of profits, as its value is zero in the absence of manipulation. If the Miller ratio differs from zero (negative or positive), this is an indication of the existence of manipulation in the profit number. Prepared according to the accrual basis. (ΔWC / CFO) t-o – (ΔWC / CFO) t-1 = 0 CA: denotes current assets, CL: denotes current liabilities WCΔ: denotes the change in net working capital, CFO: Refers to cash flow from operating activities.
ROA (Y1)	ROA is a tool for measuring a company's ability to earn profits through total asset management. The formula is net income divided by total assets [22]
ROE (Y2)	ROE is generally one of the most important variables in determining what level of capital is due. The formula is net income divided by equity.

5. DATA ANALYSIS AND DISCUSSION

This study examined the impact of income smoothing practices on bank financial performance (ROA) and (ROE) in the period 2015-2019.

Table 2. Apply Miller's model to the study sample banks

Banks	fiscal year	(ΔWC / CFO) t-o – (ΔWC / CFO) t-1 =0
Kurdistan	2015	0
	2016	20.782
	2017	-21.149
	2018	-21.149
	2019	-3
Cihan	2015	0
	2016	284
	2017	-2.743
	2018	2.825
	2019	-1.375
Erbil	2015	0
	2016	453
	2017	0.02
	2018	-363
	2019	-2.05
Mosul	2015	0
	2016	8
	2017	-3.151
	2018	4.494
	2019	3.762

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It appears in Table No. (2) that it has been confirmed that there are income smoothing practices in a sample of banks listed in the Iraq Stock Exchange through the use of the Miller model, where the decision was taken based on the consideration that if the result of the Miller ratio is not equal to zero, then the bank is considered a practitioner of smoothing Income If the result of the Miller ratio is zero, the bank is no longer a practitioner of income smoothing, and it is clear from the table that a total of the banks in the research sample practiced income smoothing during the years (2015 to 2019). Where it turned out that there is a practice of smoothing the income according to certain models, while the results differed when using other models. It is also noted in Table No. (3) The statistical analysis of the variables of the study, which include the return on assets (ROA) variable (Y1) and the return on equity (ROE) variable (Y2). According to the sample banks and during the period 2016-2017, as follows:

Table 3. Financial performance ratios of the study sample banks

Banks	fiscal year	ROA (Y1)	ROE (Y2)
Kurdistan	2016	8	13
	2017	38	68
	2018	5	11
	2019	1	0.0003
Cihan	2016	32	68
	2017	26	51
	2018	0.0006	14
	2019	0.0007	1
Erbil	2016	16	31
	2017	13	23
	2018	4	14
	2019	-7	-14
Mosul	2016	8	13
	2017	10	18
	2018	6	9
	2019	8	12

In terms of the dependent variables, it appears in Table No. (3), represented by the variable return on assets (ROA) of the Bank of Kurdistan, the highest return was achieved in 2017, and it was the lowest return in 2019, and the amount of return ranged between these two years for the rest of the years, which means that this rate varied for this The bank during the period and relatively high risk. And the average return on equity (ROE), the second variable of the Bank of Kurdistan, was the highest return achieved in 2016, and it was the lowest return in 2019, and the amount of return ranged between these two years for the rest of the years, which means the variation of this rate for this bank during the period and the high Relatively risky. Which reflects the variation in this rate during the study period.

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It reached (ROA) for Cihan Bank, it was the highest return achieved in 2016, and it was the lowest return in 2018, and the amount of return ranged between these two years for the rest of the years, which means the variation of this rate for this bank during the period and the relatively high risk. And that (ROE) the second dependent variable of Cihan Bank reached and was the highest return achieved in 2016, as it was the lowest return in 2019, and the amount of return ranged between these two years for the rest of the years, which means the variation of this rate for this bank during the period and the relatively high risk. Which reflects the variation in this rate during the study period.

The (ROA) for Erbil Bank has the highest return achieved in 2016, as it was the lowest return in 2019, and the amount of return ranged between these two years for the rest of the years, which means the variation of this rate for this bank during the period and the relatively high risk, and the (ROE) was the second dependent variable for the bank in Erbil. It reached the highest return achieved in 2016, as it was the lowest return in 2019, and the amount of return ranged between these two years for the rest of the years, which means the variation of this rate for this bank during the period and the relatively high risk. Which reflects the variation in this rate during the study period.

The (ROA) for the Mosul Bank had the highest return achieved in 2018, as it was the lowest return in 2019, and the amount of return ranged between these two years for the rest of the years, which means the variation of this rate for this bank during the period and the relatively high risk. Also, (ROE), the second dependent variable of the Mosul Bank, has the highest return achieved in 2016, and it was the lowest return in 2019, and the amount of return ranged between these two years for the rest of the years, which means the variation of this rate for this bank during the period and the relatively high risk. Which reflects the variation in this rate during the study period.

5.1. DESCRIPTIVE STATISTICS

Table No. (4) shows the general average of the independent variable income smoothing (X), which amounted to (-1.2097) with a negative value, which means that the majority of banks have income reduction practices for tax evasion, and the highest value was (20.78) in the Bank of Kurdistan in 2016, as well The lowest value was (-21.15) in the Bank of Kurdistan in 2017, and the standard deviation was (9.5545) and the coefficient of variation was (91.289), and this indicates that the values of the variables in the study sample were clear.

Table 4. Analysis of variables for the study sample

	N	Minimum	Maximum	Mean	Std.	Variance
91.289	9.5545	-1.2097	20.78	-21.15	16	Income Smoothing
-.01	.04	.0106	.01210	.000	16	ROA Y1
-.01	.07	.0208	68	-14	16	ROE Y2

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The first dependent variable (Y1), which represents the rate of return on assets (ROA), was the general average at the level of the sample banks amounted to (0.0106), and the highest value was (0.01210) in Erbil Bank in 2016, which means that this indicator has recorded a decline during the study period. While it was the lowest value in the Bank of Erbil in 2019 and the standard deviation was (0.04) and the coefficient of variation was (-0.01), which increased the variance of this indicator and this confirms the high-income smoothing.

Also, the second dependent variable (Y2), which represents the rate of return on equity (ROE), was the general average at the level of the sample banks amounted to (0.0208), and the highest value was (0.068) in the Kurdistan Bank in 2017 and Cihan Bank in (2016). This means that this indicator has recorded a decline during the study period. While the lowest value was (-0.014) in the Bank of Erbil in 2019, the standard deviation was (0.07), and the coefficient of variation was (-0.01), which increased the variation in this indicator, and this confirms the high smoothing of income.

5.2. HYPOTHESES TESTING

Table No. (5) Shows the effect of the independent variable (income smoothing practices) on the dependent variables (financial performance indicators) through the following:

Table 5. Results of regression analysis

Variables	Dependent Variable ROA (Y1)					
	R	R^2	T test	B	A	SIG
Income smoothing (X)	2	14.7	704	2	3.83	0.50
	Dependent Variable ROE (Y2)					
Income smoothing (X)	1	18.24	741	1	4.27	0.55

The dependent variable ROA: The slope of the correlation coefficient (R) is (0.50) and the coefficient (R2) reached (3.83), which means that (4%) of the change in return on assets was caused by the variable income smoothing practices during the research period. The calculated (t test) value of (** 0.002) is supported, which means that the relationship is significant in the model at a confidence level of (0.002). The values of (B), which was (0.704), the value of the slope value in the model as in Table No. (5), and this project came in the first example, and this project was in the preliminary work. On this basis, the hypothesis was accepted, which states that there is a statistically significant effect of smoothing income on the return on assets in the study sample.

The dependent variable ROE: as the correlation coefficient (R) reached (0.55) and the coefficient of determination (R2) reached (4.27), which means that (4%) of the change in return on equity was caused by the independent variable income smoothing practices during the period The research supports the calculated (t test) value of

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(0.001), which means that the relationship is significant in the model at a confidence level of (0.001). As for the values of (B), which were (0.741), it may indicate that the change in the independent variable (income smoothing practices) by one unit is reflected by the amount of these values on the return on equity. This means the amount of slope in the model as in Table No. (5). The value of (A), which amounted to (18.24), refers to the value of the dependent variable when the value of the independent variable is equal to zero. This effect came in line with the propositions of applying income smoothing practices and their impact on the return on equity. On this basis, the first hypothesis was accepted, which states that "there is a statistically significant effect of smoothing the income on the return on equity in the study sample banks".

6. CONCLUSION

This study aims to investigate how income smoothing methods affect financial performance measures and how income smoothing functions as a mediator between these indicators in Iraqi public banks. It has been demonstrated that income smoothing improves the quality of wages. The quality of financial reports and earnings reports can be raised by income smoothing. The report's quality increases with decreasing income volatility. The study's findings revealed that revenue smoothing procedures exist in the banks that made up the study sample, and their origin may be traced to the conflicting interests of the parties to the agency represented by management and shareholders.

The management and stockholders are the parties to the agency that are represented. From the values of the standard deviation, the coefficient of difference, the maximum value, and the lowest value, it became clear from the analysis that there is a disparity in the values of the independent and dependent variables. The study's findings demonstrate that the income smoothing practices variable has a significant and statistically significant impact on the dependent variables (indicators of financial ratios) which the (T-test) value has demonstrated.

Profitability is a crucial indicator of a bank's health and has the power to sway the choices of investors. As the informational value of returns on assets controlled by banks is crucial to luring investors to invest in banks, the test results reveal a substantial positive trend, indicating that management would struggle to manage profits amid the deteriorating profitability of banks. This will increase the motivation for banks with lower levels of profitability to level out their income, and consistent revenue values can also satisfy a bank's top management.

The study's limits on the availability of data between 2015 and 2019 have led to a decrease in the sample's number of banks. When doing comparable research on Iraqi commercial banks, more pertinent data can be found by expanding the sample size by including more banks. Although the Iraqi Stock Exchange produced a decent summary report, one of the drawbacks of this study is the lack and incompleteness of information connected to the financial reports of the various business units. This may limit subsequent investigation in greater depth on income smoothing for enterprises in other industries.

Factors analyzed and years will be enhanced to allow a realistic picture of income smoothing on the Private Commercial Banks. Other financial ratios may be employed in future publications to analyze the variables influencing income smoothing. Hence, the performance of each type of business can be analyzed in more depth. For instance, various financial ratios other than (ROA) and (ROE).

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empresa

Investigación y pensamiento crítico