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Chinese sports product market competitiveness fuzzy evaluation and analytic hierarchy process research

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ABSTRACT

With Chinese sports rapidly development, sports product market competitiveness is also constantly improving, to objective and reasonable evaluate market competitiveness, it needs to construct sports product market competitiveness comprehensive evaluation system, the paper uses analytic hierarchy process method, it makes analysis of sports market competitiveness affected brand loyalty, transmission capacity, price ability, quality capacity these four aspects, and builds solving weight coefficient model, in addition it applies fuzzy mathematics to establish comprehensive evaluation, in order to more clearly present model scientificity, the people takes Chinese super league (CSL), Chinese volleyball association(CVA), Chinese basketball association(CBA) three main associations product competitiveness as examples, and finally it gets three main associations sports product competitiveness respective features, which points out orientations for future researching on sports product market competitiveness. © 2014 Trade Science Inc. - INDIA

KEYWORDS

Sports product;
Market competitiveness;
Fuzzy mathematics;
Analytic hierarchy process.

INTRODUCTION

Since China entering into opening up and reform, especially the 11th Third Plenary Session success holding, chairman Xi Jin-Ping put forward further deep reforming, Chinese all industries are rapidly developing, from which sports product market competitiveness is more intense, so to improve its competitiveness, it should establish a set of completely comprehensive evaluation system.

Regarding sports product market competitiveness researches, many people have made contributions, such as: Zhou Bo discussed core competitiveness sports industries basic principle in sports industries core com-

petitiveness, and made comprehensive analysis and research on Germany, Italy and America as well as other multiple countries' sports core competitiveness, finally it got that establishing correct value thought was fundamental method of sports industries core competitiveness; Ma Cheng Shun analyzed Chinese sports product, analyzed influence factors and established reasonable evaluation system, which provided concrete methods for the research.

The paper is on the basis of previous research, it makes deep analysis and researches on sports product market competitiveness, uses analytic hierarchy process method to define weight, and applies fuzzy mathematics method to make comprehensive evaluation,

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which provides platform for future development in the field.

SPORTS PRODUCT COMPETITIVENESS EVALUATION SYSTEM MODEL

Select reasonable indicators for evaluation system construction

With Chinese Olympic Games success hosting, relative sports product market competitiveness indicators are also changing, combines with Chinese and foreign as well as experts relative experiences, we define to evaluate from brand loyalty, transmission capacity, price ability and quality capacity these four aspects, and set them as first grade evaluation indicators, and for second grade indicators selection, the paper adopts Delphi method, its process is as following Figure 1 show:

To define second grade indicators, the paper selects larger recognition degree indicators to make questionnaire survey, after defining it adopts Likert grade evaluation method to optimize, after two times screening, the paper gets best indicator result, as following TABLE 1 show:

By twice screening, we define nine second grade indicators in above tablet that defined accordingly by relative sports product market competitiveness evaluation indicators.

The paper sorts and concludes on above indicators, by applying analytic hierarchy process method, it defines sports product market competitiveness weights, so that provides theoretical guiding for better measur-

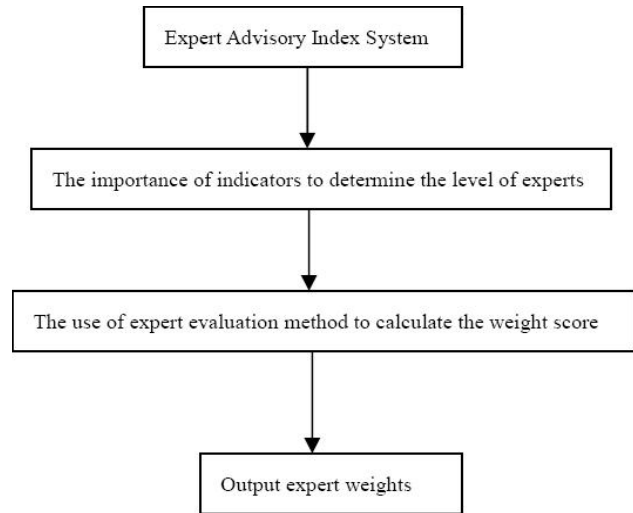


Figure 1: Experts weighting model framework map design ideas

TABLE 1: Sports product competitiveness indicator table

Target layer	Criterion layer	Project layer
Sports product market competitiveness (U)	Brand loyalty (T ₁)	Consumer pleasure (K ₁₁)
		Consumer repeat purchase behavior (K ₁₂)
	Product quality capacity (T ₂)	Consumer repeat purchase trend (K ₁₃)
		Competition competitive level (K ₂₁)
Transmission impact (T ₃)	Product price ability (T ₄)	Competition attraction (K ₂₂)
		Ticket reputation (K ₃₁)
	Product price ability (T ₄)	Ticket popularity (K ₃₂)
		Popularity (K ₄₁)
		Ticket price authorization (K ₄₂)

ing sports product competitiveness, its construction analytic hierarchy process structural model as above TABLE 1 show.

Construct judgment matrix

For above criterion layer’s three kinds of indicators, it makes meticulous comparison of the two’s relative importance to construct judgment matrix. Such as: Take T_i, T_j to make important comparison, the structure is using b_{ij} to express, and then all factors after comparing can get judgment matrix U . Its expression is as following.

$$U = \begin{pmatrix} b_{11} & b_{12} & \cdots & b_{1j} \\ b_{21} & b_{22} & \cdots & b_{2j} \\ \vdots & \vdots & \ddots & \vdots \\ b_{i1} & b_{i2} & \cdots & b_{ij} \end{pmatrix}$$

In formula, b_{ij} the two compared importance uses quantized value to express, uses 1—9 number to describe, number representative meaning is as following TABLE 2 show:

According to above method, we construct first and second grade judgment matrix, in addition, we also respectively implement single hierarchical arrangement

TABLE 2 : 1—9 scale meaning

Scale	Meaning
1	Indicates two factors have equal importance by comparing
3	Indicates the former is slightly more important than the later by comparing two factors
5	Indicates the former is more important than the later by comparing two factors
7	Indicates the former is relatively more important than the later by comparing two factors
9	Indicates the former is extremely more important than the later by comparing two factors
Even number	Represents importance is between two odd numbers
Reciprocal	Represents factors positive and negative comparison order

work, corresponding result is as following TABLE 3 show:

For above process, meanwhile it also draws second grade indicators judgment matrix, as following TABLE 4 show:

Weight vector calculation

According to first grade indicator’s judgment matrix vector, carry out normalization with it; solve the sum and then make normalization, then it can get weight vec-

TABLE 3 : First grade indicator judgment matrix table

U	T_1	T_2	T_3	T_4
T_1	2	3	2	1
T_2	1/3	2	1/2	1/3
T_3	1/4	3	2	1/3
T_4	2	3	2	2

tor. According to feature value and feature vector relations, it can solve feature value; its implementation method is as following:

Firstly, normalize judgment matrix every column, its result is:

$$b_{ij} = b_{ij} / \sum_{k=1}^n b_{kj} (i, j = 1, 2, \dots, n) \tag{1}$$

Then solve the sum by lines on judgment matrix that makes normalization by column, it can get:

$$\bar{W}_i = \sum_{j=1}^n b_{ij} (i = 1, 2, \dots, n) \tag{2}$$

TABLE 4 : Second grade indicators’ judgment matrix

T_1	K_{11}	K_{12}	K_{13}
K_{11}	1	2	1
K_{12}	2	2	1
K_{13}	1	1/2	2

TABLE 5 : RI value table

n	1	2	3	4	5	6	7	8	9	10	11
RI	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49	1.51

Above vector $\bar{W} = [\bar{W}_1, \bar{W}_2, \dots, \bar{W}_n]^T$ proceeds with normalization processing:

$$\bar{W}_i = \frac{\bar{W}_i}{\sum_{j=1}^n \bar{W}_j} \quad (i = 1, 2, \dots, n) \tag{3}$$

Then: $W = [W_1, W_2, \dots, W_n]^T$ is solved feature vector.

According to above formula, we can respectively solve sports product comprehensive assessment analysis first grade indicator, second grade indicator to first grade indicator weight.

Consistency test

To matrix $U = (b_{ij})_{n \times n}$, if matrix element meets $b_{ij}b_{jk} = b_{ik}$, then matrix is straight matrix. Among them, $b_{ij} > 0, b_{ij} = 1/b_{ji}$. In order to use it to calculate factor weight, it requires that matrix inconsistency only under acceptable conditions. When problems are relative complicated, we cannot take all factors into account, which causes paired comparison construct judgment matrix instant, judgment matrix cannot arrive at ideal state consistency.

Judgment matrix consistency indicator CI , and judgment matrix consistency ratio CR , its computational method is as following formula show:

$$CI = \frac{\lambda_{max} - n}{n - 1} \tag{4}$$

Among them, n represent order number of judgment matrix that is also the number of compared factors.

$$CR = \frac{CI}{RI} \tag{5}$$

Among them, RI represents Random Consistency Index value, as following TABLE 5 show.

When $CR \geq 0.1$, it is thought that judgment matrix occurs inconsistency that needs to make adjustment on

TABLE 6 : Criterion layer indicator weight table

First grade indicator	Weight coefficient	Hierarchical weight parameters
T_1	0.386	0.386
T_2	0.098	0.098
T_3	0.156	0.156
T_4	0.365	0.365

TABLE 7 : Second grade indicator weight coefficient table

Second grade indicator	K_{11}	K_{12}	K_{13}
Weight coefficient	0.332	0.415	0.265

TABLE 8 : Sports product market competitiveness evaluation indicator weight table

First grade indicator	Weight	Second grade indicator	Weight	Comprehensive weight
T_1	0.355	K_{11}	0.256	0.112
		K_{12}	0.578	0.212
		K_{13}	0.412	0.151
T_2	0.389	K_{21}	0.312	0.131
		K_{22}	0.414	0.165
T_3	0.165	K_{31}	0.615	0.097
		K_{32}	0.390	0.061
T_4	0.091	K_{41}	0.312	0.032
		K_{42}	0.668	0.059

judgment matrix again. When $CR < 0.1$, judgment matrix inconsistency is within acceptable range.

Single hierarchy judgment matrix conforms to consistency requirements by consistency testing; it can be thought that calculated weight is reasonable. Next step is doing combination consistency testing. The paper selected indicators just go through above process and then get verification result as following TABLE 6 show:

Due to the paper $CR = 0.08 < 0.1$, it proves the paper constructed judgment matrix can pass the test and meanwhile it also proves its weights reliability.

In above TABLE 7, $CR = 0.046 < 0.1$, it proves the paper constructed judgment matrix can pass the test and meanwhile it also proves its weights reliability.

Due to second grade indicators other indicators don't conform to operation software requirements, so the paper carries out evaluation method, it uses following formula:

$$(\text{First grade indicator weight}) * (\text{second grade indicator statistical weight}) = (\text{Second grade indicator comprehensive weight}) \quad (6)$$

By above formula, we can get following TABLE 8:

SPORTS PRODUCT COMPETITIVENESS COMPREHENSIVE EVALUATION MODEL

In order to objective and reasonable scientific evaluate competitiveness status, the paper selects to adopt fuzzy comprehensive evaluation method to make evaluation, its process is as following show:

Establish evaluated object set:

$$X = \{X_1, X_2, X_3\} \\ = \{\text{Volleyball association, Professional basketball association, Chinese super league}\} \quad (7)$$

Among them, let target layer to be:

$$G = \{A_1, A_2, A_3, A_4\} \\ = \{\text{Product price ability, Product quality capacity, Consumer loyalty, Transmission impact}\} \quad (8)$$

Then corresponding criterion layer is:

$$A_1 = \{A_{11}, A_{12}, A_{13}\} \\ = \{\text{Attraction, Competitive level, Consumer physical and psychological pleasure}\} \quad (9)$$

$$A_2 = \{A_{21}, A_{22}\} \\ = \{\text{Ticket price recognition degree, ticket price}\} \quad (10)$$

$$A_3 = \{A_{31}, A_{32}\} \\ = \{\text{Competition reputation, Competition popularity}\} \quad (11)$$

$$A_4 = \{A_{41}, A_{42}\} \\ = \{\text{Consumer repeat purchase behavior, Consumer repeat purchase trend}\} \quad (12)$$

In order to more clearly present merit degree, the paper defines five kinds of evaluation degrees that:

$$V = \{V_1, V_2, V_3, V_4\} \\ = \{\text{Extremely disagree, Quite agree, Disagree, Agree}\} \quad (13)$$

EVALUATION MODEL APPLICATIONS

By above theory, it can get sports product competitiveness judgment comprehensive evaluation method, in order to more clearly present its values, the paper selects Chinese super league (CSL), Chinese volleyball association (CVA), Chinese basketball association (CBA) the three ones as evaluation objects, and adopt weight arrangement method.

If in one layer, m pieces of factors weight calculation result is α_m , corresponding consistency indica-

TABLE 9 : Sports product market competitiveness evaluation indicator scoring table

Evaluation indicator	CSL	CVA	CBA
K_{11}	3.221	2.896	3.121
K_{12}	0.862	-0.996	0.041
K_{13}	3.326	2.724	2.874
K_{21}	3.645	3.123	3.141
K_{22}	3.624	3.216	2.563
K_{31}	3.556	2.845	3.456
K_{32}	3.426	2.817	3.014
K_{41}	3.895	3.298	3.679
K_{42}	3.748	3.214	3.112

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tor value respectively is CI_m , in next layer n pieces of factors to A layer calculation weight is β_{nm} , then in T layer factors total arrangement weight is score status

$$w_i = \sum_{j=1}^m \alpha_i \beta_{ij} \tag{14}$$

By above formula, it calculates each indicator scoring status in total evaluation indicators as following TABLE 9 show:

According to above analytic hierarchy process theory, we can define three associations' product qual-

ity indicator status, as following TABLE 10 show:

By above TABLE 10, it can get basketball association loyalty has advantages over football and volleyball.

Regarding sports product transmission impact aspect status, as following TABLE 11 show:

By above TABLE 11, comprehensively, its football and volleyball reputation aspect is to be further strengthened.

Regarding sports product price status as following TABLE 12 show:

By above TABLE 12, we can easily know above three main associations prices are relatively reasonable.

TABLE 10 : Brand loyalty indicator index table

	T_4		K_{41}		K_{42}		
	Index	Scores	Weights	Scores	Weights	Scores	Weights
CVA	0.996	2.978	0.153	2.978	0.153	2.978	0.153
CSL	1.314	3.562	0.152	3.562	0.152	3.562	0.152
CBA	1.331	3.569	0.144	3.569	0.144	3.569	0.144

TABLE 11 : Transmission impact indicator index table

	T_3		K_{31}		K_{32}		
	Index	Scores	Weights	Scores	Weights	Scores	Weights
CVA	0.512	3.523	0.061	3.523	0.061	3.523	0.061
CSL	0.621	2.756	0.061	2.756	0.061	2.756	0.061
CBA	0.574	3.624	0.061	3.624	0.061	3.624	0.061

TABLE 12 : Product price ability indicator index table

	T_2		K_{21}		K_{22}		
	Index	Scores	Weights	Scores	Weights	Scores	Weights
CVA	0.189	0.042	0.031	0.042	0.031	0.042	0.031
CSL	0.158	-0.996	0.031	-0.996	0.031	-0.996	0.031
CBA	0.223	0.875	0.031	0.875	0.031	0.875	0.031

TABLE 13 : Product quality capacity indicator index table

	T_1			K_{11}			K_{12}			K_{13}	
	Index	Scores	Weights	Index	Scores	Weights	Index	Scores	Weights	Index	
CVA	1.223	3.154	0.131	0.396	3.296	0.156	0.545	2.814	0.112	0.285	
CSL	1.131	3.112	0.131	0.412	3.689	0.156	0.598	2.988	0.112	0.314	
CBA	1.512	3.789	0.131	0.498	3.957	0.156	0.642	3.498	0.112	0.356	

Regarding sports product quality aspect status, as following TABLE 13 show:

By above TABLE 13, we can get that in three associations' sports product quality and scoring status, basketball association level is lower, and singly from product quality, football and volleyball associations aspects index is relative lower, which proves competitiveness is relative poor, but from charms, football league

TABLE 14 : Chinese CBA, CVA, CSL associations market competitiveness index table

Indicator	Score	CVA	CSL	CBA
(T_1)	1.657	0.892	0.896	0.967
(T_2)	2.114	0.998	1.214	1.312
(T_3)	0.798	0.485	0.512	0.568
(T_4)	0.502	0.176	0.245	0.294
Comprehensive index	5	2.651	3.079	3.541

relatively has advantages.

THREE MAIN ASSOCIATIONS' COMPETITIVENESS COMPREHENSIVE EVALUATION MODEL

According to above process, it can make comprehensive evaluation on three main associations, its computational formula is:

$$Y = (A1 + A2 + A3 + A4) = 0.129A11 + 0.162A12 + 0.103A13 + 0.028A21 + 0.061A22 + 0.064A31 + 0.098A32 + 0.148A41 + 0.208A42$$

According to above formula, it can get three main associations four indicators comprehensive index, and divide scores into three cases, from which weak: below 3.0, normal: 3.0—3.5, strong: 3.5—4.5, each indicator total scoring result is as following TABLE 14 show:

In order to more clearly present mutual relations, the paper draws bar figure, as following Figure 2 show:

By above Figure 2, it can know three main associations strong and weak extend in product competitiveness.

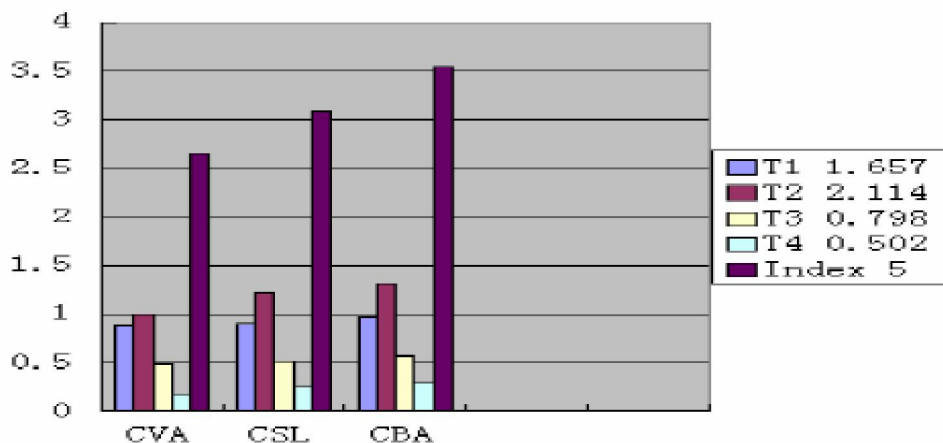


Figure 2 : Our CBA, CVA, CSL League competitiveness indicators index table

CONCLUSION

The paper uses analytic hierarchy process and fuzzy mathematics to make comprehensive evaluation on sports product market competitiveness status, and gets sports product market competitiveness evaluation system, meanwhile combines with three main associations market competitiveness to analyze, finally it get in three major competitions, volleyball association competitiveness index is 2.651 < 3.0, it proves that volleyball asso-

ciation sports market competitiveness belongs to the weakest type; football league competitiveness index is 3.079 ≈ 3.0, it proves that football league sports market competitiveness belongs to the normal type; basketball association (CBA) competitiveness index is 3.541 > 3.5, it proves that basketball association sports market has larger competitiveness.

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