SWOT analysis for development of sports media industry based on multi-element principal component cluster analysis

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Abstract. With rapid development of Shandong economy and increasing improvement of people's livelihood, Shandong sports industry also develops rapidly. However, Shandong sports industry is still at exploration and development stage. SWOT analysis method of modern management is applied in the Thesis to analyze development of Shandong sports media industry in combination with multi-element principal component cluster analysis. Summarized analysis for internal and external environment of development of Shandong sports industry is realized to find strengths and opportunities, recognize weaknesses and threats and SWOT matrix is built according to SWOT for development of Shandong sports industry. All internal and external environment factors under consideration are matched for combination to obtain a series of optional countermeasures for development of Shandong sports industry.

Key words. Multi-element principal component, Cluster analysis, Sports media industry, SWOT analysis.

1. Introduction

As an emerging industry, sports industry gradually plays a more important role in national economy and has become one of new growth points with the greatest vitality during development of national economy. It has enormous potential and promising development prospect. In recent years, with the 10th National Games of

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Shandong held in 2015 as opportunity, as for Shandong sports industry, bold practice and innovation have been implemented to continuously deepen institutional reform and improve operation mechanism, making Shandong sports industry have considerable progress. Nowadays, in terms of internal environment, Shandong sports industry has been on a large scale and sound sports industry system has been gradually established. In addition, the economic benefit of Shandong sports industry has been improved year by year and the development level of sports industry ranks top throughout the country. However, on the whole, Shandong sports industry is still at exploration and development stage and there are still a series of problems including not strong industrial competitiveness, imbalanced development progress, unsound management system, incomplete laws and regulations. These problems also seriously restrict development of Shandong sports industry. In terms of external environment, Shandong sports industry has experience in holding many large competitions, especially enormous development opportunities brought to Shandong sports industry by Nanjing Youth Olympic Games in 2014. Shandong economy with high-speed development provides enormous development space for Shandong sports industry and current a series of national and provincial policy supports bring favorable development environment; however, it also faces threats from strong challenge of sports industry outside the province and continuous expansion and development of culture and related industries. Hence, it becomes especially important to summarize development status of Shandong sports industry at present and guide direction for further development of Shandong sports industry. An important SWOT analysis method is proposed by modern management during description of plan formulation and implementation. SWOT analysis refers to that comparison among strengths, weaknesses, opportunities and threats of plan implementation must be fully noticed during plan formulation and implementation to help plan makers and implementers predict and make plan and strategy based on SWOT fully utilize strengths, capitalize opportunities, avoid weaknesses and face threats. The author in the Thesis attempts to analyze development of Shandong sports industry with the analysis method of modern management to propose strategy with positive significance.

2. SWOT Analysis for development of Shandong sports industry

2.1. Strengths (S) for development of Shandong sports industry

(1) Large industry scale. In 2006, Shandong sports and related industry realized total output of 50.716 billion yuan, added value of 14.681 billion yuan. The proportion of added value of sports industry in Shandong gross regional domestic product (GDP) was 0.68%; in 2007, Shandong sports and related industry realized total output of 64.053 billion yuan, added value of 19.704 billion yuan. The proportion of added value of sports industry in Shandong gross regional domestic product (GDP) rose to 0.77%. In 2006 and 2007, sports industry practitioners were respectively 295 thousand people and 315 thousand people. Flourishing of sports industry further

satisfies increasingly diversified fitness demand of the masses and also makes proper contribution to economic and social development of Shandong Province. (2) Industrial base is good. In recent years, with increasing improvement of Shandong sports infrastructure, nationwide fitness campaigns in all regions have flourished and sports industry structure is continuously complete to preliminarily form industry system combining sports industry and related industry. In recent years, fitness relaxation, competition performance, sports training, venue service, sporting goods, lottery entertainment and other industries have taken initial shape to become main part of Shandong sports industry. Sports rehabilitation, sports building, sports tourism (sports vacation), sports creativity, sports intermediary, sports media, sports technology and other emerging industries tend to develop fast.

2.2. Weaknesses (W) for development of Shandong sports industry

(1) Not strong industrial competitiveness. Although many development indexes of Shandong sports industry rank first nationwide, in terms of resource allocation, the competitiveness of Shandong sports industry is not strong and lacks band products. Many sports good enterprises in Shandong Province fail to develop new famous-brand products and there is generally problem of old-fashioned variety and inferior quality. All these factors become adverse factors restricting development of Shandong sports industry. (2) Imbalanced development progress. The development of sound sports industry is relatively balanced and there is strong complementarity among all related industries. There is certain chain effect. As for Shandong sports industry, the internal industry structure is unreasonable and products are simple. There are no close lateral linkages among industries and some industries are repeated. On the other hand, there is still difference between development of sports industry in south Jiangsu and north Jiangsu. Layout and structure of Shandong sports industry remain to be further optimized. (3) Unsound management system. At present, as for Shandong sports industry, macro-regulation mechanism, market regulation mechanism and social participation mechanism suitable for development of sports industry are not completely established and related management organizations are also scattered. Government organization implementing macro-management for sports industry is unclear and government management sector is separated. The leadership of central government is poor, causing industrial segmentation and break of value chain. (4) Incomplete laws and regulations. In terms of normalized market management and guarantee system for development of sports industry, laws and regulations of sports industry of the whole Shandong Province are incomplete and a set of complete legislative guarantee system is not built. In development policy of Shandong sports industry, related enterprises fail to be better protected in allowable space. Only through related legislations can some enterprises be prevented from management difficulty owing to vicious competition, thus guaranteeing sound and orderly development from source of market management.

2.3. Opportunities (O) for development of Shandong sports industry

(1) Large competitions bring new development opportunities. In recent years, Shandong Province has held a series of large sports events and successful holding of these large competitions in Shandong Province have far-reaching effect on economic development and social progress in Shandong Province and boost development of Shandong sports industry in the future. Understanding boosts cooperation which facilitates development in return. Communication of Shandong image in the country and in the world will attract more famous enterprises to share the cake of Shandong sports industry and provides wider space for development of Shandong sports industry. (2) Provincial economy provides development space. Since the reform and opening-up, Shandong economy has developed rapidly and people's living standard has been improved continuously. In particular, with the advent of 21st century, Shandong Province continuously keeps high-speed economic growth. In the next time, Shandong economy will keep high growth speed and economic aggregate and per capita GDP of Shandong Province will be improved drastically. All these will provide good foundation and wide spade for development of Shandong sports industry. (3) Policy objective creates favorable environment. Sports industry is aggregate of economic activity providing society with sports products and sports services and it is an important part of modern service industry and advanced manufacturing industry. It has unique functions and purposes in satisfying demand of the masses, adjusting industrial structure, increasing social employment and boosting economic growth. All this creates favorable development environment for development of Shandong sports industry.

2.4. Threats (T) for development of Shandong sports industry

(1) Strong challenge of sports industry in other provinces. Under the overall climate of global economy integration, modernization and urbanization, the development of sports industry in other provinces is also rapid, bringing enormous challenge to development of Shandong sports industry. For example, Shaanxi Provincial Sports Industry Group Co., Ltd. takes sports industry, sports capital operation, sports service industry and featured sports industry as main business and participates in provincial public sports facility construction, public service, sports industry planning of the whole province, industry policy-making and research and scheming of major project. All these bring strong challenge to development of Shandong sports industry. (2) Intervention for expansion of culture-related industry. With gradual increasing of leisure time, people have diversified consumption demand. "National fitness program" further enjoys popular support to continuously increase sports population and sports consumption group is continuously expanding. Accordingly, sports consumption demand is continuously improved. However, under the background of diversified demand of sports consumption market, the market system and structure of sports industry are incomplete, which makes product supply of sports market obviously insufficient and market demand and supply seriously im-

balanced; in addition, owing to high substitutability of cultural industry and other related industry in providing service product with sports product, it will further cause diversion of sports consumption group and seriously influence and restrict sustainable development of Chinese sports industry in the new century.

2.5. SWOT matrix construction

SWOT matrix construction for development of Shandong sports industry is shown in Table 1.

Table 1. Schematic diagram of SWOT matrix construction for development of Shandong sports industry

	(strengths)	(weaknesses)
	1. Large industry scale 2. Good industry foundation	1. Not strong industry competitiveness 2. Imbalanced development 3. Unsound management system 3. Incomplete laws and regulations
(opportunities)	Maximum and maximum countermeasures (SO strategy countermeasures) Carry forward strengths and seize opportunities	Minimum and maximum countermeasures (WO strategy countermeasures) Change weaknesses and seize opportunities
1. Large competitions bring new development opportunities. 2.Provincial economy provides development space 3.Policy objective creates favorable environment	1. Seize competition opportunity and expand scale of sports industry 2. Strengthen policy support and energetically develop industry foundation	1. Optimize industry layout and balance industrial development course 2 Exert market mechanism and improve industry management system
(threats)	Maximum and minimum countermeasures (ST strategy countermeasures) Carry forward strengths and resolve threats	Minimum and minimum countermeasures (WT strategy countermeasures) Resolve threats and change weaknesses
1. Strong challenge of sports industry in other provinces. 2. Intervention for expansion of culture-related industry	1. Highlight features and resist shock of external industry	1. Cultivate high-quality talents and improve industrial competition strength

3. Principal component analysis

Principal component analysis is also called PCA which was proposed by Hotelling in 1933. Principal component analysis is a multivariate statistics method converting multiple indexes to several comprehensive indexes with dimensionality reduction

concept under the premise of losing a little information. Generally, the converted comprehensive index is called principal component. Thereinto, each principal component is linear combination of original variable and all principal components are mutually irrelevant to make principal component have some more excellent performances than original variable. In research of actual problem, to comprehensively and systematically analyze problem, many aspects influencing the problem should be considered and they are called indexes. As each index reflects certain information of the problem under research to a certain degree and indexes may be relevant to a certain degree, there is certain repetition among information reflected by original index. At the time of statistical analysis of multi-index problem, too many indexes will increase complexity of problem research. Hence, in realistic problem research, it is hoped to reflect much information through fewer indexes. Principal component analysis can simplify index through dimensionality reduction, make the problem relatively simple and reduce analysis difficulty of problem, with important significance for researching actual problem.

3.1. *Geometrical significance*

In actual problem research, to reduce analysis difficulty and improve analysis efficiency, generally, p dimension of stochastic vector $X = (X_1, X_2, \cdots, X_p)'$ composed of original indexes (p) is not directly analyzed instead of linear transformation for vector X and original p dimension of stochastic vector is transformed to new aggregate variable $Y_1, Y_2, \cdots, Y_p$. Where the variance of variables $Y_1, Y_2, \cdots, Y_p$ decreases progressively and variables $Y_1, Y_2, \cdots, Y_p$ are mutually independent. Therefore, the purpose of simplifying data structure and improving analysis efficiency is realized at the expense of losing a little information.

Suppose there is N samples and each sample has two observed values, X_1, X_2. Hence, in the coordinate space composed of variables X_1, X_2, the distribution of N samples is of strip shape, as shown in Fig. 1.
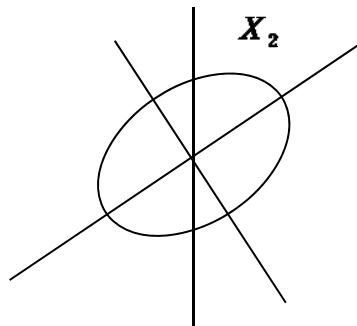

Fig. 1. Distribution of N samples

It can be seen from Fig. 1 that N samples all have trappy discreteness along X_1 axis or X_2 axis and the discreteness can be quantitatively expressed with the variance of variable of X_1 and the variance of X_2. Obviously, if either one of X_1 and

X_2 is considered, information in original data will be lost to a great degree. Hence, it is considered to linearly combine X_1, X_2 to two new variables Y_1, Y_2 through linear transformation. Geometrically, anti-clockwise rotation of θ degree is implemented simultaneously to obtain new coordinate axes Y_1 and Y_2. The coordination rotation formula is as follows:

$$\begin{cases} Y_1 = X_1 \cos\theta + X_2 \sin\theta\,, \\ Y_2 = -X_1 \sin\theta + X_2 \cos\theta\,. \end{cases} \tag{1}$$

The matrix form is:

$$\begin{bmatrix} Y_1 \\ Y_2 \end{bmatrix} = \begin{bmatrix} \cos\theta & \sin\theta \\ -\sin\theta & \cos\theta \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \end{bmatrix} = UX\,. \tag{2}$$

Where, U is rotation transformation matrix. It can be known from above formula that it is a orthogonal matrix. Namely, it satisfies that $U' = U^{-1}$, $U'U = I$.

After such rotation, the discreteness of N samples in Y_1 axis is the largest. Variable Y_1 represents most information in original data. Therefore, at the time of problem research, even variable Y_2 is not considered, it will not damage the overall situation, thus reaching the purpose of dimensionality reduction.

3.2. *Solution to principal component*

Suppose matrix $A' = A$, arrange characteristic values of A $\lambda_1, \lambda_2, \cdots, \lambda_n$ by size. We may as well suppose $\lambda_1 \geq \lambda_2 \geq \cdots \geq \lambda_n$ and $\gamma_1, \gamma_2, \cdots, \gamma_p$ are standard orthogonal feature vectors corresponding to all characteristic values of matrix A. Then for any vector x,

$$\max_{x \neq 0} \frac{x'Ax}{x'x} = \lambda_1, \min_{x \neq 0} \frac{x'Ax}{x'x} = \lambda_n\,. \tag{3}$$

Suppose the covariance matrix of stochastic vector $X = (X_1, X_2, \cdots, X_p)'$ is Σ and $\lambda_1 \geq \lambda_2 \geq \cdots \geq \lambda_p$ is the characteristic value of Σ, with $\gamma_1, \gamma_2, \cdots, \gamma_p$ as standard orthogonal feature vectors corresponding to all characteristic values of matrix A. The ith principal component is:

$$Y_i = \gamma_{1i}X_1 + \gamma_{2i}X_2 + \cdots + \gamma_{pi}X_p\,. \tag{4}$$

Then

$$\begin{aligned} var(Y_i) &= \gamma_i' \Sigma \gamma_i \\ cov(Y_i, Y_j) &= \gamma_i' \Sigma \gamma_j = 0, i \neq j \end{aligned} \tag{5}$$

Let $P = (\gamma_1, \gamma_2, \cdots, \gamma_p)$, $\Lambda = \mathrm{diag}(\lambda_1, \lambda_2, \cdots, \lambda_p)$.

According to above introduction, we respectively take standard feature vectors $\gamma_1, \gamma_2, \cdots, \gamma_p$ corresponding to non-zero characteristic values $\lambda_1 \geq \lambda_2 \geq \cdots \geq \lambda_p > 0$ of covariance matrix Σ of $X_1, X_2, \cdots, X_p$ as factor vector and $Y_1 = \gamma_1' X, Y_2 = \gamma_2' X, \cdots, Y_p = \gamma_p' X$ are respectively called the first principal component, the second principal component......the pth principal component of stochastic vector X. Necessary and sufficient condition for $Y_1, Y_2, \cdots, Y_p$, components of Y successively as

the first principal component, the second principal component......the pth principal component of is that:

(1) $Y = P'X$, namely P is p-order orthogonal matrix;

(2) Y components are mutually irrelevant, namely, D $(Y) = \mathrm{diag}(\lambda_1, \lambda_2, \cdots, \lambda_p)$;

(3) p components of Y are arranged by size of variance, namely $\lambda_1 \geq \lambda_2 \geq \cdots \geq \lambda_p$.

In actual problem, researching multi-index is frequent. However, under most conditions, different indexes are correlated to a certain degree. As there are many indexes and there is certain correlation among indexes, it will inevitably increase complexity of problem analysis. Principal component analysis is a method to handle dimensionality reduction mathematically. Principal component analysis is to try to re-combine original indexes to a group of new mutually irrelevant comprehensive indexes to substitute original indexes and select several fewer comprehensive indexes to reflect information of original indexes a much as possible as per actual need.

3.3. *Cluster analysis method*

(1) System cluster analysis. System cluster method is to firstly take n elements as n types, and then combine two types with the most approximate natures (or the largest similarity degree) to a new type to obtain n-1 type. Then find the most approximate two types to combine into a type to obtain n-2 type. Repeat it until all elements are within a type. The principal methods include: the shortest distance method, the longest distance method, gravity method, group average method and method for sum of squares of deviations (Ward method).

(2) Fuzzy cluster analysis. The calculation steps of fuzzy cluster analysis are as follows:

1. Transform original data. Transformation methods generally include standardized transformation, range transformation, logarithm transformation, etc.

2. Calculate fuzzy similar matrix. Select common similarity factors $r_{ij}^* = \cos(\theta)$ in [-1,1] section to compose similarity factor matrix and transform on the basis of this

$$r_{ij} = \frac{1 + r_{ij}^*}{2}. \tag{6}$$

To make r_{ij}^* compressed to $[0,1]$ section. $R = (r_{ij})$ constitutes a fuzzy matrix.

3. Establish fuzzy equivalent matrix. Provide convolution operation for fuzzy matrix: $R \rightarrow R^2 \rightarrow R^3 \rightarrow \cdots \rightarrow R^n$. After limited number of convolution, make $R^n \cdot R = R^n$ and obtain fuzzy taxonomic relation R^n.

4. Cluster. Given different surrounding level λ, solve R_λ cross-array, find λ display of R to obtain common classification relationship R_λ. When $\lambda = 1$, each sample constitutes a type. With decrease of λ value, make classification from fineness to thickness.

4.   Experiment analysis

4.1.   Spss operation steps

Standardize original data and select Analyze—>Classify—>Hierarchical cluster (system cluster method) in menu options. In system cluster method, select Cases option and cluster samples. Select Agglomeration Schedule in Statistics option and select Whthin-group linkage in cluster method, calculate square Euclidean distance of distance selection and output sha-column diagram and tree-like cluster diagram.
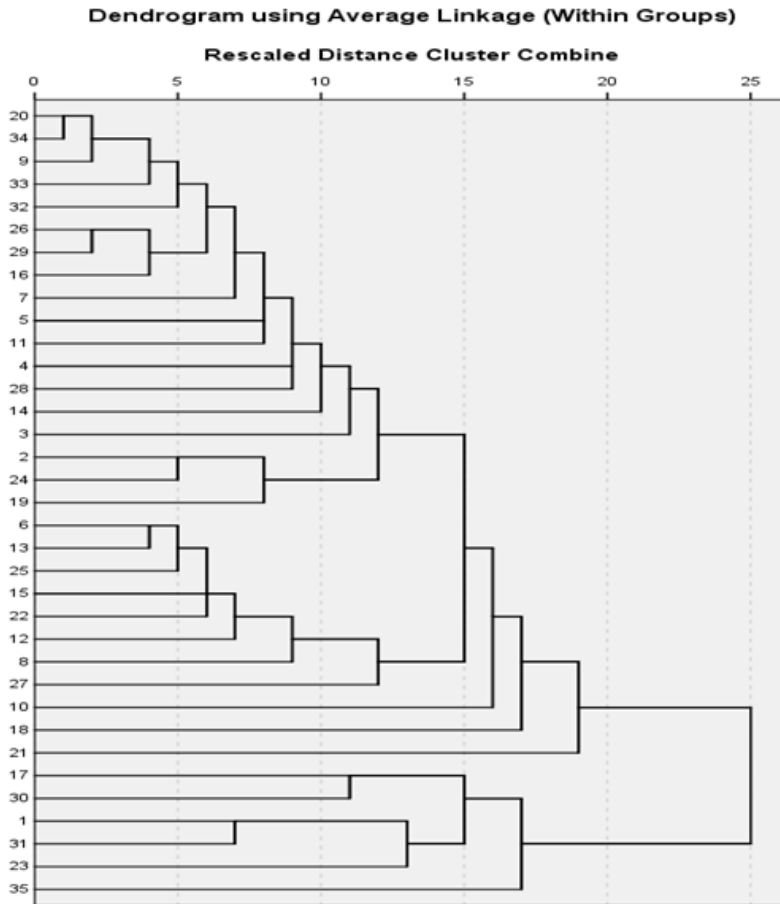

Fig. 2. Tree-like cluster diagram

Classification can be obtained from classification number according to output result Fig. 2, namely tree-like cluster diagram. If the selected classification number is three, we can cut down from the distance of about 18 to obtain the result of two types. In case of four types, we can cut down from the distance of about 17 to obtain the result of three types. In case of five types, we can cut down from the distance

of about 16. It is shown in Table 2.

Table 2. Cluster results

		Cluster Membership		
	Case	5 Clusters	4 Clusters	3 Clusters
	1	1	1	1
	2	2	2	2
	3	2	2	2
	4	2	2	2
	5	2	2	2
	6	2	2	2
	7	2	2	2
	8	2	2	2
	9	2	2	2
	10	2	2	2
	11	2	2	2
	12	2	2	2
	13	2	2	2
	14	2	2	2
	15	2	2	2
	16	2	2	2
dimension0	17	1	1	1
	18	3	3	2
	19	2	2	2
	20	2	2	2
	21	4	4	3
	22	2	2	2
	23	1	1	1
	24	2	2	2
	25	2	2	2
	26	2	2	2
	27	2	2	2
	28	2	2	2
	29	2	2	2
	30	1	1	1
	31	1	1	1
	32	2	2	2
	33	2	2	2
	34	2	2	2
	35	5	1	1

After adopting cluster analysis technology, in the development evaluation of sports media industry, approximate performances are classified into the same type to make up one of defects of traditional classification method "when development of sports media industry is not significantly different, results may be significant different after classification"; variance of each factor with center is distribution relative to the whole, which also correspondingly makes up the second defects of traditional

classification method "failure to reflect distribution of certain factor relative to the whole". Such evaluation result can provide basis for formulating pertinent solutions to development of sports media industry, thus improving development effect of sports media industry.

5. Conclusion

Shandong sports industry also develops rapidly. However, Shandong sports industry is still at exploration and development stage. SWOT analysis method of modern management is applied in the Thesis to build SWOT matrix for SWOT of development of Shandong sports industry, analyze development of Shandong sports media industry in combination with multi-element principal component cluster analysis. Summarized analysis for internal and external environment of development of Shandong sports industry is realized.

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