Research on the Path of Synergistic Development of the Sports Industry in Guanzhong Region

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Abstract. The stability and coordination of the regional sports industry can promote the rapid development of the economy. To study the current situation of the coordination development of the sports industry in the urban agglomeration in the Guanzhong region, this paper constructs an even and coordinated evaluation index system related to the sports industry and the economy and selects five cities in the Guanzhong region as research objects from 2011 to 2020 to assess the current situation of the coordination development of the sports industry in the urban agglomeration in the Guanzhong region. The research results show that the level of integrated development of the sports industry in the urban agglomeration in the Guanzhong region has made rapid progress in the past, but the current level it is at is still low. In the future, the potential of the city sports industry can be further unlocked through industrial coordination, and the level of sports industry development in each city can be balanced as far as possible, thus promoting the transformation of the sports industry in the Guanzhong region to a high level of synergy.

Keywords: Sports industry · Coupling Coordination Model · Entropy method · Guanzhong region

1 Introduction

In recent years, the contribution of the sports industry to economic development has become increasingly evident, and the pursuit of synergistic development of the sports industry within regions has become an emerging trend. The Chinese central government explicitly requires that the sports industry will be constructed as a pillar industry of the national economy in 2035.

However, the stage of development of the sports industry varies from region to region in China due to the location advantages and economic base of different regions. There are significant differences in the level of development of the sports industry between different regions [1]. According to existing studies, there are synergistic effects between industrial development and economic development. For example, Debbage (1999) studied the industrial structure of the US air transport industry and found that the degree of economic development in different regions can have different impacts on the local air transport

industry and that there is close coordination between them [2]. Lan & Zhong (2018) took the level of economic development of the city and the level of development of the logistics industry as the research object and found that there is a synergistic relationship between the level of economic development and the development of the logistics industry through statistical tests, and can have a positive impact on the development of the logistics industry [3]. Gibson, Kaplanidou & Kang (2012) analyzed the coordination relationship between sporting activities, the tourism industry, and economic development, and they found that many small sporting events such as marathons, ball games, and other sports can pull in the local tourism industry, which in turn brings economic benefits to the community and drives economic development [4].

Based on the study of economic-industrial coordination development, Porter (1983) introduced the concept of coordinated industrial development and used coordination theory to explain the interrelationships between complex systems [5]. Perona & Saccani (2004) argue that building on existing resources by adapting technology, redistributing resources and benefits, and changing business models can improve profits or reduce costs [6]. The process is industrial synergy, which fosters new industries, contributes to the overall industrial competitiveness of the region, and generates regional competitive advantages, thus reducing the gap between regional economic development [7, 8].

In recent years, scholars have made recommendations for the economic growth and industrial layout of specific regions' industrial synergies theory. For example, Xu et al., (2020) studied the coordination development status of the sports industry and health service industry, adopting the thirty-one provinces, municipality cities, and autonomous regions of China from 2013 to 2017 as the analyzed object [9]. Yuan & Liu (2019) calculated the level of development of industrial coordination in Guangdong Province through the entropy method and coordination degree model by taking the sports industry and tourism industry of Guangdong Province as the research object [10]. The results show that the level of integrated development of the tourism and sports industry is high, but the degree of coordination needs to be improved.

Research cases on the coordination development of the sports industry within China have mainly focused on the more economically developed regions such as the Yangtze River Delta, Beijing-Tianjin-Hebei, and the Wuhan city circle [11]. In the existing literature, there is less research on the coordination development of the sports industry in the Guanzhong region, which therefore merits analysis.

It is important to study the extent of the coordinated development of the sports industry in the Guanzhong region and the development path, to assess the current degree of industrial coordination and to explore the gaps between individual cities. This study will not only provide suggestions for the restructuring of the sports industry in the Guanzhong region but also enable the layout of the sports industry in the Guanzhong region from a system-wide perspective, which will have a positive impact on the synergistic development of the sports industry in the Guanzhong region.

This paper analyses coordination development of the sports industry in the Guanzhong region through the entropy weighting method and the coupled coordination degree model.

The Guanzhong region includes Xi'an, Baoji, Tongchuan, Xianyang, Weinan, and the Yangling Demonstration Zone. Due to the few statistics that can be found for the Yangling

Demonstration Zone, we combine the data for the Yangling Demonstration Zone with Xi'an for calculation. We take the five cities as subsystems, and select data related to the sports industry in the Guanzhong cities between 2011 and 2020 to establish the index system. The index weights are determined through the entropy weighting method, and then the degree of coordination of the sports industry between each city and the Guanzhong City Cluster is analyzed. The results show that between 2011 and 2020, the coordinated development of the sports industry in the Guanzhong urban agglomeration has been increasing, but the current level of coordination is still low, and there is a need for reasonable layout and industrial coordination, so to improve the level of coordination development of the sports industry.

The rest of the paper is organized as follows: Sect. 2 introduces the research methodology and the data sources of the paper, Sect. 3 selects five cities in the Guanzhong region as the subject of the empirical study, and Sect. 4 obtains the conclusions of the paper based on the results of the empirical analysis.

2   Research Methods

2.1   Coupling Coordination Model

The coupling coordination model is used to analyze the level of coordinated development of things. The degree of coupling refers to the dynamic correlation between two or more systems that interact and influence each other to achieve coordinated development and can reflect the degree of interdependence and mutual constraints between systems. The formula of coupling degree C as follows

$$C = \left[\frac{\prod_{i=1}^{m} U_i}{\left(\frac{1}{m} \sum_{i=1}^{m} U_i \right)^m} \right]^{\frac{1}{m}}, \tag{1}$$

where m represents the number of subsystems. The degree of coupling coordination D can be expressed as $D = \sqrt{C \times T}$, $T = \{T_i\}_{i=1}^{m}$ is the comprehensive evaluation index. Here we set each city as subsystem, and T_i is the weighting factor corresponding to the i - th city. The value of T_i is set according to the percentage of the number of sports population in each city in the Guanzhong region.

2.2   Entropy Method

The entropy method is a mathematical method used to determine the degree of dispersion of an indicator. The greater the degree of dispersion, the greater the influence of the indicator on the overall evaluation. The entropy value can be used to determine the degree of dispersion of an indicator.

The degree of influence of the sequence parameters on the system is related to their values and their importance. In order to scientifically and reasonably assess the synergistic development of the coordination of the sports industry in the Guanzhong

region, it is necessary to assign weights to the indicators established in the previous paper. In this paper, in order to ensure the rationality and scientific nature of the evaluation of the indicators, the entropy method is used to assign weights to the indicators, which is calculated as follows

$$E_j = -k \sum_{i=1}^{m} P_{ij} \ln P_{ij},$$ (2)

where $i = 1, \ldots, n, \ j = 1, \ldots, m$ and the E_j is the weight of j - th index, the $P_{ij} = x_{ij} / \sum_{i=1}^{n} x_{ij}$ is the weight of i - th sample in j - th index.

The formula of k is

$$k = \frac{1}{\ln(n)},$$ (3)

where n is the volume of samples. Here we can calcuate the coefficient of variation

$$D_j = 1 - E_j.$$ (4)

The weight value of j - th index can be calculated, the formula is

$$w_j = \frac{d_j}{\sum_{j=1}^{m} d_j}.$$ (5)

3 Empirical Analysis

3.1 Establishment of Evaluation Index System

A scientific and reasonable index system for evaluating the coordination development of the sports industry in the Guanzhong region is a prerequisite for accurate evaluation. According to the previous studies [10, 11], we construct the index system of the sports industry in the Guanzhong region based on the synergistic theory. From the aspects of market level, development potential, and sports population, we have constructed an evaluation index system for the integrated development of the sports industry, which includes 12 indexes.

3.2 Data Source and Processing

According to the evaluation index system of sports industry development, five cities in the Guanzhong region of Shaanxi Province were selected for the study from 2010 to 2020: Xi'an, Baoji, Weinan and Tongchuan. The cities in the Guanzhong region are regarded as subsystems and the overall degree of coordination is assessed according to the coupled coordination degree model. The data were mainly obtained from the Shaanxi Provincial Statistical Yearbook, the Xi'an Statistical Yearbook, the Baoji Statistical Yearbook and

Table 1. The evaluation index system for the coupling coordination of the sports industry

Subsystem	Index
Regional Sports Industry System (Guanzhong region)	GDP per capita (yuan/person)
	Per capita disposable income of residents (yuan)
	Household consumption in sports (yuan)
	Total investment in fixed assets (100 million yuan)
	Growth rate of fixed asset investment (%)
	Growth rate of tertiary industry (%)
	Number of sports population (10 thousand people)
	Number of sporting events held
	Employment in Sports Town Units (10,000 people)
	Number of medals
	Number of athletes increased
	Number of coaches Increased

the official websites of the Shaanxi Provincial Department of Statistics and the Bureau of Sports.

The indicator system constructed in Table 1 covers a number of areas, and each indicator has a different scale, and indicators with large scale differences are difficult to compare. Therefore, it is necessary to standardise the data, so that the data of different indicators can be calculated and processed under a unified standard, and the formula for data standardisation is

$$x_{ij} = \frac{X_{ij} - \min(X_{\cdot j})}{\max(X_{\cdot j}) - \min(X_{\cdot j})}, \tag{6}$$

where X_{ij} is the value of indexes, and $\max(X_{\cdot j})$ is the maximum value j - th indicator, $\min(X_{\cdot j})$ is the minimum value of the j - th indicator.

3.3 Determination of Index System Weight

According to the entropy weighting method, the data of each evaluation index of each city in the Guanzhong region from 2010 to 2020 were used to calculate the weights corresponding to each index, the details are listed in Table 2.

According to the synergistic development model, the coupling coordination degree D ranges from 0 to 1. To better interpret the calculation results, we have divided the coupling coordination according to the degree D, as detailed in Table 3.

We have studied the degree of coordinated development of five cities in the Guanzhong region through the entropy method and the even and coordination model, with result for Xi'an in Table 4.

Table 2. The entropy weight for evaluation index

| Index	Entropy weight
GDP per capita (yuan/person)	0.057
Per capita disposable income of residents (yuan)	0.044
Household consumption in sports (yuan)	0.048
Total investment in fixed assets (100 million yuan)	0.094
Growth rate of fixed asset investment (%)	0.212
Growth rate of tertiary industry (%)	0.034
Number of sports population (10 thousand people)	0.093
Number of sporting events held	0.101
Employment in Sports Town Units (10,000 people)	0.096
Number of medals	0.086
Number of athletes increased	0.065
Number of coaches Increased	0.065

Table 3. The grading of coupling coordination degree

Degee	Grade	Degee	Grade
[0.0–0.1)	Extremely incongruous	[0.5–0.6)	Narrow coordination
[0.1–0.2)	Severe incongruous	[0.6–0.7)	Primary coordination
[0.2–0.3)	Moderate incongruous	[0.7–0.8)	Intermediate coordination
[0.3–0.4)	Mild incongruous	[0.8–0.9)	Good coordination
[0.4–0.5)	Veging incongruous	[0.9–1.0)	Quality coordination

According to the results of the Table 4, the coordination degree of the sports industry in Xi'an shows an increasing trend and is in a state of coordination and development. In 2011 and 2014, the degree of coordination of the sports industry is low, and in 2019 and 2020, the degree of coordination of the sports industry is high. It is possible to calculate the coordination of sports industry development in Tongchuan, Baoji, Yangling and Weinan.

In Fig. 1, we can find that the integrated development of the sports industry in the urban agglomeration of the Guanzhong region. Overall, the degree of coordination development of the sports industry in the Guanzhong region has increased in recent years, but there are fluctuations. According to the classification of the level of coordination of the sports industry in the Guanzhong region urban agglomeration, the mean, maximum and minimum values of the synergy of the sports industry in the Guanzhong region are 0.5166,0.639 and 0.242.

Table 4. The coordination degree of Xi'an

Year	C value	T value	D value	Coordination grade
2020	0.701	0.733	0.717	8
2019	0.746	0.552	0.642	7
2018	0.491	0.415	0.452	5
2017	0.35	0.377	0.363	4
2016	0.648	0.403	0.511	6
2015	0.48	0.372	0.422	5
2014	0.809	0.427	0.588	6
2013	0.776	0.538	0.646	7
2012	0.538	0.403	0.465	5
2011	0.339	0.346	0.343	4
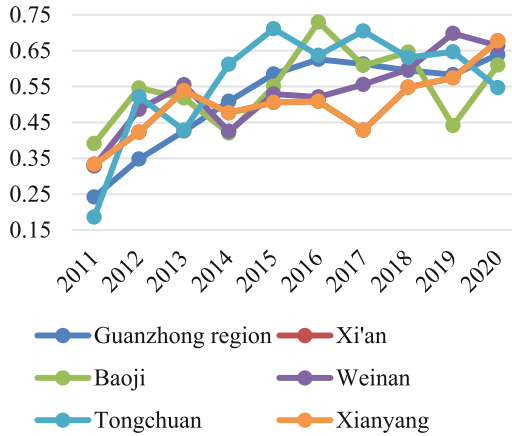
Fig. 1. The coordination development trend of the sports industry in Guanzhong region

The grade of coordination of the sports industry in the Guanzhong region shows a stable growth trend, with a cyclical pattern in some years. The overall mean value of sports industry coordination in the Guanzhong region is 0.5166, with a growth rate of 164.5% in 2020 compared to 2011, with Xi'an and Baoji contributing the most to sports industry coordination and Tongchuan the least. Table 5 lists the coordination development trend of subsystems in Guanzhong region.

In summary, the development of coordination of the sports industry in the Guanzhong region is low. The development is in the transition from mild incongruous to the primary coordination stage, and there is still a large gap from the ideal level of coordination, indicating there is still room for improvement in the level of coordination development of the sports industry in the Guanzhong region.

Table 5. The coordination development trend in Guanzhong region and various subsystems (2011–2020).

Year	Guan zhong region	Xi'an	Bao ji	Wei nan	Tong chuan	Xian yang
2011	0.24	0.33	0.39	0.32	0.18	0.37
2012	0.34	0.42	0.54	0.48	0.52	0.57
2013	0.42	0.53	0.51	0.55	0.42	0.56
2014	0.50	0.47	0.42	0.42	0.61	0.47
2015	0.58	0.50	0.55	0.52	0.51	0.68
2016	0.62	0.50	0.63	0.52	0.63	0.48
2017	0.61	0.42	0.60	0.55	0.70	0.49
2018	0.59	0.54	0.64	0.59	0.63	0.61
2019	0.58	0.57	0.44	0.69	0.64	0.47
2020	0.63	0.67	0.61	0.66	0.54	0.57

4 Conclusions

This paper uses the entropy weighting method to determine the weights of the indicators in the subsystem, then construct the coupling coordination model to measure and evaluate the level of development, and the conclusions as follows:

(1) The level of coordination of the urban sports industry in the Guanzhong region has grown significantly. The hosting of sporting events, related funding, and the growth of the sports population can effectively promote the development of the regional sports industry. However, there are still problems of uneven regional development, such as a small sports population and low funding in Tongchuan. Therefore, in the future, the development level of the sports industry in each city can be improved by promoting fitness for residents.

(2) The level of coordination development of the sports industry in the Guanzhong regional urban agglomeration shows a positive trend, developing from the mild incongruous stage to the primary coordination. Moreover, the degree of coordination at this stage is not high, the coordination degree of the Guanzhong regional urban agglomeration from 2011 to 2020 is 0.5166, the overall is in the narrow coordination stage.

(3) The current degree of integrated development of the sports industry in the Guanzhong region is at a preliminary stage, factors that restrict the development mainly lie in the large differences in the level of development of the sports industry in the different cities. In recent years, fixed asset investment, the size of the sports population, and the size of the sports practitioners of the sports industry in Tongchuan lag behind the average. Therefore, it is important for small cities in the Guanzhong region to effectively combine the sports industry with other local industries and promote the public development of different industries, thus improving the level of industrial development.

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