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Research on Network Marketing Performance Evaluation Based on Fuzzy Theory

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Abstract: Implementing network marketing performance evaluation is an effective way to enhance network marketing, and how to evaluate it is one of the difficulties and hot research fields for the researchers related. The paper presents a new model for evaluating network marketing performance based on analyzing the characteristics of network customers' behavior. First, the principle of analytic hierarchy process and fuzzy comprehensive evaluation are analyzed and the two methods are combined to satisfy the dynamics, subjective and transitional characteristics of network marketing performance evaluation indicators and improve evaluation accuracy; Second, an evaluation indicator system of network marketing performance evaluation is designed through analyzing the characteristics of network consumers' behavior with more details; Finally datum from three network enterprises are taken for examples to verify the validity and feasibility of the model and the experimental results show that the model can evaluate network marketing performance practically and can help network enterprises take corresponding concrete measures to enhance its marketing performance.

Keywords: Network marketing performance evaluation; Multistage comprehensive fuzzy evaluation; Analytic hierarchy process; Consumer behavior analysis

1. Introduction

With the development of the Internet and the globalization of trade, the Internet has become a new force which affected the development of marketing. The rise and development of network marketing can not separate from the development of the Internet. The widespread use of network marketing makes internet marketing performance emerged. Network marketing performance evaluation makes objective and accurate evaluation on the development of enterprises and operating results, which to sum up and improve the network marketing activities. And only by making correct evaluation on the previous marketing activities of enterprises can the launching of current and future marketing activities of enterprises be better guided. Hence, network marketing performance evaluation is becoming a more and more popular research hotspot, also a research difficulty, becoming one of the urgent problems in various fields related [1].

2. Literature Review

Up to now, mathematical models adopted by evaluation of network marketing performance mainly include the following categories. ① Analytic hierarchy process is a good method for quantitative evaluation via quantitative method, having the functions of establishing the ideal weight structure of evaluated object value and analyzing the weight structure of actually-built value by evaluated object; however, the method has strong limitations and subjectivity, with large personal error, not suitable for complicated system with lots of evaluation indicators[2]. ②Fuzzy comprehensive evaluation is a method carrying out comprehensive evaluation and decision on system through fuzzy set theory, the greatest advantage of which is that it works well on system evaluation of multi-factor and multi-level complicated problems. However, the membership of fuzzy evaluation method as well as the definition and calculation of membership function are too absolute, difficult to reflect the dynamics and intermediate transitivity of evaluation indicators of English course education performance[3,4]; ③BP neural network evaluation method makes use of its strong capability in processing nonlinear problems to carry out evaluation of English course education performance; the method has advantages like self-learning, strong fault tolerance and adaptability; however, the algorithm is easy to be trapped into defects like local minimum, over-learning, strong operation specialization[5,6]

The paper integrates the methods of multistage comprehensive fuzzy evaluation and analytic hierarchy process to overcome the shortages of two original methods and to

make the best of advantages of two original methods when used in network marketing performance evaluation.

3. Evaluation Method Design

Fuzzy overall evaluation in this paper is conducted according to the following five steps[7].

3.1. Establish Evaluation Element Set

Evaluation element set is an ordinary set constituted by all the elements influencing evaluation object; suppose there are n evaluation indicator elements expressed by u1, u2, u3, …, un respectively, then the set constituted by these n evaluation elements is called evaluation element set, i.e. U={ u1, u2, u3, …, un }[11].

3.2. Confirm Evaluation Set

Evaluation set is also called judgment set, which is comprised of all the evaluation results of evaluator on evaluation object, is an ordinary set formed by all the possible evaluation results of evaluators on evaluation object. Evaluation results can be divided into m hierarchies according to actual demand of specific cases, which can be expressed by v1, v2, v3, …, vm respectively, then evaluation set can be constituted as V={ v1, v2, v3, …, vm }.

3.3. Confirm the weight of evaluation indicator

The reasonable confirmation of indicator weight embodies the different weight relations among all the evaluation indicators in the system, increases the comparability among all the evaluation indicators and the effectiveness of evaluation result. AHP is objective with such merits as practicability, conciseness and systematicness. Thus, this paper adopts AHP to confirm the weights of all the evaluation indicators, obtaining the weight wi of each evaluation indicator ui. The set constituted by each weight wi is called weight set W, as shown in formula 1.

$$W=\{ w1, w2, w3, \ldots, wn \} \quad \sum_{i=1}^{n} w_i = 1 \quad wi \geq 0 \qquad (1)$$

There are generally the following steps to confirm indicator weight by AHP:

The specific steps to calculate indicator weight by adopting AHP are as follows.

① Construct Judgment Matrix

After building hierarchical structure, the subordination between elements in upper and lower hierarchies is confirmed. Suppose that taking top element U as criterion, the next hierarchical element dominated by it is u1, u2, …, un; corresponding weights w1, w2, …, wn of their relative importance towards U will be obtained through pairwise inter-comparison. Assign the value to indicators' relative importance based on scale table, n compared elements in the lower hierarchy consist of a pairwise inter-comparison judgment matrix $A=(aij)^{m\times n}$.

② Calculate the Weights of All the Indicators

This paper adopts root method to calculate weight; steps are as follows:

(a) Calculate the product of each line in comparison matrix;

(b) Extract nth root of products obtained in step a;

(c) Total all the products obtained in step b;

(d) Weight wi is obtained through dividing values obtained in step b by values in step c.

③ Consistency Check of Judgment Matrix

While building judgment matrix, due to complexity of objective things, there are always errors in judgment matrix. Generally, there may be no complete consistency in judgment matrix, so consistency check of judgment matrix is required. Quantitative indicator used for measuring judgment matrix is called consistency indicator CI, as shown in formula 2[8].

$$CI=(\lambda max-n)/(n-1) \qquad (2)$$

In formula 2[8], λmax is the maximum eigenvalue of judgment matrix, n is the number of comparison indicator. λmax is calculated as follows: respectively multiply elements in each line of judgment matrix by vector component of weight W, then add, obtaining Awi; divide Awi respectively by wi, obtaining value Awi/wi. λmax is the average value of Awi/wi.

In order to confirm the allowed range of inconsistency degree, the corresponding average random consistency indicator RI of n can be looked for Table 1.

Table 1. Average Random Consistency Indicator

Order	1	2	3	4	5
RI	0	0	0.58	0.90	1.12

At last, judge whether the matrix is consistent through consistency ratio CR, CR=CI/RI. If CR<0.1, the consistency of judgment matrix is acceptable. Whereas, if CR≥0.1, the consistency of judgment matrix is unacceptable; judgment matrix should be properly amended to keep the consistency of judgment matrix to certain extent.

3.4. Single-factor Fuzzy Evaluation

Suppose that evaluation object carries out evaluation according to the ith factor in factor set U ui (i=1, 2, 3, …, n), the subordination of which as to the jth factor in evaluation set V vj (j=1, 2, 3, …, m) is expressed as rij, formula 3 can be used to show the evaluation result of the ith factor ui.

$$Ri=\{ ri1, ri2, ri3 \ldots, rim \} \qquad (3)$$

Ri in formula 3 is single-factor evaluation set, so formula 4 can be obtained, i.e. single-factor evaluation set of each factor[10].

$$R=\begin{bmatrix} R_1 \\ R_2 \\ \cdots \\ R_N \end{bmatrix}=\begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1m} \\ r_{21} & r_{22} & \cdots & r_{2m} \\ \cdots & \cdots & \cdots & \cdots \\ r_{n1} & r_{n2} & \cdots & r_{nm} \end{bmatrix} \quad (4)$$

R in formula 4 is called single-factor evaluation matrix. Rij can be obtained through experts grading method, subordination function method or other managerial mathematical methods.

3.5. Build Evaluation Model to Carry out Fuzzy Overall Evaluation

In consideration of difference importance of each factor, i.e. different indicator weights, it is necessary to combine the weight set W and R of all the evaluation indicators, to carry out overall evaluation, building overall evaluation model formula 5.

$$B=WoR$$

$$=(w_1,\ w_2,\cdots,\ w_n)\circ\begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1m} \\ r_{21} & r_{22} & \cdots & r_{2m} \\ \vdots & \vdots & \vdots & \vdots \\ r_{n1} & r_{n2} & \cdots & r_{nm} \end{bmatrix} \quad (5)$$

$$=(b_1,\ b_2,\cdots,\ b_m)$$

In formula 5, B is the result set of fuzzy overall evaluation, bj (j=1, 2, 3, …, m) is called fuzzy overall evaluation indicator, which judges the indicator subordination of the jth evaluation element in evaluation set while comprehensively considering the impact of all the indicators on evaluation object.

In the above evaluation process, symbol "o" is fuzzy synthetic operator, also called fuzzy operator, generally having the following four forms:

Model 1 M(∧, ∨)——Major Factor Determining Type, see formula 6

$$b_j=\bigvee_{i=1}^{n}(w_i\wedge r_{ij}) \quad (j=1, 2, \ldots, m) \quad (6)$$

"∨" in formula 6 represents large-taking symbol, "∧" represents small-taking symbol, the model features the focus on major factors, and that other factors have little impact on results. This operation sometimes makes decision result not easy to be distinguished.

Model 2 M(·, ∨)——Major Factor Highlighting Type, see formula 7.

$$b_j=\bigvee_{i=1}^{n}(w_i r_{ij}) \quad (7)$$

" · " in formula 7 represents multiplication, the model first multiply species of attribute by single factor subordination, then get a greater one, the feature of which is to highlight major factor and ignore the role of secondary factor.

Model 3 M(∧, ⊕)——Major Factor Highlighting Type 8

$$b_j=\oplus\sum_{i=1}^{n}(w_i\wedge r_{ij}) \quad (8)$$

" ⊕ " in formula 8 is bounded sum, i.e. $a\oplus b=\min(1,\ a+b)$, $\oplus\sum_{i=1}^{n}$ is to get a sum of n under the operation of $\oplus$, i.e. $b_j=\min\left[1,\sum_{i=1}^{n}(w_i\wedge r_{ij})\right]$

Model 4 M(·, +)——Weighted Average Type, see formula 9

$$b_j=\sum_{i=1}^{n}(w_i r_{ij}) \quad (j=1, 2,\ldots, m) \quad (9)$$

The model first multiplies wi by Rij, then do the sum operation. The model, according to the weight of indicator factor, evenly gives consideration to all the indicator factors, especially applicable to the situation when multiple factors jointly work. Therefore, the competitiveness evaluation of commercial banks in this paper adopts that model for calculation.

4. Experiment Confirmation

4.1. Analysis and Establishment of Evaluation Indicator System

Network marketing performance evaluation is a complicated comprehensive operation system constituted by multiple elements, the numerous elements and subsystems of which exist in different forms, jointly assembly and forming competitiveness. This paper, based on the principle network consumer behavior analysis, in the light of connotation characteristics of competitiveness network marketing performance evaluation, especially on the basis of competitiveness analysis of experts consultations, combined with literatures, establishes a wide and scientific evaluation indicator system for network marketing performance evaluation [4,5,6,7], which includes four hierarchies, three categories(that are website performance, enterprise performance, customer relationship), seven second-grade indicator, thirty third-grade indicator. Limited of the paper space, the seven second-grade and thirty third-grade indicators are omitted here.

4.2. Experimental Results and Analysis

Experimental data come from database of three network enterprises, call A ,B and C respectively. For data of customer part, 500 network consumers of each network enterprises are selected as the basis for data training and experimental verification in the paper, totally 1500 con-

sumers' data for study data that come from practical investigation and visit. In order to make the selected consumers' data representatives, 300 learners(100 learner from each university) with more than 2 years network buying experience, 300 consumers with 1 years learning experience, 300 learners with less than 1 years learning experience.

Limited to paper space, the evaluation of intermediate results is omitted here, only providing secondary evaluation results and final comprehensive evaluation results, see Table 1.

Table 1. Part Evaluation Results of Different Network Enterprises

	Website Performance	Enterprise Performance	Customer Relationship	Final Evaluation
Corporation A	3.174	4.123	4.149	3.761
Corporation B	3.567	3.895	4.341	3.782
Corporation C	3.971	4.452	4.783	4.352

5. Conclusion

Comprehensive evaluation of network marketing performance is an effective method for guaranteeing network marketing performance, lying in the core status of the entire evaluation system of network marketing. Thus, there is a favorable application prospect for the analysis and competitiveness evaluation of network marketing performance based on the principle of fuzzy analysis. This paper makes use of multi-hierarchy fuzzy evaluation method to establish comprehensive evaluation model for network marketing performance, also carries out case study taking the data of three network enterprises as an example. Meanwhile, the multi-hierarchy fuzzy evaluation method built in this paper can be reference for the analysis and evaluation of other multi-factor systems.

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