Research Article
Research on Influence Factors of Brand Added Value Based on Method of IAHP and DEA

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Abstract: Based on the research of scholars both at home and abroad, this study studies brand added value by using IAHP and DEA and gets some influence factors and its weight. Actual date of HiSense group has been analyzed by using DEA, we analyze its developing efficiency in recent 10 years. The conclusion can improve its brand construction, improve its market competitiveness and influence and has important theoretical and realistic significance.

Keywords: Brand added value, DEA, IAHP, influence factor

INTRODUCTION

Economic added value is based on the original value, is new value which is created by effective labor in the production process. Enterprises get a influential brand which has been accepted by consumer and market recognition through the construction of their reputation and production management and bring the relevant additional value for enterprises, is the enterprise brand added value.

In the market economy environment, the key factor of enterprise survival and development is the ability of gaining resources from outside, this kind of ability is whether the enterprise can get customer's long-term higher returns by lowest cost. The values of product are different in the process of Buying and selling. Assume that the selling price is P and the production cost is C, if P is larger than C, the added value is difference value between P and C.

There has been intensive study at home and abroad for brand added value and get significant research results. Ruichun (2005) analyzed brand strategy of corporation from the angle of intellectual property and achieved good effect. Lihui (2009) studied brand theory and regional development synergistically and get the practical research. Takafumi *et al*. (2007) did a positive research for Japanese brand strategy and the result has important reference meanings to our country social economic development. Dawei and Binbin (2000) have the study on the stimulation additional value with its own method which has a good guidance to similar problem. Rik *et al*. (2004) provide a theoretical and practical approach on brand management with the analysis on Beijing machine press. Runde (2003) have

the analysis on the additional value of product with its innovation analysis which has guidance to the products' value problem. Zhihui (2007) have the detailed study on the added value of product and it's creating way, which has a good meaning to the actual process.

This study studies brand added value by using IAHP and DEA and gets some influence factors and its weight. We analyze its developing efficiency in recent 10 years. The conclusion can improve its brand construction, improve its market competitiveness and influence and has important theoretical and realistic significance.

ANALYSIS OF INFLUENCE FACTORS

Brand added value is more important for the development of enterprises; we should analyze influence factors in the process of its development.

To pursue higher added value, customer demand, product realization, customer concept and connection, competitors and social resources should be considered.

IAHP application in the analysis of brand added value: IAHP is based on AHP, it should get the weight of every factor in the basis of people's subjective judgment. A sheer level model structure includes target C, evaluated elements for target C and decision maker. The decision maker should evaluate those elements reasonably to get a rank for realizing this target.

α_{ij} is the relative importance of A_i against A_j, $a_{ij}>0$, $a_{ij} = 1/a_{ji}$, $a_{ii} = 1$, i, j = 1, 2,…, 9. Specific steps are as follow:

- Structure the judgment matrix A
- Calculate relative importance between factors under a single criterion, calculate the largest characteristic value λ_{max} of A and its characteristic vector $W = (w_1, w_2,\ldots, w_n)^T$
- Normalize $W = (w_1, w_2,\ldots, w_n)^T$, w_i $(i = 1, 2,\ldots, n)$ is the weight of A_i against target element C_k
- Discuss the consistency of the matrix: C.I. = $(\lambda_{max} - n)$ /n-1 then calculate arithmetic mean of characteristic value: R.I.
- We can get consistency ratio according with:

$$C.R. = \frac{C.I.}{R.I.}$$

When C.R.<0.1, we think consistency of matrix is acceptable. From the comparison of importance between two factors, we can use IAHP to escape uncertainty and subjectivity. IAHP adds interval mathematics into AHP, is the same as AHP, the difference is construction and solution of judgment matrix. It is as follow:

Solve characteristic value and characteristic vector of judgment matrix. $A = (a_{ij})_{n \times n}$ is interval matrix, $a_{ij} = [a^-_{ij}, a^+_{ij}]$, where $A^- = (a^-_{ij})_{n \times n}$ is the lower limit of important factors, $A^+ = (a^+_{ij})_{n \times n}$ is the upper limit of important factors. So, $A = [A^-, A^+]$. The same: $X_i = [X^-_i, X^+_i]$, let $X^- = (X^-_1, X^-_2,\ldots, X^-_n)^T$, $X^+ = (X^+_1, X^+_2,\ldots, X^+_n)^T$. $A\lambda = x\lambda$, where λ is the characteristic value and x is the characteristic vector. λ^- and λ^+ are the characteristic values of corresponding matrix and X and X are corresponding characteristic vectors. $x = [kx^-, mx^+]$ are all characteristic vectors for corresponding λ, where,

$$k = \sqrt{\sum_{j=1}^{n} \frac{1}{\sum_{i=1}^{n} a^+_{ij}}} \qquad m = \sqrt{\sum_{j=1}^{n} \frac{1}{\sum_{i=1}^{n} a^-_{ij}}},$$

Calculation method of IAHP is:

- Calculate judgment matrixes A^- and A^+ and get corresponding characteristic vectors X^- and X^+.
- Calculate k and m and bring into $x = [kx^-, mx^+]$.
- Choose factors which have high impact factor and rank them.
- Consistency check, the same as AHP. When C.R.<0.1, we think consistency of matrix is acceptable.

The application of DEA in the analysis of brand added value: DEA was advanced in 1978 by operations researchers. In this method, C^2R is a basic model of DEA, suppose that there are n decision unit. For every decision unit, there are m types of input and s

types of output. x_{ij} is the quantity of input i against decision unit j, y_{rj} is the quantity of output r against decision unit j. v_i is a measure against input i, u_r is a measure against output r. where $x_{ij}>0$, $y_{rj}>0$, $v_i \geq 0$, $u_r \geq 0$ $i = 1, 2,\ldots, m$, $r = 1, 2,\ldots, s$, $j = 1, 2,\ldots, n$. The model is:

$$(D)\begin{cases} \min \quad \theta = V_{D_1} \\ s.t. \quad \sum_{j=1}^{n} X_j \lambda_j + S^- = \theta X_0 \\ \qquad \sum_{j=1}^{n} Y_j \lambda_j - S^+ = Y_0 \\ \lambda_j \geq 0 \, (j = 1, 2, \cdots, n), S^+, S^- \geq 0 \end{cases}$$

For model C^2R, we define DEA as follow:

- For linear programming D, the optimal solutions w^0 and μ^0 satisfy $V_D = \mu^{0T} Y_0 = 1$, thus DMU_{j_0} is weak DEA efficiency.
- For linear programming D, the optimal solutions w^0 and μ^0 satisfy $V_D = \mu^{0T} Y_0 = 1$ and w^0 and $\mu^0>0$, thus DMU_{j_0} is DEA efficiency.

So, if DMU_{j_0} is DEA efficiency, DMU_{j_0} is weak DEA efficiency.

ANALYSIS OF BRAND OPERATION BASED ON SYSTEM DYNAMICS

In economic globalization era, brand strategy has become a tool for transnational company controlling global market. But our independent brand operation are facing many foreign aggression, the enterprise has the lack of independent research and development ability. Enterprise independent brands have the lack of core technology support and can't have high added value, only can earn little profit at the low end of industry. Our independent brand operation ability is low; this has restricted the sustainable development of Chinese enterprises.

Related concepts of independent brand operation: The brand is a kind of independent resources and capital, it is to carry out the operation and at the same time, the brand is also a kind of intellectual property, it can seem like capital operation, so as to realize the value. The brand will make people has deeper better impression through the enterprise reasonable operation, form a huge intangible assets, it means that the wealth which is brought by the brand assets for the enterprise is countless. The independent brand heads from its core technology which is owned by the independent innovation is the core technology ownership and right of autonomy which is formed by independent
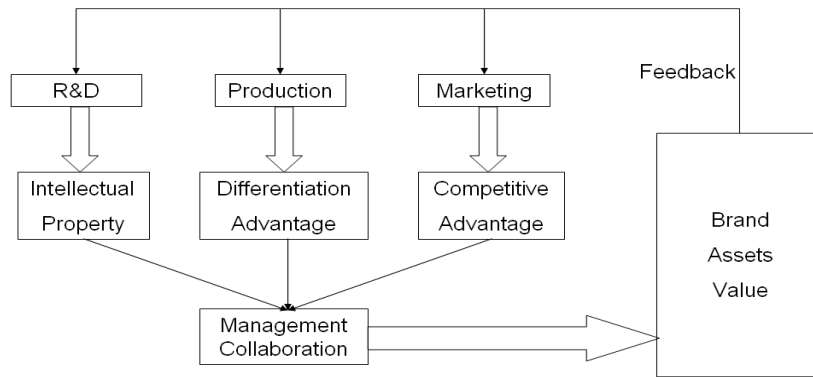
Fig. 1: The model of enterprise independent brand operation ability system

intellectual property. The independent brand is the comprehensive competition power which is synthesized by the enterprise independent research, human resources, financial capital, management, enterprise culture, product quality and marketing strategy. The independent brand is not only the ownership of the independent brand, but also the independence of enterprise brand operation ability, is the result of allocation through a series of operating activities on their own efficient allocation of resources. Enterprise independent brand cannot be separated from the support of enterprise operation management activities.

Structure analysis of independent brand operation: The enterprise independent brand operation ability system can be divided into R&D, production and marketing deconstruction. It breaks through the traditional brand marketing limitations, pays attention to the view of technology innovation system, pursues the system target which is brand power and the realization of brand value, gets innovation means of management synergy for system. In R&D subsystem, enterprises integrate various resources for creative design and research activities, transform the new creative and new technology into technical standards, blend the core technology in the sample and form the sample which has the advantages of intellectual property rights. The production subsystem ensures product quality and products have the difference advantage. In marketing subsystem, enterprises will be supported by the core technology, import products having difference advantage into market and get the formation of goods which have the market competitive advantage. Enterprise independent brand operation ability system can realize the goal of brand assets value through the management synergy of those three subsystems. The model of enterprise independent brand operation ability system is shown in Fig. 1.

The dynamic model of enterprise independent brands: According with system dynamics, we see the independent brand operation ability system as a non-linear complex system. Try to analyze the interaction among R&D, production and marketing subsystems and the formation mechanism in the process of forming brand equity and to find out the feedback for 3 subsystems. When we build SD model for the independent brand operation ability system, we don't consider the change of elements in unnamed independent brand operation ability system and the time lag between elements and independent brand operation ability system. The enterprise independent brand operation ability system is consisted by three subsystems, the interaction between the elements of subsystem promotes the brand assets value, the realizing of goals has the feedback effect for each subsystem.

Research and development, production and marketing subsystem are associated interaction. Technology innovation activities can form unique products, can lead the market and promote enterprises to develop new markets. The shorter the life cycle of production subsystems is, the more agile the supply is and contributed to the establishment of a good relationship between supply and marketing network and can provide a more immediate and accurate information for demand analysis. At the same time, marketing has the feedback effect for R&D subsystems. The information from demand analysis is the source of enterprise development ideas and can guide the direction of enterprise R&D activities. This makes management synergy between R&D and marketing subsystems become the focus of the system innovation, the enterprise should grasp the market demand and create the market demand. Only in this way, the enterprise can win the brand competition.

The brand assets value system is composed of three subsystems. According to the analysis of the marketing theory against the consumer purchasing process, the brand awareness which is established and promoted through the demand analysis by the enterprise can promote the new product for the identity and guide potential customers to be interest in buying behavior. When consumers buy the product, they have the overall

feeling of the new product high grade which is given by the guarantee good quality of enterprise production subsystems and R&D subsystems, then have the higher evaluation for the good experience and promote the formation of brand reputation. On the basis of brand reputation, enterprise development ideas and technical standard support product uniqueness, strength the extension and association from consumers to the brand and form brand trust. So consumers have a long-term stable consumption behavior and then form the brand loyalty. The enterprise establishes brand equity and gets brand value borrowing from the brand assets operation.

Enterprise independent brand operation ability system is a cycle system, the goal realization of the brand assets value has the feedback effect for three subsystems, can improve the independent brand operation ability. The brand assets value is mainly embodied in relationship value and power value. The relationship value means to establish, maintain and develop the input of a long-term relationship between independent brands and consumers and brings the interests value for the consumer and enterprise. The enterprise keep long-term relationship with consumers, then can be able to maintain market stability against competitors and the cost is far lower than the paid price of attracting new customers. The power value refers to getting benefit through the exercise and use of brand power. The brand power is the organic unity of the legal power and market power, but its most important part of the value composition is the of market power value, is reflected by the market control which is formed by consumer brand trust and loyalty form consumers. Enterprises can get huge excess profit relying on this kind of control and feedback for each subsystem.

POSITIVE ANALYSIS FOR INFLUENCE FACTORS

Analysis of importance for influence factors: Establish relevant hierarchical analysis model, it should be seen in Fig. 2.

The research on influence factors of brand additional value could be divided into enterprise, consume and compete. After establishing hierarchical structure, we should calculate local weight of hierarchical structure, then we should establish judgment matrix. Calculate the weights of B_1, B_2, B_3 against A.

Calculate corresponding characteristic vectors:

$$x^- = \begin{bmatrix} 0.691 & 0.160 & 0.149 \end{bmatrix}^T \quad \lambda_1 = 3.006 \quad CR = 0.005$$

$$x^+ = \begin{bmatrix} 0.758 & 0.151 & 0.091 \end{bmatrix}^T \quad \lambda_2 = 3.032 \quad CR = 0.028$$

So, the average value of CR is 0.0165 and it is less than 0.1, the consistency is acceptable.

Fig. 2: Hierarchical chart
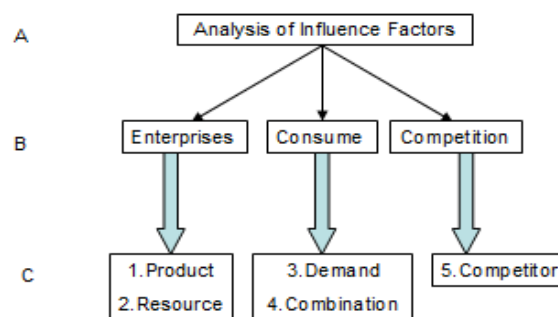
Table 1: Interval judgment matrix

A - B	B_1	B_2	B_3
B_1	[1.000, 1.000]	[4.000, 6.000]	[5.000, 7.000]
B_2	[0.167, 0.250]	[1.000, 1.000]	[1.000, 2.000]
B_3	[0.143, 0.200]	[0.500, 1.000]	[1.000, 1.000]

Table 2: Efficiency analysis of Hisense group in 2002-2011

Year	crste	vrste	Scale	
2002	0.386	1.000	0.386	irs
2003	0.242	0.628	0.386	irs
2004	0.090	0.200	0.453	irs
2005	0.638	1.000	0.638	irs
2006	0.285	0.416	0.685	irs
2007	0.730	1.000	0.730	irs
2008	0.135	0.350	0.386	irs
2009	0.332	0.364	0.913	irs
2010	1.000	1.000	1.000	-
2011	0.910	1.000	0.910	drs
Mean	0.475	0.696	0.649	

crete: Technical efficiency; vrste: Scale efficiency; crste = vrste × scale

As is seen in Table 1, the judgment matrix of the level A-B is shown above, with the calculation of IAHP, we can obtain the result.
Using,

$$k = \sqrt{\sum_{j=1}^{n} \left(1 \Big/ \sum_{i=1}^{n} b_{ij}^+ \right)}$$

$$m = \sqrt{\sum_{j=1}^{n} \left(1 \Big/ \sum_{i=1}^{n} b_{ij}^- \right)}$$

we can get k = 1.0073, m = 1.0431.

According with $w = [kx^-, mx^+]$ we can calculate $w = [w_1, w_2, w_3]$.

Because of $m(B_i) = 1/2 (kx_i^- + mx_i^+)$ we can get $m(B) = [0.7434, 0.1593, 0.1225]^T$ they are weights of those three factors.

So, if the enterprise want to increase additional value, if should pay more attention to its own development firstly. The product which satisfy the demand of customers should be manufactured and the resource should be researched, all these are the basic condition for enterprise existing. After having the

foundation, the enterprise needs to focus on the market all the needs of different consumers, so as to make the products more characteristics, increase the product replacement ratio of the product. Enterprises also need to make the proper marketing strategy and establish proper connection for consumers' cognitive and original ideas and enterprise product approval degree will also increase. In the study of their own supply and demand, the enterprise also needs to study the situation of competitors for its better development. The three influential elements of added value are important, but we all must do our own work for surviving and long-term development.

Analysis of factors effect for brand added value based on Hisense group: Hisense group is a communications and related equipment manufacturing industry in China, can be called the biggest one of color TV production enterprise. Face the fierce market competition in recent years, Hisense group increase R&D and adjust the enterprise internal assessment and incentive mechanism rationally, it have made remarkable progress, realize the net profit into the larger growth.

This study collected income and cost data of Hisense group from 2002 to 2011 and analyze those date by using DEA, the result is shown in Table 2.

With the method of IAHP, we can get the efficiency analysis of Hisense group in the data of 2002-2011 (Table 2).

We can see that the scale efficiency is increase by degrees from 2002 to 2009, but the scale efficiency is fixed in 2010 and the scale efficiency is decrease by degrees in 2011. If the combined efficiency equals to 1, this region is DEA efficiency. In the process of research, we can see that Hisense group pays more attention on its own development and R&D, realizes their own unique products and achieved good effect.

CONCLUSION

This study analyzes the influence factors of brand added value by using IAHP and DEA and gets a rank for those influence factors. It shows that the enterprise should pay attention on its own development, different consumer demand and improving the replacement ratio of enterprise products. We analyze its developing efficiency in recent 10 years, we know the importance of brand added value for enterprise efficiency. The conclusion can improve its brand construction, improve its market competitiveness and influence and has important theoretical and realistic significance.

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