

Research on the Evaluation of High-end Sense of Passenger Car Brand based on the Differentiation of Market Segments

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Abstract

China's auto industry is moving from scale expansion to value escalation, and high-end has become the key for local brands to break through the stock competition. However, as a complex subjective user perception, the high-end sense has long lacked measurable and reproducible industry evaluation standards, and car companies are generally facing cognitive difficulties. This paper takes the high-end sense of passenger car brand as the research object, and focuses on cars SUV, MPV, The five major market segments of off-road vehicles and sports cars put forward a three-tier, nine dimensional theoretical model of the physical layer, the experience layer, the meaning layer, and made clear the operational definition of the high-end feeling. Relying on expert think tanks and multi City empirical platforms, integrating AHP entropy weight and game theory combination weighting, this paper constructs differentiated evaluation criteria suitable for the five major market segments; Combined with fuzzy comprehensive evaluation TOPSIS, The normal cloud model is used to build the mathematical framework of comprehensive index calculation and grade discrimination. Empirical results show that there are significant differences in the weight of high-end sense in each market segment: cars value quietness and driving texture, SUVs focus on space and full scene experience, MPVs focus on the second row of noble feelings, SUVs rely on mechanical and credible narratives, and sports cars highlight the scarcity of performance and symbols. This study makes up for the gap in the evaluation standard of high-end sense in the industry, provides the basis for product definition, testing and validation and brand building, and also lays the method foundation for the transformation of achievements into industry standards.

Keywords

Premium Perception; Combination Empowerment; Fuzzy Comprehensive Evaluation; Normal Cloud Model.

1. Introduction

China's auto industry is undergoing a once-in-a-century structural transformation. Electrification and intelligentization are reshaping the product evaluation system. The mechanical performance barriers that traditional luxury brands built over a long period are being gradually dissolved by the three-electric system (battery, motor, and electronic control) and smart cockpits. Domestic brands now have an opportunity to move upmarket, and the average transaction price and market share of mid-to-high-end models keep rising. Against this background, "premiumness" has become a core competitive factor for models priced above 200,000 yuan, not just a marketing concept. Yet the industry lacks a suitable evaluation tool. Existing vehicle evaluation systems, including crash safety tests, objective performance tests, and quality and reliability assessments, focus on measuring objective performance and quality, and cannot capture users' subjective perception of premiumness. Premiumness is a

comprehensive subjective experience formed through multiple senses-sight, hearing, touch, and interaction-and is constructive, context-dependent, and individually variable, so it cannot be measured by traditional objective testing paradigms. As a result, when developing premium models, carmakers mostly rely on benchmarking and imitation based on experience, reverse-engineering the design practices of foreign luxury products, and lack a scientifically grounded premiumness evaluation standard that can support forward-looking R&D.

In the evaluation method level, fuzzy comprehensive evaluation and TOPSIS have been quite mature, but they are mostly used for general decision-making problems such as supplier selection and vehicle type comprehensive ranking. For example, in literature [1] in order to better evaluate the importance of College Students' innovation and entrepreneurship events for students' ability training, this paper, facing the college students' "four innovation" events, constructs a three-level evaluation index system with innovation, entrepreneurship, creativity and creativity as the criteria, and sets 17 secondary indicators including objective and subjective categories. The analytic hierarchy process fuzzy comprehensive evaluation model is established and the supporting information platform is developed. The platform covers five modules: data collection, weight management, model operation, result output and data security, ensuring the implementation of the evaluation model. The results show that the model can provide new reference ideas for the evaluation of College Students' innovation and entrepreneurship events. In order to quantitatively evaluate the seismic performance of bridges in the whole life cycle, literature [2] sorted out the key seismic influencing factors of the five subsystems of superstructure, substructure, foundation, connecting support and auxiliary seismic facilities. The results showed that the model could provide theoretical and practical support for bridge seismic operation and maintenance and risk control. In reference [3], in order to analyze the impact of the performance of the fuel tank float sensor on the driving safety of traditional fuel vehicles, quality risk assessment was carried out for its production vulcanization process. The risk factors were identified through causal analysis, and the AHP fuzzy comprehensive evaluation model was constructed to realize the quantitative assessment of key risks, and special coping strategies were formulated, which could provide practical reference for improving the quality risk management of float vulcanization process. Although fuzzy comprehensive evaluation has brought important reference data to the engineering field, there is little research on systematic coupling with combination weighting and human factors experimental data. On the whole, the existing literature lacks a complete standard system for market segmentation differentiation oriented to the specific perception concept of "high-end sense", which is the starting point of this paper.

To sum up, this paper introduces the fuzzy comprehensive evaluation method to carry out the evaluation research on the high-end sense of passenger car brand. Considering that the high-end feeling of the car belongs to the subjective perception attribute of multi sensory coupling, and there are strong fuzziness and individual differences, it is difficult to measure directly by a single objective index. Fuzzy comprehensive evaluation can quantitatively transform users' Multi-dimensional subjective perception and effectively eliminate the uncertainty of subjective evaluation. This method can realize the quantitative comparison of the high-end perception level of different passenger car brands, make up for the deficiency of the existing vehicle evaluation system on the subjective high-end perception evaluation, and also provide technical support for the high-end forward design and product development of vehicle enterprises.

2. Theoretical Foundation

2.1. Definition of Premium Feel

In this paper, the high-end sense of passenger car brand is defined as the comprehensive perceptual judgment on the rationality of the brand premium formed by the user in the whole

life cycle of the product, receiving multidimensional stimuli through multiple sensory channels and interaction, cognitive processing and emotional evaluation, and comparing with the value expectation of users in the market segment. The definition includes four core points: multichannel, covering visual, auditory, touch, olfactory, somatosensory and interactive stimuli; Constructiveness, which is the result of cognitive processing, is not the inherent physical attribute of the product; Referential, with the expectation of market segments as the anchor point; Premium, based on willingness to pay, has real economic impact [4-5].

Based on the definition of high-end feeling, this paper proposes a three-layer nine dimensional model. The three layers refer to the physical layer, the experience layer and the meaning layer. The physical layer is the objective attribute of the product that can be directly perceived, including shape color, material technology and sound and light atmosphere; The experience layer focuses on the dynamic use experience, covering four dimensions: driving texture, human-computer interaction, space enjoyment and quiet comfort; The meaning layer represents the symbolic value outside the product, including two dimensions: brand narrative and scarcity exclusive. The three layers play a two-way role, the physical layer provides basic support from bottom to top, and the meaning layer completes the meaning of value from top to bottom. Physical property is a necessary but not sufficient condition for high-end products, and it is difficult to achieve high-end products due to insufficient hardware foundation; However, if only the hardware is stacked without good use experience and value narrative, the dilemma of "low-end stacking" will appear.

2.2. Fuzzy Comprehensive Evaluation

The sense of high-end is a typical fuzzy concept. For example, there is no clear boundary between "relatively high-end", "fairly high-end" and "very high-end" and "really high-end", so the fuzzy comprehensive evaluation is adopted for the first level comprehensive measurement. Set the index level comment set to correspond to "general, good, high-end, excellent and benchmark" in turn. The mathematical model of the indicator layer comment set is shown in formula (1) [6].

$$V = \{v_1, v_2, v_3, v_4, v_5\} \quad (1)$$

Among them, v_1 means average, v_2 means good, v_3 means high-end, v_4 means excellent, and v_5 means benchmark. For the j -th index, the membership vector of the evaluation level is constructed from the sample frequency distribution to obtain the single index evaluation matrix [6]. The mathematical model of the evaluation matrix is shown in formula (2).

$$R = (r_{jk})_{n \times 5} \quad (2)$$

Compared with the conventional weighted average operator, the high-end sense evaluation conforms to the barrel logic: a single obvious short board can destroy the overall perception, which matches the asymmetric characteristics of Kano model. The weighted average has a weak constraint on the short plate, while the weighted geometric average operator has a stronger penalty effect on the low value index. Therefore, this paper selects the weighted geometric average operator as the main operator for the comprehensive evaluation of high-end feeling. The mathematical model of weighted geometric average operator is shown in formula (3).

$$B_k = \prod_{j=1}^n (r_{jk})^{w_j}, \text{ st } \sum_{j=1}^n w_j = 1 \quad (3)$$

Formula (3) is a weighted geometric average fuzzy comprehensive evaluation model, which has stronger punishment for low score indicators, and is suitable for high-end perception evaluation scenarios. Where, B_k represents the comprehensive evaluation value of the k th evaluation object, r_{jk} indicates the membership degree of the j th index to the k th object, and w_j indicates the weight of the j th index.

2.3. Normal Cloud Model Level Classification

The ambiguity and randomness of "this high-end is not that high-end" exist in the same level of high-end evaluation. Therefore, the normal cloud model is introduced as a softening tool for grade discrimination. The normal cloud model is a qualitative quantitative transformation model that integrates fuzziness and randomness. It uses three digital features of expectation E_x , entropy E_n and super entropy H_e to represent the qualitative concept, and generates cloud droplets through the cloud generator, which is suitable for dealing with the comprehensive evaluation problems with subjective uncertainty such as high-end feeling [7-8]. The mathematical expression of normal cloud model is formula (4).

$$\mu(x) = \exp\left\{-\frac{(x - E_x)^2}{2(E_n')^2}\right\}, E_n' \sim N(E_n, H_e^2) \quad (4)$$

In formula (4), each group of $\mu(x)$ is called cloud drops; A large number of cloud droplets converge to form a bell shaped cloud map.

3. Overall Framework Design of the Evaluation System

3.1. Indicator Selection

This evaluation system adopts a three-level structure of "target level - criteria level - indicator level". The target layer is the high-end comprehensive index of the market segment, and the criterion layer corresponds to the three-tier nine dimensional model established above; The indicator layer is selected from the initial indicator pool. The initial indicator pool is built on three types of data sources: first, the high-frequency evaluation indicators of domestic and foreign research extracted by bibliometric method; The second is the engineering evaluation index condensed in the expert workshop of the head vehicle enterprise; Third, user perception indicators extracted from multi city user in-depth interviews and diary research. The multi-source integration method takes into account academic theory, engineering landing and users' real subjective perception to ensure the completeness of the index system.

3.2. Mathematical Model of Weighting

Weight is the core of the evaluation system. All kinds of single weighting methods have inherent limitations: subjective weighting methods such as AHP are easily disturbed by experts' subjective preferences; Objective weighting such as entropy weight method completely depends on the distribution of sample data, and the output result may violate the inherent theoretical priority of charm attribute. Therefore, this paper introduces the combination weighting of game theory, integrating the advantages of subjective and objective weights^[9-10]. At the same time, the adjustment vector mechanism is set for the five major market segments to generate differentiated weights suitable for different market characteristics and improve the scene adaptation ability of the evaluation system. The combination weighting formula of game theory is shown in formula (5).

$$\min_{\alpha_1, \alpha_2} \|\alpha_1 w_1 + \alpha_2 w_2 - w_1\|_2^2 + \|\alpha_1 w_1 + \alpha_2 w_2 - w_2\|_2^2 \quad (5)$$

Formula (5) explains that α_1, α_2 are the combination coefficient to be solved, and w_1 and w_2 are the subjective and objective weight vectors respectively. Formula (5) means to solve the combination coefficient so that the combination weight vector can approach the weight vector as much as possible at the same time, so as to realize the game equilibrium between the two kinds of weights.

The combination weighting of game theory aims at Nash equilibrium, coordinates the subjective weight of AHP and the objective weight of entropy weight, and minimizes the two norm distance between the combination weight and each basic weight vector; The combination coefficient is solved and normalized to obtain the index weight that takes into account the expert's theoretical cognition and the objective information of the sample, which fits the theoretical priority constraint of the charm attribute in the high-end feeling evaluation.

4. Empirical Research Design

4.1. Multi-City Empirical Study

The empirical platform covers four regional cities in East China (Hangzhou), North China (Beijing), South China (Shenzhen) and southwest China (Chengdu), taking into account the differences in user structure between first tier cities and new first tier cities. The survey objects are users who have participated in the decision-making of car purchase with a price of more than 200000 yuan or in-depth experience of high-end brands (including leasing and in-depth test drive) in the past two years.

4.2. Data Collection

The data collection of this study adopts the "questionnaire+experiment" mixed research design, and carries out data acquisition from three dimensions: subjective, objective and physiological. The subjective dimension uses the semantic difference scale to measure the user perception of each indicator, and each indicator is set with 35 groups of bipolar adjectives; The overall high-end feeling sets up a single item for the overall evaluation, and introduces the willingness to pay premium as the standard variable. Objective dimension carry out physical measurement for quantifiable indicators, including door closing sound quality, interior clearance surface difference, seat pressure distribution, interior noise under idle and cruise conditions, etc. Four cities were selected from the physiological dimension to carry out human factors experiments in combination with the laboratory environment and the real scene of the real vehicle. The subjects completed the product experience according to the standardized experience line, collected the visual fixation track with the help of eye tracker, and collected the skin electrophysiological signals through wrist and finger sensors. Multi source data confirm each other, which can reduce the deviation caused by a single survey method, and ensure the comprehensiveness and reliability of the high-end perception data of passenger cars.

4.3. Interpretation of Empirical Results

(1) Car: the dual play of driving texture and quietness

The user value structure of the car market presents the dual core driving characteristics of "driving texture+quiet comfort", with the highest weight, which is suitable for the combined use of business and family of car users. The regression analysis of the control price band shows that the two indicators of the door closing sound and the chassis over the sill aftershock control have the highest partial regression coefficient for the high-end feeling of the car.

(2) SUV: full scene comfort and space enjoyment

In the SUV market evaluation weight structure, the spatial dimension weight and the whole scene experience dimension weight are outstanding. User survey results show that "whole scene leisurely" is the most frequently mentioned spontaneous associative vocabulary. The research included the unique experience of SUV, such as the open field of vision brought by the sitting height, the stability and calmness of wading and driving on rotten roads, into the evaluation system. The above weight characteristics reflect that SUV users pay more attention to spatial practicability and the passing experience under complex road conditions, reflecting the high-end perception logic of user differentiation in this market segment.

(3) MPV: comfort centered on the second row

The weight of MPV market presents obvious characteristics of "Passenger Center", the weight of space is the largest, and the weight of driving texture is at the lowest level in the five major market segments. The evaluation system classifies the noble experience of the second row as a first-class scene, with multiple parameter clusters, covering the courtesy of getting on and off, including pedal height, armrest position, door opening angle, and the pressure distribution uniformity of the ride envelope, visual field dominance and other indicators, which fully conforms to the MPV's high-end perception logic with the feeling of the rear passengers as the core.

(4) Off road vehicle: mechanical credibility

The off-road vehicle has the highest weight in the meaning layer in the five sets of market segmentation evaluation criteria, and the brand narrative and scarce exclusive weight bonus is 1/3. Its high-end sense construction highly relies on symbolic value and narrative expression. The "click feeling" of mechanical locking mechanism operation and the instantaneous feedback of differential intervention together constitute the unique high-end perception language of off-road vehicles, which is different from the high-end evaluation logic of other categories that focus on cabin experience.

(5) Sports car: Romantic performance and scarcity of symbols

The weight of the sports car market ranked the top two in terms of driving texture and CMF, while the weight of quietness and comfort was the lowest. Sound wave controllability, i.e. on-off and graded exhaust sound wave, is included in the evaluation standard as the exclusive index of sports cars. The scarcity symbol is another important support for the high-end feeling of sports cars. This system introduces for the first time the relevant indicators such as visual verifiability of limited number, traceability narrative of handcraft and pedestrian identification delay, which are consistent with the unique high-end perception characteristics of sports cars.

5. Conclusion and Outlook

Based on the realistic demand of high-end passenger car brands, this paper completed the concept definition, model construction, mathematical modeling, multi City empirical research and the whole chain of industrial transformation. The main conclusions are as follows: the high-end sense can be operationalized into a three-tier, nine dimensional structure of property experience meaning. There are significant differences in the weights of different market segments. The differentiated weight mechanism takes into account the comparability of the system and the grading accuracy; The high-end evaluation has asymmetric characteristics, which confirms the applicability of geometric operators. The product should give priority to eliminating fatal short boards rather than stacking bright spots; The evaluation results can be sunk to each experience module, and the engineering limit value can be output through sensitivity classification, so as to get through the landing path from the index to the technical parameters.

There are still some limitations in this study: the samples are concentrated in the first and second tier cities in China, lack of overseas market samples, and need to carry out the high-end

sense of cross-cultural applicability test; Physiological measurement only covers hearing and touch, and objective test methods such as psychophysical calibration of smell need to be improved; At present, the weight of advanced perception such as "ease" of intelligent driving is low, and it is necessary to track the weight evolution brought about by the popularity of intelligent driving in urban areas. With the globalization of Chinese auto enterprises, the value of this evaluation system will be further released. Differentiated standards with both scientific basis and market adaptability can not only serve as the basis for judging high-end products, but also help China's automobile industry to build the discourse power of rules and realize the transformation from the evaluation object to the rule maker.

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