

Research on the Application of Fuzzy Comprehensive Evaluation Method in Promotional Psychological Effects

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Abstract: Promotion is one of the most widely used marketing strategies by retail enterprises, how to measure the psychological effect of promotion on consumers is an important part of the study of the effect of promotion, but also a relatively weak link in the field of research. In this paper, we first determine the promotion effect assessment indexes through literature research and interviews, introduce the fuzzy comprehensive evaluation method, and choose supermarket promotion as the research object to conduct empirical research on the psychological effect of promotion. In order to improve the part of empirical analysis of the psychological effect of promotion. And to provide executable consumer psychological analysis tools for the promotional behavior of retail enterprises.

Keywords: Promotion, Psychology, Fuzzy, Psychological Effects.

1. Introduction

With the rise of China's residents' consumption level, the retail industry has developed rapidly. At the same time, foreign retail giants continue to pour in, and market competition is becoming more and more fierce. Retailers clustered in the same business district often use promotions to drive short-term sales and expand their user base. From the perspective of consumers' purchase decision-making process, the psychological effect of promotion is particularly important to purchase behavior, so it has become an important research content to effectively evaluate the psychological effect of promotion on consumers.

2. Fuzzy Comprehensive Evaluation Method

In 1965, the automatic control expert Chad (L. A. Zadeh) proposed the fuzzy sets theory (fuzzy sets) to express the uncertainty of things, and thus developed fuzzy mathematics and other subject areas. Fuzzy comprehensive evaluation method is a comprehensive evaluation method based on fuzzy mathematics, it is based on fuzzy mathematics affiliation theory to qualitative evaluation into quantitative evaluation, that is, the use of fuzzy mathematics to make a general evaluation of things or objects subject to a variety of factors.[1]This method is characterized by clear and systematic results, which can better solve the fuzzy and difficult-to-quantify problems, and is suitable for a variety of non-deterministic problems.

Most of the psychological effect measurements in the psychological effect assessment use language to describe the psychological validity of the measurement object.[2]Its indicators are mostly qualitative indicators, generally graded using the language of the degree of use, using the Likert scale method to quantify the qualitative indicators, and stipulating that the indicators are graded as:

$$V = \{v_1, v_2, \dots, v_m\}$$

Usually 5 and 7 levels are used to calibrate the degree of affiliation and in this study 5 levels were used to calibrate the

rank of the indicator:

$$V_1 = \{\text{High, relatively high, average, relatively low, low}\}$$

3. Promotional Effects

The study on promotional effects focuses on sales promotion, which refers to marketing communication activities that incentivize consumers to purchase and enhance distributor efficiency, distinct from advertising, public relations, and personal selling. [3]This includes various short-term sales efforts such as point-of-sale promotions, lotteries, and coupons. Promotions have both short-term sales effects and psychological effects on consumers.

Philip Kotler et al. (2009) proposed methods for measuring promotional effectiveness in "Marketing Management": sales data, consumer surveys, and experiments. These three methods are widely acknowledged and utilized in academia. [4]Promotions are typically defined as short-term stimuli for sales, with both domestic and international scholars primarily emphasizing their immediate incentive effects. Neslin (1985) found that promotional activities can significantly boost sales volume, increase company revenue, reduce the time interval for consumers purchasing promoted products, and expand market share for the promoted brand.

Beyond their immediate sales impact, promotions also have more profound communication effects. Research by Rothchild indicated that if promotional products satisfy consumers, they are likely to continue purchasing even after the promotion ends. This finding has contributed to the exploration of the psychological effects of promotions. [5]The focus of this study is the psychological impact of promotions on consumers. Building upon existing research, the psychological effects of promotions are categorized into three primary indicators and ten secondary indicators. These indicators are quantitatively assessed using fuzzy comprehensive evaluation methods to derive the promotional psychological evaluation index values.

4. Consumer Promotion Psychological Effect Assessment

4.1. Sample and Sample Verification

To enhance the feasibility and practicality of the research, this study employs a combined methodology of questionnaire surveys and interviews. The selected sampling frame consists of supermarket consumers, as promotions are a commonly utilized marketing strategy in supermarkets, hence offering a broad representation. A total of 200 questionnaires were distributed for this survey, with 191 effectively returned, resulting in a response rate of 96%. The Cronbach's alpha coefficient for the survey instrument was 0.813, indicating a good level of reliability for the scale, thus affirming the consistency and dependability of the questionnaire.

4.2. Questionnaire Design and Data Analysis

The questionnaire design and data analysis consist of two main sections: the first section addresses the demographic characteristics of consumers, which includes questions regarding gender, age, occupation, and income. The results regarding demographic characteristics reveal that the primary shopping demographic at the supermarket is female, comprising 61.74%, while males account for 38.26%. The age

distribution shows that individuals aged 20-40 make up the majority, representing 68.4% of the total. Young and middle-aged consumers are the main customer base for supermarket shopping. Among the participants, those with a high school or vocational education represent the largest group at 36.72%, followed by undergraduate and associate degree holders, each constituting around 20%. In terms of occupational distribution, employees from enterprises make up the majority at 49.52%, followed by students and self-employed individuals, each representing approximately 15%. About half of the respondents reported an average monthly income ranging from 2000 to 4000 yuan. The second section of the questionnaire focuses on assessing consumer psychological effects. To quantitatively describe the psychological and behavioral responses to promotions, three primary indicators were established based on existing psychological research metrics: cognitive perception, behavioral inclination, and emotional responses. These primary indicators are further detailed into ten secondary indicators, which include attention rate, perception level, quality perception, price perception, brand loyalty, information dissemination, quantity expansion, brand conversion, sense of achievement, and feelings of pleasure. Descriptions of behavioral statements corresponding to the secondary indicators will be statistically analyzed using an attitude scale (refer to Table 1).

Table 1. Evaluation Indicators for Promotional Psychological Effects

Serial No.	Indicator	Indicator breakdown	Mental Statements Expressions	options				
				Strongly Agree	Agree	Don't Care	Disagree	Strongly Disagree
1	mental cognition	attention rate	I'll be keeping an eye out for grocery store leaflets and coupons	58	89	21	15	8
2		perceptivity	Promotional items are relatively affordable.	43	74	32	31	11
3		Quality perception	I believe that the quality of promotional products is comparable to that of regular products.	21	48	42	51	29
4		price consciousness	During holidays, products in supermarkets are available at discounted prices.	46	68	22	47	8
5	mental cognition	brand loyalty	The promotional products for the cleavage enhancement are performing well; I will continue to use them.	48	67	42	28	6
6		Dissemination of information	I am more than happy to share information about promotional products with those around me.	19	38	75	42	17
7		Volume expansion	Even if I don't need it immediately, I will purchase promotional items.	37	51	43	36	24
8		brand transformation	When purchasing similar products, I tend to opt for those that are on promotion.	24	47	53	38	29
9	Moods and emotions	sense of accomplishment	Acquiring suitable promotional products gives me a sense of accomplishment.	24	49	63	38	17
10		sense of well-being	It is a delightful experience to acquire promotional merchandise.	26	37	51	42	35

4.3. Data Analysis

Initially, I will quantify the indicators that describe consumer psychology and behavior, creating an evaluation matrix for the original data A.

$$A = \begin{bmatrix} 58 & 89 & 21 & 15 & 8 \\ 43 & 74 & 32 & 31 & 11 \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ 24 & 49 & 63 & 38 & 17 \\ 26 & 37 & 51 & 42 & 35 \end{bmatrix}$$

Based on the percentage rates of various evaluation indicators at a specific assessment level, acquire the evaluation matrix. R' .

$$R' = \begin{bmatrix} 0.3037 & 0.4660 & 0.1099 & 0.0785 & 0.0419 \\ 0.2251 & 0.3874 & 0.1675 & 0.1623 & 0.0576 \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ 0.1257 & 0.2565 & 0.3298 & 0.1990 & 0.0890 \\ 0.1361 & 0.1937 & 0.2670 & 0.2199 & 0.1832 \end{bmatrix}$$

Based on the formula $R = (r_{ij})_{m \times n}$ standardization R' can be performed to obtain the results R .

$$R = \begin{bmatrix} 1.0000 & 1.0000 & 0.1000 & 0.1000 & 0.1621 \\ 0.6538 & 0.7404 & 0.2833 & 0.5000 & 0.2552 \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ 0.2154 & 0.3077 & 0.8000 & 0.6750 & 0.4414 \\ 0.2615 & 0.1000 & 0.6000 & 0.7750 & 1.0000 \end{bmatrix}$$

Based on the formula(1)And formula(2)Calculate the entropy and entropy weights of each evaluation index. After developing the computational program and importing it into the Matlab software, I obtained various metrics.

$$E_i = -\frac{1}{\ln n} \sum_{j=1}^n \frac{r_{ij}}{\sum_{j=1}^n r_{ij}} \ln \sum_{j=1}^n r_{ij} \quad (1)$$

$$\omega_i = \frac{1 - E_i}{m - \sum_{i=1}^n E_i} \quad (2)$$

The entropy and entropy weight calculation results for the 10 secondary indicators are as follows:

$$E = [0.7328, 0.9490, 0.8858, 0.8633, 0.9161, 0.8182, 0.9847, 0.9312, 0.9357, 0.8719]$$

$$\omega = [0.2404, 0.0459, 0.1028, 0.1230, 0.0755, 0.1636, 0.0138, 0.0619, 0.0579, 0.1153]$$

The entropy and entropy weights of the three secondary

indicators are as follows:

$$E_1 = [0.7041, 0.9670, 0.8121, 0.8483] \quad \omega_1 = [0.4426, 0.0493, 0.2811, 0.2270]$$

$$E_2 = [0.7041, 0.8054, 0.9304, 0.9263] \quad \omega_2 = [0.4669, 0.3070, 0.1098, 0.1163]$$

$$E_3 = [0.7041, 0.8121] \quad \omega_3 = [0.6116, 0.3884]$$

From this, the entropy weights of various evaluation indicators related to promotional psychological effects can be obtained.(Refer to Table 2.)

Based on the obtained weights of the indicators, the fuzzy vector of the secondary indicators of psychological cognition is derived through fuzzy comprehensive analysis.

$$\omega_T = [0.5121, 0.3148, 0.1732]$$

$$C_1 = \omega_1 = [0.4426, 0.0493, 0.2811, 0.227]$$

Table 2. Evaluation Index Weight Table for Promotional Psychological Effects

Indicator	Weight	Secondary indicators	Weight
mental cognition	0.5121	attention rate	0.2404
		perceptivity	0.0459
		Quality perception	0.1028
		price consciousness	0.123
mental cognition	0.3148	brand loyalty	0.0755
		Dissemination of information	0.1636
		Volume expansion	0.0138
		brand transformation	0.0619
Moods and emotions	0.1732	sense of accomplishment	0.0579
		sense of well-being	0.1153

The matrix of indicator affiliation has been compiled, resulting in the fuzzy comprehensive evaluation vector for the psychological cognition indicators as follows:

$$R_1 = \begin{bmatrix} 1.0000 & 1.0000 & 0.1000 & 0.1000 & 0.1000 \\ 0.6351 & 0.6707 & 0.5714 & 0.5000 & 0.2286 \\ 0.1000 & 0.1000 & 1.0000 & 1.0000 & 1.0000 \\ 0.7081 & 0.5390 & 0.1429 & 0.9000 & 0.1000 \end{bmatrix}$$

$$D_1 = C_1 * R_1 = [0.2311, 0.3768, 0.1449, 0.1737, 0.0736]$$

The same method is utilized to obtain the result vector of behavioral tendencies toward emotional affect indicators.

$$D_2 = C_2 * R_2 = [0.1838, 0.2828, 0.2802, 0.1798, 0.0734]$$

$$D_3 = C_3 * R_3 = [0.1297, 0.2321, 0.3054, 0.2071, 0.1256]$$

$$C_T = \omega_T = [0.5121, 0.3148, 0.1732]$$

$$D_T = \begin{bmatrix} D_1 \\ D_2 \\ D_3 \end{bmatrix} = \begin{bmatrix} 0.2311 & 0.3768 & 0.1449 & 0.1737 & 0.0736 \\ 0.1838 & 0.2828 & 0.2802 & 0.1798 & 0.0734 \\ 0.1297 & 0.2321 & 0.3054 & 0.2071 & 0.1256 \end{bmatrix}$$

evaluation, the outcomes are as follows:

Upon completion of the secondary fuzzy comprehensive

$$M_T = C_T * D_T = [0.1986 \quad 0.3222 \quad 0.2153 \quad 0.1814 \quad 0.0825]$$

The evaluation results for the psychological effects of

promotions yield the following values:

$$X = 0.1986 * 1 + 0.3222 * 2 + 0.2153 * 3 + 0.1814 * 4 + 0.0825 * 5 = 3.3730$$

5. The Conclusions and Implications are as Follows

1) The psychological effects of promotions on consumers comprise three aspects: cognitive perception, behavioral inclination, and emotional response. Cognitive perception serves as the most critical evaluation metric of promotional psychological effects and encompasses four indicators: consumers' attention to promotions, perception levels, quality perception, and price perception. After analyzing the research data using the entropy weight method, it was found that the weight of cognitive perception factors is the highest, at 0.512. This is followed by behavioral inclination and emotional factors, which are weighted at 0.3148 and 0.1732, respectively. This indicates that the way consumers process promotional information directly influences their subsequent potential behavioral responses. Such cognitive outcomes are largely determined by the product itself, including the perceived quality and price. Additionally, these perceptual results often rely on consumers' existing knowledge, experiences, and accumulated insights.

2) From a behavioral perspective, consumers exhibit a notable inclination towards sharing, with a significant weight of 0.1636. In contrast, the weights associated with the expected quantitative expansion, brand switching, and brand loyalty are relatively lower. This analysis reveals a high level of collective behavior among consumers, particularly as the development of social media facilitates the dissemination of information, leading consumers to be more inclined than ever to share promotional information with friends. On the flip side, the direct effectiveness of promotions, as measured by the anticipated increase in sales, appears to be diminishing, indicating a declining impact of promotions on sales performance. To enhance consumer attention, promotions must be more innovative in their formats and approaches, as indicated by the psychological evaluation results.

3) It is evident that promotions can evoke a strong sense of pleasure in consumers, with 33% supporting this notion. Research indicates that the marketing atmosphere created by promotions fosters positive associations, resulting in increased dopamine production, which stimulates emotional

responses such as excitement and enjoyment.

4) When synthesizing the weights of ten different metrics, the hierarchical order of importance includes attention rate, information dissemination, price perception, pleasure, quality perception, brand loyalty, brand switching, achievement perception, perceptual awareness, and quantitative expansion. Thus, capturing consumer attention is the foundational and most crucial factor in generating psychological effects. As a result, retail enterprises should prioritize strategies focused on attracting consumer attention during promotional activities, enhancing elements such as message conveyance and promotional format innovation. Through fuzzy comprehensive evaluation, I derived the result vector of various factors, resulting in a psychological assessment score of 3.3730. This score reflects the overall psychological effect of promotions on consumers, indicating that the impact is moderate on a five-point scale.

5) The index system of the psychological effect of promotion is a dynamic adjustment process. In practical application, the social environment, media environment, geographical factors, etc. should also be comprehensively considered. Therefore, the establishment of the index system provides a research idea and framework for the empirical analysis of the psychological effect of promotion, and the follow-up research should be dynamically adjusted in practice to make it have stronger application value.

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