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Chinese sports goods industry independent innovation input and output evaluation research based on fuzzy theory

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ABSTRACT

The paper makes evaluation on Chinese sports goods manufacturing independent innovation on the basis of fuzzy evaluation system, considers sports goods manufacturing scientific and technological achievements use rate, number of independent intellectual property rights patent licensing, research and development fund input proportion of sales revenue, enterprise development fund proportion of sales revenue, scientific and technical staff proportion of number of enterprise staff, scientific and technical personnel reward proportion of staff reward as well as other factors. The paper investigates current Chinese sports goods manufacturing independent innovation development environment, and looks for enterprises existing problems in independent creation, by constructing fuzzy comprehensive evaluation, focuses on sports goods manufacturing enterprises independent innovation, it establishes enterprises independent innovation module. Establish AHP system, and by lots of experiences, make empowerment to enterprises independent innovation influence factors, it gets that independent innovation input and independent innovation output proportions should be respectively 0.75 and 0.25 so as to realize enterprises independent innovation. Therefore Chinese sports manufacturing independent innovation capacity is still in the preliminary stage, the system is also not perfect.

KEYWORDS

Fuzzy mathematics method;
Hierarchical matrix;
Research and development;
Sports manufacturing;
Innovation evaluation.

INTRODUCTION

With Chinese economy increasing, proportion of tertiary industry has become bigger and bigger, Chinese sports goods manufacturing is also accordingly rapid developing, but its development is not smooth, as important tertiary industry, sports goods manufacturing has become important guarantee of sports industry, however, Chinese sports manufacturing still lacks of scientific, unified management, all walks of life hasn't yet formed into organic combination.

Sports industry is genuine sunrise industry, it includes sports material industry and spiritual industry, as one part of national economy, sports industry focuses on market efficiency, pursues economic efficiency. But different from other industries, sports industry has features as improving resident qualities, developing productive forces, realizing individual and national comprehensive

development. Independent innovation is advantageous support of nation's economy, it propels to intellectual property rights forming, is an important path to promote Chinese independent innovation capacity and enterprises competitiveness. In opening era, sports manufacturing independent innovation, however, it includes multiple factors.

Expect establish excellent model to make analysis of Chinese sports manufacturing is a kind of huge and complicated project. We should reference lots of experiences, correctly seize sports manufacturing independent innovation capacities differences, and make evaluation on sports manufacturing independent innovation from multiple aspects.

FUZZY MATHEMATICS METHOD MODEL ESTABLISHMENTS

Performance evaluation system establishment

Performance indicator refers to evaluated objects property indicator, by performance indicator, evaluation objects will have intuitive, detailed expression; by these indicators description, it can indirectly describe system, the paper based on Chinese sports goods manufacturing independent innovation capacity, looks for performance indicators, and established independent innovation module, as Figure 1 show.

Fuzzy evaluation model establishment

This paper adopts fuzzy comprehensive evaluation, it considers multiple factors on that condition, to realize objective layer, and it establishes factor set, judgment set. The paper makes research from independent innovation input, independent innovation output the two main aspects, and constructs evaluation indicator system. Set performance measuring indicator system evaluation set U and selection ranking domain V.

Apply the method, establish evaluation set:

$$U = \{U_1, U_2\}$$

$$U_1 = \{U_{11}, U_{12}, U_{13}, U_{14}, U_{15}, U_{16}\}$$

$$U_2 = \{U_{21}, U_{22}\}$$

According to general evaluation system, define selection ranking domain:

$$V = \{V_1, V_2, V_3, V_4, V_5\}$$

$$= \{\text{excellent}, \text{good}, \text{medium}, \text{qualified}, \text{bad}\}$$

The paper based on analytic hierarchy process analyzes Chinese sports goods manufacturing independent innovation. Establish objective layer, criterion layer, project layer relations.

Objective layer: Chinese sports goods manufacturing independent innovation evaluation A.

Criterion layer: Independent innovation input status B_1, independent innovation output status B_2

Project layer: Current enterprises scientific and technological achievements use rate C_{11}, number of independent intellectual property rights patent licensing C_{12}, R&D fund input proportion of sales revenue C_{13}, enterprise development fund proportion of sales rev-

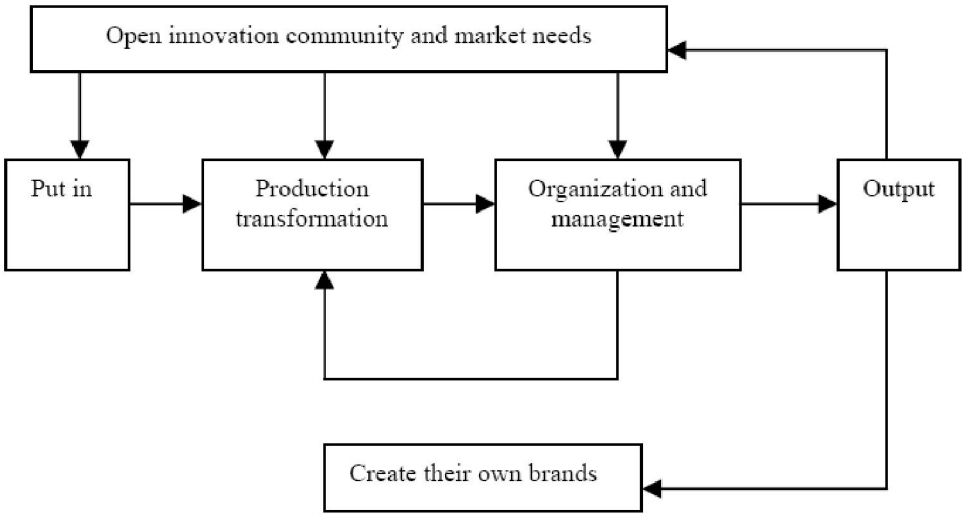

Figure 1: Independent innovation module

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enue C_{14}, each kind of scientific and technical staff proportion of number of enterprise staff C_{15}, scientific and technical personnel reward and enterprise staff average reward proportions C_{16}.

New products sales revenue proportions of all products sales revenue C_{21}, scientific and technical personnel reward and enterprise staff average reward proportions C_{22}, it gets hierarchical structure, as TABLE 1 show. According to TABLE 1, it establishes analytic hierarchy process chart as Figure 2 show.

Hierarchical single arrangement and consistency test

Use consistency indicator to test: $CI = \frac{\lambda_{\max} - n}{n-1}$.

Among them, $\lambda_{\max}$ is comparison matrix maximum feature value, n is comparison matrix order. CI value gets smaller, judgment matrix will get closer to completely consistent. On the contrary, judgment matrix completely consistency deviation degree gets bigger. Among them, RI value is as TABLE 2 show.

(1) For judgment matrix A, $\lambda^{(0)}{}_{\max} = 4.073, RI = 0.9$

$$CI = \frac{4.073 - 4}{4 - 1} = 0.24$$

$$CR = \frac{CI}{RI} = \frac{0.024}{0.90} = 0.027 < 0.1$$

It shows A inconsistent degree within tolerance, now it can use feature vector instead of weight vector.

Fuzzy consistency judgment matrix construction

By indicator(criterion) importance binary compari-

TABLE 1 : Hierarchical structure

Objective layer	Criterion layer	Project layer
Chinese sports goods manufacturing independent innovation evaluation A	Independent innovation input status B_1	Current enterprises scientific and technological achievements use rate C_{11}
		number of independent intellectual property rights patent licensing C_{12}
		R&D fund input proportion of sales revenue C_{13}
		enterprise development fund proportion of sales revenue C_{14}
		each kind of scientific and technical staff proportion of number of enterprise staff C_{15}
		scientific and technical personnel reward and enterprise staff average reward proportions C_{16}
	Independent innovation output status B_2	New products sales revenue proportions of all products sales revenue C_{21}
		scientific and technical personnel reward and enterprise staff average reward proportions C_{22}

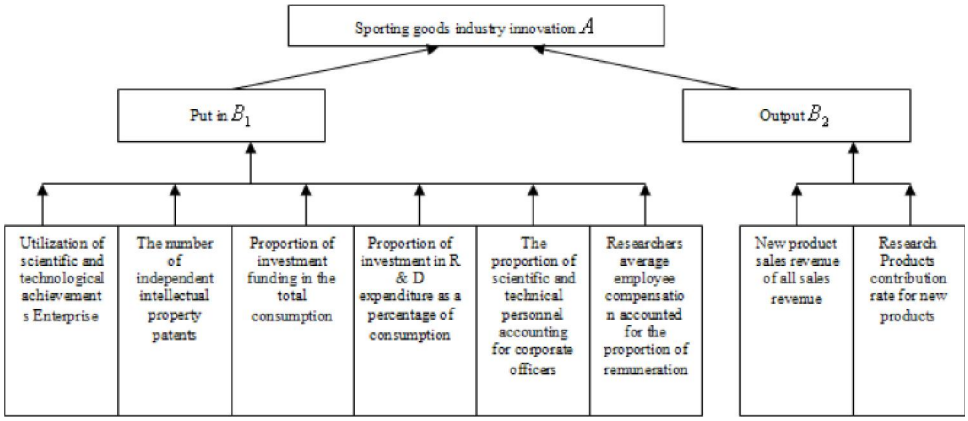

Figure 2 : Chinese sports goods manufacturing independent innovation analytic hierarchy process chart

TABLE 2 : RI value

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

son principle: if indicator(criterion) C_i and C_j carry out important binary comparison, it regulates representative importance qualitative arrangement scale r_{ij} to take values among 0, 0.5, 1.

If $C_i < C_j$, it takes r_{ij} =1, r_{ji} =0;

If $C_j > C_i$, it takes r_{ij} =0, r_{ji} =1;

If $C_i = C_j$, it takes $r_{ij} = r_{ji}$ =0.5.

(1) Firstly for criterion B_1, it provides its included 8 indicators to important binary comparison qualitative permutation matrix as:

$$R = \begin{bmatrix} 0.5 & 0 & 0.5 & 1 & 1 & 1 \\ 1 & 0.5 & 1 & 1 & 1 & 1 \\ 0.5 & 0 & 0.5 & 1 & 1 & 1 \\ 0 & 0 & 0 & 0.5 & 0.5 & 1 \\ 0 & 0 & 0 & 0.5 & 0.5 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0.5 \end{bmatrix}$$

According to theorem, it tests matrix, the first line don't need to test, test starts from the second line elements. $C_{12} = 0 < C_{13} = 0.5$, so that $C_{23} = 1$ meets requirement, similarly it can verify the second line all other values meet requirements; The third line elements, $C_{13} = 0.5 < C_{14} = 1$, it deduces $C_{34} = 1$, same as actual value, it meets requirements, similarly it can verify the third line elements meet requirements. Similarly it can verify other elements in table, till they meet consistency test. By testing, constructed matrix meets requirements, no need to adjust.

According to the matrix, solve each indicator weight:

$$R_1 = \begin{bmatrix} 0.5 & 0 & 0.5 & 1 & 1 & 1 \\ 1 & 0.5 & 1 & 1 & 1 & 1 \\ 0.5 & 0 & 0.5 & 1 & 1 & 1 \\ 0 & 0 & 0 & 0.5 & 0.5 & 1 \\ 0 & 0 & 0 & 0.5 & 0.5 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0.5 \end{bmatrix}$$

Combine with predetermined quantity scale relative membership, it provides relative membership vector with regard to criterion B_1:

ω_{10} =(0.7 1 0.7 0.36 0.36 0.09)

After normalization:

ω_1 =(0.22 0.31 0.22 0.11 0.11 0.03)

(2) For criterion B_2:

$$R_2 = \begin{bmatrix} 0.5 & 1 \\ 0 & 0.5 \end{bmatrix}$$

ω_{20} =(1 0.33)

After normalization:

ω_2 =(0.75 0.25)

(3) Relative to objective layer A, for criterion layer B, it provides binary comparison ordered consistency judgment matrix:

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$$R\begin{bmatrix} 0.5 & 1 \\ 0 & 0.5 \end{bmatrix}$$

ω =(1 0.33)

After normalization:

ω =(0.75 0.25)

(4) Synthesize(1)—(3) calculation indicator to objective layer weight q_{ij} :

$q_{ij} = \omega_i * \omega_{ij}$ (when $i = 1$; $j = 1, 2, 3, 4, 5, 6$; when $i = 2$, $j = 1, 2$)

Calculate weight comprehensive ordering vector

At first, calculate all experts provided judgment matrix weight vectors. According to multiple experts provided judgment matrix :

$Ak = (\alpha k_{ij})_{n \times n}$,

According to above steps, establish weight vector:

$wk = \{w_{k1}, w_{k2}, w_{k3}, \cdots, w_{kn}\} (k = 1, 2, \cdots x)$

Here, k represents one expert from them, x represents total number of experts, j represents one objective layer one indicator, n is total number of one objective layer indicators.

Again, calculate weight vector geometrical mean, according to formula:

$$W^{'} j = \sqrt{W_{f1} \times W_{f2} \times k \times W_{fs}}$$

Among them, $W^{'} j$ is x pieces of experts to some objective layer some indicator empowered weight value geometric mean.

Make normalization handling, according to formula:

$$w_j = \frac{w^{'} f}{\sum_{j=1}^{n} W^{'} f}$$

Among them, $W^{'} j$ is some objective layer j indicator weight value after normalization handling with geometric mean. Therefore it gets weights that is composed of $W^{'} j$, it gets hierarchical total arrangement table, as TABLE 3 show.

As TABLE 3 show, we can get that independent innovation input and independent innovation output proportions should be 0.75and 0.25 so as to realize enterprises independent innovation, however, comparing current enterprises' independent innovation input and independent innovation output status, it doesn't look good. Therefore, for Chinese sports manufacturing enterprises, they should enlarge scientific and technological achievements use rate, number of independent intellectual property rights patent licensing, research and development fund input proportion of sales revenue, enterprise development fund proportion of sales revenue, scientific and technical staff proportion of number of enterprise staff, scientific and technical personnel reward proportion of staff reward as well as other factors proportions.

TABLE 3 : Hierarchical total arrangement table

Hierarchy	B_1	B_2	C hierarchical total arrangement result
	0.75	0.25	
C_{11}	0.22		0.17
C_{12}	0.31		0.23 (max)
C_{13}	0.22		0.17
C_{14}	0.11		0.08
C_{15}	0.11		0.08
C_{16}	0.03		0.02 (min)
C_{21}		0.75	0.19
C_{22}		0.25	0.06

CONCLUSIONS

The paper investigates current Chinese sports goods manufacturing independent innovation development environment, and looks for enterprises existing problems in independent creation, by constructing fuzzy comprehensive evaluation, focuses on sports goods manufacturing enterprises independent innovation, it establishes enterprises independent innovation module. Establish AHP system, and by lots of experiences, make empowerment to enterprises independent innovation in-

fluence factors, it gets that independent innovation input and independent innovation output proportions should be respectively 0.75 and 0.25 as well as other factors proportions so as to realize enterprises independent innovation. Therefore we can get that at present, Chinese sports manufacturing independent innovation capacity is still in the preliminary stage, the system is also not perfect. Independent innovation is advantageous support of nation's economy, it propels to intellectual property rights forming, is an important path to promote Chinese independent innovation capacity and enterprises competitiveness. In opening era, sports manufacturing independent innovation, however, it includes multiple factors.

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