

# TOPSIS Tobacco Business Enterprise Based on Entropy Weight Method Cigarette new product evaluation model construction

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**Abstract.** The tobacco industry takes brand as the core of resource allocation of marketing elements, which is an innovative initiative of the decisive role of market resource allocation. Improving the evaluation system of brand specifications is a key link in promoting moderate brand competition and giving play to the core role of brand resource allocation. At present, tobacco commercial enterprises mainly draw on the brand competitiveness evaluation system, but lack of perfect new product competitiveness evaluation system, resulting in brand cultivation is not precise enough, and new product exit is difficult to market. In this paper, by interpreting the connotation of cigarette new product competitiveness of tobacco commercial enterprises, from the perspective of the whole process of cigarette value realisation, the TOPSIS model is used to construct a comprehensive evaluation model for tobacco commercial enterprises that contains three evaluation dimensions of new product development potential, market status and sales volume scale, and the entropy weighting method is used to assign weights to the seven secondary indicators, so as to provide a solid foundation for the precise cultivation of brands, the evaluation of new products and the market-oriented elimination mechanism of tobacco commercial enterprises. It provides a solid foundation for tobacco commercial enterprises to accurately cultivate brands and improve new product evaluation and market-based elimination mechanism.

**Keywords:** Tobacco commercial enterprise; new product evaluation; entropy weight method; TOPSIS evaluation method.

## 1. Introduction

The competitiveness of new products of tobacco commercial enterprises is mainly reflected in the ability of new products to meet market demand and bring benefits to relevant stakeholders such as commercial enterprises, retail customers and consumers. Due to the different geographical distribution of tobacco commercial enterprises, there are obvious differences in market demand in different regions, and the same new product may show different levels of competitiveness in different regions. Therefore, the new product competitiveness of a commercial enterprise specifically refers to the ability of the new product to meet the requirements of the market covered by the commercial enterprise. In addition, tobacco commercial enterprises face both the retail customer market and the consumer market, so the competitiveness of new products should reflect that the new products can meet the needs of these two markets [1-3].

The evaluation of new products is based on the evaluation index library provided by the provincial company, and based on the three evaluation dimensions of development potential, market status and sales volume scale during the evaluation period, combined with the local actuality, seven secondary indicators are scientifically selected and assigned corresponding weights[4-6]. They are estimated gross profit margin, local sales contribution, local onboarding rate, repurchase rate, ordering rate, market sales rate and price index. Except for the market sales rate and price index, which are extracted from the price collection system, the rest of the indicators are retrieved from the marketing system [7].

## **2. Analysis of the current situation of new product management**

### **2.1. Analysis of the Current Situation of CZ Tobacco Cigarette New Product Management**

In the current ever-changing market environment, enterprises in order to enhance the core competitiveness of the market will generally carry out new product construction work. Through such work, consumers are constantly divided into categories, and then constantly discover new target consumer groups from the market, and strive for more users and market share. Therefore, as an important construction means of brand strategy, more and more enterprises hope to seize opportunities in the market through new product construction [8-10]. Of course, the cigarette industry is also the same. New product management is an important part of brand building, which requires companies to firstly scrutinise and record the brand specifications of cigarettes to provide an information base for new product management. In addition, it is also necessary to collect information on different cigarette brands, compare brand strengths and weaknesses horizontally/vertically, determine the brand's competitive advantages and weaknesses, and form an annual brand cultivation strategy so as to continuously improve the efficiency of brand management work.

### **2.2. CZ Tobacco Cigarette New Product Management Problems**

#### **(1) New product layout needs to be optimised**

At present, the city in the sale of cigarettes in more than 150 specifications, is still in a state of excess, to adapt to the high-quality development of the brand planning, new product layout has yet to be established, brand evaluation mechanism, brand in and out of the rules need to be further improved. The layout of new products is not reasonable, the brand ladder has not yet formed, the focus of cultivation is not clear enough, the cultivation method is relatively sloppy, the lack of innovative means and other issues are still relatively prominent. The traditional development momentum has weakened, the industry's traditional dominant specifications in some regional market development is hindered, the state of the weak, the new kinetic energy has not yet been fully formed, the survival rate of new products is not high, most of the new market performance is general, optimising the brand ecology, conversion of old and new kinetic energy needs to be studied in-depth.

#### **(2) New product management is not reasonable**

The current management of new cigarette products is not reasonable enough, mostly based on work experience, without scientific basis for evaluation, making the results unconvincing. The special background of the tobacco industry, such as high gross profit, people are likely to be driven by the interests of personal feelings into the work, affecting the normal business operations. Part of the unit there is also obvious local protectionism, in order to tax and other aspects of interest in favour of supporting local cigarette brands, foreign brands to set a high threshold of entry, which protects the local brand, but disrupted the market competition system, the development of emerging cigarette brands struggling, the current situation of the unreasonable structure of new cigarette products is difficult to be effectively improved.

#### **(3) New product evaluation is not yet comprehensive**

Although CZ Tobacco Commercial Enterprises has certain working basis and results, for example, it has established institutions and departments in charge of new product management, and also designed the organisational system of these departments, and established and operated the information system related to new product management, there are still some shortcomings. For example, the new product evaluation system and related decision support system have not yet been established. At present, the analysis indexes of new product management mainly come from the annual cigarette sales data, and seldom consider consumer feedback from the perspective of consumer demand. It is rather one-sided to analyse sales volume changes and their reasons purely from information received from suppliers and customers. Therefore, in order to achieve the long-term development of new cigarette products, the company must establish a more scientific new product evaluation system with the support of the existing information system, select appropriate evaluation

indicators and make analyses, so as to provide a scientific and reasonable basis for decision-making in the implementation of the cigarette new product management strategy.

### 3. Model Building

#### 3.1. Construction of Cigarette New Product Evaluation Indicator System for Commercial Enterprises

(1) The evaluation of new products is based on the evaluation index library provided by the provincial company, with three evaluation dimensions of new product development potential, market status and sales volume during the evaluation period, combined with the local actuality, scientifically selecting seven secondary indicators and assigning the corresponding weights, which are the estimated gross margin, local sales volume contribution, local on-store rate, re-purchase rate, ordering rate, market sales rate, price index, except for the market sales rate and price index, which are extracted from the price library collection system, the remaining indicators are data retrieved from the marketing system. Except for the two indicators of market mobility rate and price index, which are extracted from the price collection system, the rest of the indicators are retrieved from the marketing system.

(2) According to the needs of brand evaluation, on the basis of the approved industrial, commercial and category upper limit widths, analysis and sorting were carried out, and then scientific evaluation was carried out at the level of category and gauge. Finally, the three third-level indicators that are more controversial are deleted, and the expression of one second-level indicator is adjusted, and a hierarchical system of evaluation indicators containing three first-level indicators and seven second-level indicators is finally sorted out (see Table 1).

**Table.1.** Cigarette new product regulation evaluation index system.

Target Layers	Middle Layer	Base elevation	Combined weights
Tobacco business enterprise new product evaluation	New Product Development Potential	Estimated gross margin	Determination of weights according to the entropy weighting method
		Local sales contribution	
	market state	local on boarding rate	
		repurchase rate	
		fully booked	
	Volume size	market share	
		price index	

(3) There are seven specifications for the evaluation of new products (on sale for more than six months and less than one year), namely, Zhonghua (Fine Branch) 97S hard box, Zhonghua (Golden Fine Branch) 97S hard box, Liqun (Leisure Fine Branch) hard box, Huangshan (New Medium Branch with Red Square Printing) hard box, Hibiscus King (Hard Medium Branch) 89S hard box, Guiao Zi [Chuan] (Good Luck with Wide and Narrow Branches) hard box, and Diamond (Soft Lotus Flower) soft box.

(4) Calculation formula for relevant indicators

Estimated Gross Margin: Estimated Gross Margin of new products during the evaluation time = Wholesale Price / Suggested Retail Price \* 100%

Local sales contribution: average of sales category share per month during the evaluation time. Sales category share = single product regulation sales / total sales in the category \* 100%

Local In-store Rate: Average of monthly in-store rate during the evaluation time. Instalment rate = a single product this month, the number of customers have order records / local total number of customers × 100%

Repurchase rate: the average of monthly repurchase rate during the evaluation time. Repurchase rate = the number of customers who ordered this month / the number of customers who ordered last month \* 100%.

Subscription rate: Subscription rate=Number of local subscriptions/number of local launches\*100

Market Churn Rate: Average of the churn rate for each month of the evaluation period. (Local inventory + local orders for the current period - local inventory at the end of the current period) / (local inventory + local orders for the current period) \* 100%.

Price Index: Average value of Price Index for each month during the evaluation time. Price Index = Actual Retail Price / Suggested Retail Price \* 100%

### 3.2. Overview of the TOPSIS model methodology

(1) TOPSIS method, often referred to as the superiority solution distance method, is a commonly used comprehensive evaluation method, which can make full use of the information in the original data, and its results can accurately reflect the gap between the evaluation programmes.

(2) TOPSIS method, first the original data for forwarding, and then the forwarding of the matrix for standardisation, to eliminate the impact of the index scale, respectively, the evaluation of each object, the optimal programme and the distance between the worst programme, to obtain the proximity of each object and the optimal programme, as the basis for evaluating the merits and demerits.

(3) The method of data calculation is simple, the distribution of data, sample content is not strictly limited, for the indicators have existed a certain objective value can be used as an evaluation criterion, hierarchical analysis to carry out the scoring of a particular indicator is no longer applicable, at this time you can use TOPSIS method for evaluation.

### 3.3. Constructing tobacco new product evaluation model based on TOPSIS

The new product evaluation is based on the seven evaluation indicators of the new product in 2021, the specific indicators are shown in Table 2 New Product Evaluation Indicator Detail.

**Table 2.** New Product Evaluation Indicators.

Product Name	Estimated gross margin	sales volume as a percentage of	stock take-up rate	repurchase rate	fully booked	churn rate	price index
China (Fine) 97S Hard Case	15.20%	7.73%	13.96%	99.00%	95.30%	57.30%	103.00%
Zhonghua (Golden Fine Branch) 97S Hard Case	15.20%	6.50%	7.28%	98.00%	99.79%	70.66%	95.00%
Leiqun (Leisure Fine) Hard Case	15.20%	14.53%	5.22%	96.00%	96.09%	61.71%	89.04%
Huangshan (Red Square Print New Medium Branch) Hard Case	12.33%	10.54%	20.74%	95.00%	97.32%	71.03%	102.00%
Hibiscus King (Hard Medium) 89S Hard Case	12.33%	4.74%	11.77%	94.00%	95.41%	66.97%	97.00%
Jiaozi [Chuan] (Good Luck) Hard Case	12.33%	0.14%	5.11%	95.00%	99.58%	67.21%	95.00%
Diamond (Soft Lotus) Soft Case	15.20%	3.73%	7.18%	93.00%	90.84%	83.11%	94.00%

(1) Judging the types of evaluation indicators one by one and normalising them

Unify the type of indicators, transform all indicators into extremely large is called indicator forwarding, divided into extremely large indicators, extremely small indicators, intermediate type indicators and interval type indicators.

1) Indicator normalisation. Indicator forwarding is to convert different types of indicators into extremely large indicators uniformly, different types of indicators are converted in different ways:



### 3.4. Entropy weight method for the modification of TOPSIS model

(1) The entropy weight method is useful in that the evaluation weights corresponding to each indicator can be derived only from the raw data given for each indicator. Compared with the hierarchical analysis method, it is more objective. The basic principle of entropy weight method is: the more drastic changes in the indicator data corresponds to the greater amount of information, then its weight should be higher.

(2) Entropy weighting method is based on the degree of change of an indicator to assign weights, for example: Zhang and Wang are two high school students, Zhang learnt well back to the end of the exam scores, Wang learnt to often fail the exam. In an exam, Xiao Zhang still got a perfect score, and Xiao Wang also got a perfect score. Then it is very different, the little king here contains information is very big, the corresponding weight is also higher.

(3) Probability is a measure of the likelihood of something happening. The amount of information is denoted by I and the probability is denoted by p. Then we can establish a functional relationship between them with the formula (6):

$$I_{(x)} = -\ln(p(x)) \tag{6}$$

Assuming that x denotes a certain situation that may happen to event X, and p(x) denotes the probability of this situation occurring we can define:  $I(x) = -\ln(p(x))$ , since  $0 \leq p(x) \leq 1$ , so  $I(x) \geq 0$ . If the possible scenarios of event X are:  $x_1, x_2, \dots, x_n$ , then we can define the information entropy of event X as equation (7):

$$H_{(x)} = \sum_{i=1}^n [p(x_i) I_{(x)}] = -\sum_{i=1}^n [p(x_i) \ln(p(x_i))] \tag{7}$$

(4) We put the calculation step of entropy weight method through the following three steps:

1) Determine whether there are negative numbers in the input matrix, and if there are, re-normalise them to non-negative intervals.

2) Calculate the weight of the ith sample under the jth indicator as the probability used in the entropy calculation.

3) Calculate the information entropy, information utility value of each indicator and normalise the entropy weight of each indicator, equation (8).

$$W_j = \frac{d_j}{\sum_{j=1}^m d_j} \quad j=1,2,\dots,m \tag{8}$$

(5) Weights determined by the final entropy weighting method. Estimated gross margin, sales volume, on-store rate, repurchase rate, subscription rate, dynamic sales rate, price index are 0.0094, 0.4351, 0.2266, 0.0004, 0.0008, 0.0109, 0.3168, respectively.

### 3.5. TOPSIS new product evaluation model calculates scores and normalises them

1) Define the maximum value, equation (9):

$$Z^+ = (\max\{z_{11}, z_{21}, \dots, z_{n1}\}, (\max\{z_{12}, z_{22}, \dots, z_{n2}\}, \dots, (\max\{z_{1n}, z_{2n}, \dots, z_{nn}\}) \tag{9}$$

2) Define the minimum value, equation (10):

$$Z^- = (\min\{z_{11}, z_{21}, \dots, z_{n1}\}, (\min\{z_{12}, z_{22}, \dots, z_{n2}\}, \dots, (\min\{z_{1n}, z_{2n}, \dots, z_{nn}\}) \tag{10}$$

3) Define the distance of the ith (i = 1, 2... n) evaluation object from the maximum value, equation (11):

$$D_i^+ = \sqrt{\sum_{j=1}^m (z_j^+ - z_{ij})^2} \tag{11}$$

4) Define the distance of the ith (i = 1, 2... n) evaluation object from the minimum value, equation (12):

$$D_i^- = \sqrt{\sum_{j=1}^m (z_j^- - z_{ij})^2} \tag{12}$$

5) We can calculate the un-normalised score for the  $i$  ( $i = 1, 2, \dots, n$ )th evaluation subject, equation (13).

$$s_i = \frac{D_i^-}{D_i^+ + D_i^-} \quad (13)$$

It is obvious that  $0 \leq s_i \leq 1$ , and the larger  $s_i$  is, the smaller  $D_i^+$  is, i.e., the closer it is to the maximum value.

6) The normalised final scores are as follows

New product name stand\_S =

Zhonghua (Fine Branch) 97S Hard Case: 0.1758

Zhonghua (Golden Fine Branch) 97S Hardbox: 0.1291

Liqun (Leisure Fine Branch) Hard Case: 0.1548

Huangshan (Red Square Printed New Medium Branches) Hard Case: 0.2303

Hibiscus King (Hard Medium Branch) 89S Hard Case: 0.1388

Jiaozi [Chuan] (Good Luck) Hard Case: 0.0783

Diamond (Soft Lotus) Soft Case: 0.0929

7) Histogram of final scores (figure 2)

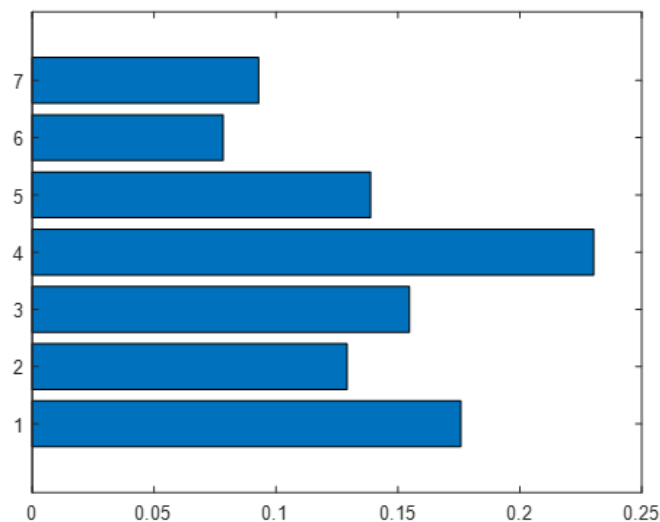


Figure 2. Score histogram.

### 3.6. Evaluation results of TOPSIS-based evaluation model for new tobacco products

According to the score of TOPSIS evaluation results based on entropy weight method, combined with seven evaluation systems, the final evaluation results can be made. For example, in this paper, the evaluation result of "Jiaozi [Chuan] (Wide and Narrow Good Luck) Hard Box" is 0.0783, which is the lowest among all the new products, and the new product can be evaluated at the lowest level, which can be used as a reference for decision-making on the withdrawal of the new product specification.

## 4. Conclusions

This study aims to establish a new product evaluation model and a corresponding evaluation mechanism to improve the market competitiveness of commercial enterprises and to make scientific decisions on the introduction and withdrawal of new product specifications. By considering the three dimensions of potential, process and result, the model provides enterprises with a scientific basis for decision-making. For example, based on the results of monthly, quarterly and annual evaluations, commercial enterprises can make timely adjustments to their supply of goods, brand cultivation and brand marketing strategies. Such an evaluation mechanism not only ensures the timeliness of the

evaluation, but also can be used for a variety of purposes, helping the enterprise to respond flexibly in the rapidly changing market. At the same time, commercial enterprises can also make use of the characteristics that summarise highly competitive new products as introduction criteria, thus improving the performance potential of introducing new product specifications. This will help enterprises introduce products or services with competitive advantages in the market in a more targeted manner, further enhancing their market position and competitiveness. Overall, the new product evaluation model and evaluation mechanism provide commercial enterprises with a scientific and comprehensive product specification management tool. Enterprises can adjust their strategies according to the evaluation results, optimise their product mix, introduce more competitive products, and formulate elimination mechanisms to eliminate products that do not have competitive advantages in a timely manner. This will help enterprises to be invincible in the fierce market competition and achieve long-term high-quality development.

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