# Study on the Optimal Selection and Evaluation System of Enterprises' Key Product

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**Abstract:** A selection and evaluation model of key product is presented on the basis of defining the concept of an enterprise's key product in the paper. Based on the evaluation system of key product, a modified analytic hierarchy process (AHP) method is also put forward.

**Keywords:** key product , evaluation system , AHP

## 1 Introduction

With the transition of market conditions from sellers' to buyers', what the enterprises produce depends on market demand; and the diversity, variability, complexity, and the competitive of market demand directly decides the non-unitary and the non-fixity of the product structure of enterprises. Whether the enterprises could survive and develop or not lies in whether they can supply to the customs with personalized and various product promptly. Various and wide-serial product structure becomes the inevitable trend of enterprises' adaptation to market and the dispersion of risks.

However various and wide-serial product structure increases the complexity of the enterprises management. With a lot of products it is difficult for a company to grasp key points and issues. That led the blindness behaviors in company's decision-making and management. So it is important to analyze product structure. Then the company can take corresponding actions. This is good for a company survival and development.

## 2 The key product of enterprises

The key product of enterprises include the leading product that support the enterprises' current conditions, and the pilot product that play a central role to the development of enterprises. The leading product are the most important products which sustain company's benefit and development in all of the products. To seize company's leading products is equal to seize company's life blood. The pilot product of enterprises refer to the product that decided the enterprises' future, these products which have the advantages of enterprise technology and the potential rapid growth speed, the potential strong market competitive ability and the strong profitability. Seize the pilot product is equal to seize future of the enterprise. So the enterprise should choose reasonable evaluation index, apply scientific evaluation model, and find the leading product and pilot product , implement key cultivation and tilt advantages , which has important significance for upgrading the competitiveness of enterprises and promoting the sustained and rapid development of enterprises.

## 3 The model of evaluation and selection of the key product

Key product's evaluation model is based on three principles: reflect inherent property, scientific evaluation indexes, availability for index data. Specific say, they are economic benefit, social benefit and technical feasibility[1].

### 3.1 The economic benefit

Considering the good economic benefit when the enterprises select the key product, the enterprises must choose those who are so badly need for national economic construction, or shorted in the domestic and international market, this can make high profits , low investment and rapid effectd, ensure marketable product and the vast potential market.

### 3.2 Social benefit

The enterprises have to consider the social benefit. when they select key product, must choose those production as key product that the "high, big, perfect, leading and new" which others can't produce or meet the requirements in quality and technology, this way don't need competing hard for markets and raw materials share, in addition can make full use of the local natural resources, promote the progress of science and technology, expand foreign trade export, increase employment opportunities, in favour of the environment protection.

### 3.3Technical feasibility

When the enterprises choose key product, they should also consider the technical feasibility, and choose those



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which can give full play to their advantages of technology.

## 4. The key product's optimum decision

An analytic hierarchy chart is given according to the above-mentioned key product valuation model. As shown in Fig. 1, the structure is not the conventional symmetric AHP type, but an asymmetric AHP structure with more objectivity and generality. The revised steps of AHP calculation is proposed in the paper.

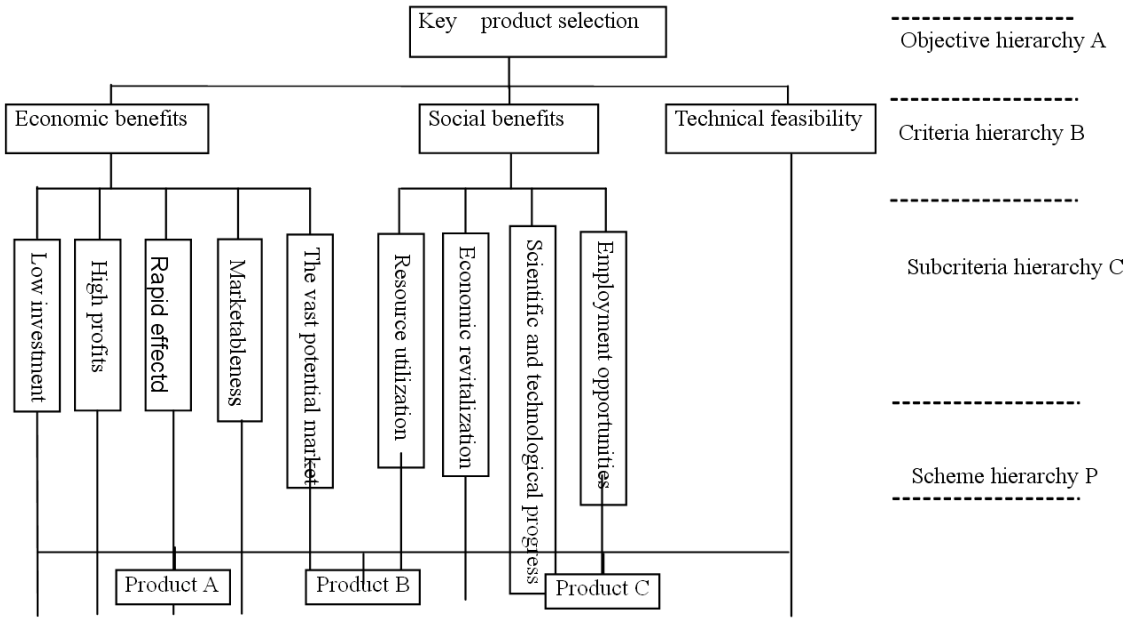


**Figure 1 Hierarchy Model of AHP**

Based on AHP proposed by Satty, T.L.[2], the revised steps break down optimum selection into some hierarchies. First get tow-two judgement matrix, then resolve the asymmetric structure into multiple regular AHP symmetric structures. Calculation starts from the lower hierarchy symmetric structure, to analytical calculation of the successive upper hierarchy symmetric structures. Weight of each scheme to the overall objective can be calculated at last and

thus get the optimal scheme.

### 4.1 Construct AHP hierarchy model

As shown in Fig.1, key product valuation model is made up of top hierarchy A (objective), criteria hierarchy B and subcriteria hierarchy C (criteria involved in achieving an objective through a scheme), bottom hierarchy P (all schemes involved to solve a problem).

### 4.2 Construct a two-two judgement matrix

Delphi method and a 1-9 scale are used to construct two-two judgement matrix due to the impossibility of getting indicators data by statistical method.

### 4.3 Perform system resolution on asymmetric AHP structure to get multiplel symmetric AHP structures (See Fig. 2).

### 4.4 Calculate weights of schemes under $B_1$ to each subcriterion and the comprehensive weight of criterion $B_1$ and perform consistency check. (the same steps are applicable to $B_2$)

1) Normalize each file of the two-two judgement matrix of $B_1$-$C_1$, $C_2$, $C_3$, $C_4$, $C_5$ by sum product method, get the standardized judgement matrix $(\bar{a}_{ij})_{m\times m}$, while $\bar{a}_{ij} = a_{ij} \Big/ \sum_{i=1}^{m} a_{ij}$ （$i, j = 1, 2, \cdots, m$）, m being the number of subcriteria under B1. Summation of each row after normalization is $\bar{w}_i = \sum_{j=1}^{m} \bar{a}_{ij}$. Normalize vector $\bar{W} = (\bar{w}_1, \bar{w}_2, \cdots, \bar{w}_m)^T$,

get weight vector of $B_1$-$C_1$, $C_2$, $C_3$,, $C_4$, $C_5$

$W = (w_1, w_2, \cdots, w_m)^T$.

2） Perform consistency check on $B_1$-$C_1$, $C_2$, $C_3$ $C_4$ $C_5$. Indicator of matrix consistency is C.R= $\frac{C.I}{R.I}$, while C.I is the simplex sequence consistency indicator, whose computing formula is C.I= $\frac{\lambda_{\max} - m}{m-1}$； $\lambda_{\max}$ is the eigenvalue of judgement matrix, whose computing formula is

$\lambda_{\max} = \sum_{i=1}^{m} \frac{(AW)_i}{m \cdot W_i^{(1)}}$, while R.I is the average random consistency indicator, which can be got in Tab.1.

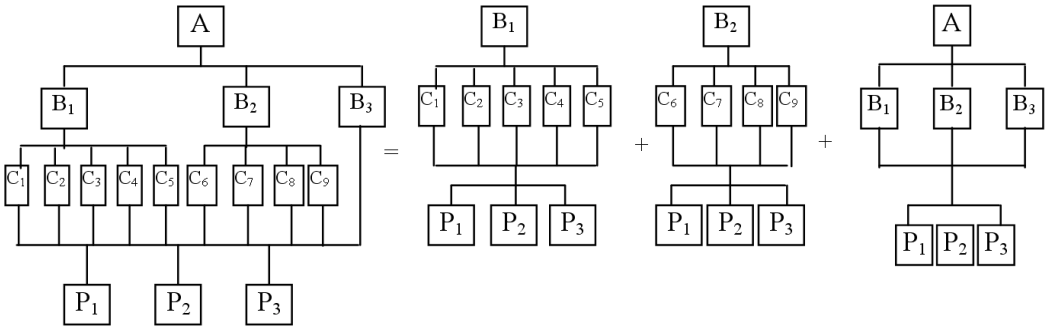


**Fig.2 Multiplel Symmetric AHP Structures**

**Table 1. The Values of *R.I***

| Dimension（$m$） | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| *R.I* | 0.00 | 0.00 | 0.58 | 0.90 | 1.12 | 1.24 | 1.32 | 1.41 | 1.45 |

When C.R≥ 0.1, some numerical value in the judgement matrix need to be adjusted till C.R< 0.1, then the judgement matrix is claimed to have satisfactory consistency. The order of hierarchical simplex value $w_1, w_2, \cdots, w_m$ is the sequence of importance level of a certain factor in its adjaceng upper hierarchy.

3）Comprehensive weight and consistency check on $B_1$-$P_1$, $P_2$, $P_3$. Weight of $B_1$-$C_1$, $C_2$, $_3$ ,$C_4$, $C_5$ calculated from the above-mentioned steps is summation of $W^{(3)} = (w_1^{(3)}, w_2^{(3)}, \cdots, w_m^{(3)})^T$.

Given: Schemes number n in scheme hierarchy P. Simplex sequence to subcriteria hierarchy $C_1$,$C_2$,$C_3$,$C_4$,$C_5$ is $w_i^{(4)} = (w_{1i}^{(4)}, w_{2i}^{(4)}, \cdots, w_{ni}^{(4)})^T$, construct corresponding matrix $W^{(4)} = (w_1^{(4)}, w_2^{(4)}, \cdots, w_i^{(4)}, \cdots w_{m1}^{(4)})^T$, $i = 1, 2, \cdots, m$. Thus get comprehensive weight of scheme hierarchy P to criterion B1:

$W_5^{(2)} = W^{(4)} \cdot W^{(3)} = (w_1^{(2)}, w_2^{(2)}, \cdots, w_q^{(2)}, \cdots w_n^{(2)})^T$, $q = 1,2, \cdots, n$.

See Tab.2 for detailed calculation.

Similar to simplex weight check, comprehensive weight of $B_1$-$P_1$, $P_2$, $P_3$ needs consistency check, and its random consistency ratio $C.R < 0.1$. $C.R$ calculation is $C.R = \sum_{j=1}^{m} w_j^{(1)} .(C.I)_j \Big/ \sum_{j=1}^{m} w_j^{(1)} .(R.I)_j$.

**Table 2. the Comprehensive weight of $B_1$. $P_1$, $P_2$, $P_3$**

| P 层 | $B_1$层及 $C_1$、$C_2$、$C_3$、$C_4$、$C_5$层元素的单层权重 | | | | P 层对 $B_1$ 的综合权重 |
|---|---|---|---|---|---|
| | $w_1^{(3)}$ | $w_2^{(3)}$ | … | $w_m^{(3)}$ | |
| $P_1$ | $w_{11}^{(4)}$ | $w_{12}^{(4)}$ | … | $w_{1m}^{(4)}$ | $w_1^{(2)} = \sum_{j=1}^{m} w_j^{(3)} \cdot w_{1j}^{(4)}$ |
| $P_2$ | $w_{21}^{(4)}$ | $w_{22}^{(4)}$ | … | $w_{2m}^{(4)}$ | $w_2^{(2)} = \sum_{j=1}^{m} w_j^{(3)} \cdot w_{2j}^{(4)}$ |
| ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ |
| $P_n$ | $w_{n1}^{(4)}$ | $w_{n2}^{(4)}$ | … | $w_{nm}^{(4)}$ | $w_n^{(2)} = \sum_{j=1}^{m} w_j^{(3)} \cdot w_{nj}^{(4)}$ |

**4.5 Calculation of simplex weights of $B_2$ to hierarchy P is the same as that of the relative weights of schemes under $B_1$ to subcriteria $C_1$, $C_2$ , $C_3$ , $C_4$ , $C_5$ as illustrated in 4.4.**


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### 4.6 Calculation of comprehensive weight

From the above steps, get weight vector of $B_s$ （ $s = 1,2,....,k$ ） to hierarchy

P: $W_s^{(2)} = (w_1^{(2)}, w_2^{(2)}, \cdots, w_n^{(2)})^T$, $k$ is the number of criteria in hierarchy B. B-P weight judgement matrix is $W^{(2)} = (W_s^{(2)})_{(k \times n)}$. From two-two judgement matrix of A-B get its simplex weight vector $W^{(1)} = (W_1^{(1)}, W_2^{(1)}, \cdots, W_s^{(1)}, \cdots w_k^{(2)})^T$ ， and the final comprehensive weight of each scheme to objective A: $W^{(0)} = (W^{(1)}.W^{(2)})_{(1 \times n)} = (w_1^{(0)}, w_2^{(0)}, \cdots, w_q^{(0)}, \cdots, w_n^{(0)})$ ，（ $q = 1,2,....,n$ ），schemes number $n$.

### 4.7 Selection of optimal scheme

Based on comprehensive weights, the corresponding scheme of $\underset{1 \le q \le n}{Max}\{w_q^{(0)}\}$ is the best one.

## 5 Conclusion

Valuation and selection of key product play an important role in the enterprises. In this paper, a new key product's valuation system and a revised analytic hierarchy process (AHP) method is put forward.

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