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# Algorithm of Comprehensive Evaluation of Quality on Marketing Simulation Practice Based on FAHP

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**Abstract:** Experimental teaching plays an important role in the whole teaching system in colleges and universities. It is one of the contents of constructing the quality engineering, which is being carried out by the Ministry of Education of People's Republic of China. It is, therefore, necessary to reasonably evaluate the quality of the course. For the evaluation of quality on marketing simulation practice in college has general qualities of multi-dimension and uncertainty, there is a lack of prevalent evaluation methods in our universities. The objective of this study is to propose a hierarchy algorithm model of evaluation factors in the teaching quality. The methods of Fuzzy Analytic Hierarchy Process (FAHP) are applied to realize quantitative evaluation for the teaching quality on marketing simulation practice in college. Finally its application of the algorithm is tested with a calculation case, which shows that comprehensive evaluation result is satisfactory and the market simulation system achieves the desired effect.

**Key words:** Algorithm, evaluation, simulation practice, quality, FAHP

## INTRODUCTION

With the rapid development of economy in China, the demand of marketing talent is increasing quickly, many companies not only require students to have a wealth of marketing theory knowledge, but also pay more attention to the students' practical ability. In the complex environment of market economy, many enterprises are worried that the leakage of business secrets, unwilling to accept the interns. Even if they accept students to take part in the enterprise practice, the students are not scheduled to participate in key departments or post to participate in substantial marketing activities, which causes the student to obtain training opportunities are very limited and it is difficult in practice to achieve the desired effect. Therefore, it is urgent needs for targeted marketing simulation training software, which can help students apply the theoretical knowledge to practical ability, improves the students' practical ability. For this reason, marketing simulation training software which is urgently needed can make the students learn the theory knowledge and put it into practice, which can strengthen the students' practical ability. According to the students' actual needs of our college, an electronic training system of marketing management is introduced which is developed by Hangzhou Beiteng Technology Co., Ltd. But the effect of the training system should be evaluated and can rapidly improve the students' practical ability.

In order to evaluate fairly the effect of marketing simulation training, this study applies this system as an example, establishes a set of quality evaluation of simulation teaching, which is very important to make a scientific, objective evaluation system.

Many scholars had made some research about the practice teaching (Jabali *et al*., 2011; Marlinda *et al*., 2012; Ren *et al*., 2011; Cao, 2008; Wang *et al*., 2009; Yue and Li, 2010), but there are seldom researches about the marketing practice. According to the all-round, multi-angle requirements of marketing simulation practice teaching, the paper constructs a comprehensive quality evaluation model of marketing simulation practice teaching. On the basis of it, the paper uses the algorithm of Fuzzy Analytic Hierarchy Process (FAHP) to calculate the relative weight of indicators and uses the evaluation method of fuzzy integrated to make a quantitative evaluation of teaching quality of marketing simulation practice.

## CONCEPT OF MARKETING SIMULATION PRACTICE COURSE

The teaching system of the marketing simulation course provides a simulation environment of the market, in which all students who participate in the training are divided into many enterprises and compete against each other in a common environment. Members of the team serve as the CEO (Chief Executive Officer), CDO (Chief

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Direct Selling Officer), CTO (Chief Technology Officer), CMO (Chief Marketing Officer), CPO (Chief Production Officer), CFO (Chief Finance Officer), CCO (Chief Channel Officer) and CIO (Chief International Officer) of the enterprises to fully experience the various stages, including product design, production, pricing, promotion.

In the process of the enterprise development, all the marketing management and other management decision of the business operation management will be made independently by the team members according to the development of the market and competition situation. Finally the performance of the enterprises will be comprehensively measured by the whole evaluation scores of the Balanced Scorecard (Xiong, 2012).

## EVALUATION MODEL OF MARKETING SIMULATION PRACTICE COURSE QUALITY

**To establish an evaluation index system of marketing simulation practice course quality:** It is a complicated multi-objective decision problem for the evaluation of marketing simulation practice teaching. At present, some methods which are commonly used include the Analytic Hierarchy Process (AHP), Fuzzy Analytic Hierarchy Process (FAHP), fuzzy comprehensive evaluation method, etc. The traditional Analytic Hierarchy Process (AHP) has the following deficiencies in the application process: (1) There is a large difference between consistency of judgment matrix and consistency of decision thinking, (2) It is very difficult to check the consistency of judgment matrix (3) It is blind to adjust the consistency (Zhang, 2000).

Fuzzy Analytic Hierarchy Process (FAHP) is a system analysis method which can be obtained after the idea and method of fuzzy mathematics is introduced into the Analytic Hierarchy Process (AHP) method, which can simplify the complexity of the relative importance of judging the target people, realize the conversion decision from qualitative to quantitative fast and conveniently with the priority relation matrix, construct fuzzy consistency judgment matrix directly by the priority relation matrix to make the consistency problem of judgment solved (Wei *et al*., 2008). But FAHP is used to make the overall evaluation of the target; it lacks a unified, concrete method of quantitative index and calculation. So here it is used for the calculation of index weight and then it is combined with the fuzzy comprehensive evaluation method the comprehensive to evaluate teaching quality of marketing simulation practice.

Table 1: Number of scales measuring the relative importance degree between the elements

| Scale | Meaning |
|---|---|
| 0.5 | Compared with two elements, they are equally important. |
| 0.6 | Compared with two elements, the former is more important than the latter slightly. |
| 0.7 | Compared with two elements, the former is more important than the latter obviously. |
| 0.8 | Compared with two elements, the former is much more important than the latter. |
| 0.9 | Compared with two elements, the former is much more important than the latter extremely. |
| 0.1,0.2, 0.3,0.4 | Compared with the element $a_i$ and $a_j$, the value $r_{ij}$ can be obtained. Then the value $r_{ji} = 1-r_{ij}$ denotes the comparison of the element $a_j$ and $a_i$ |

**To establish priority judgment matrix $F = (f_{ij})_{n\times n}$:** In order to make the relative importance of any two elements of a certain criterion layer get quantitative description, the number of scale method from 0.1 to 0.9 can be used which is shown in the Table 1.

**To construct a fuzzy consistent matrix $A = (a_{ij})_{n\times n}$:** By the above method, the constructed judgment matrix is a fuzzy complementary matrix which should implement the following mathematical transformation and then it will be a fuzzy consistent matrix:

$$a_i = \sum_{k=1}^{n} f_{ik} \quad i = 1,2,...,n \tag{1}$$

$$a_{ij} = \frac{a_i - a_j}{2n} + 0.5 \tag{2}$$

**To determine the weight set:** According to the properties of fuzzy consistent metrics, the weight of various elements of the values will be obtained by the formula (3) and (4) and then the weight set $w = \{w_1, w_2, \ldots, w_i\}$ among first-class indexes can be calculated. Finally the weight set $w_i = \{w_{i1}, w_{i2}, \ldots, w_{ij}\}$ among second-class indexes will be obtained:

$$l_i = \sum_{j=1}^{n} a_{ij} - 0.5 \qquad i = 1,2,...,n \tag{3}$$

$$w_i = \frac{l_i}{\sum l_i} \tag{4}$$

**To establish the evaluation set V:** The evaluation set is a set which includes all possible outcomes of evaluation indicators and can be obtained by the experts. Because the evaluation set is a collection including all the evaluation results, it is only one and can be expressed as the following the formula (5):

$$v = \{v_1, v_2, \ldots, v_m\} \quad (5)$$

**To establish evaluation membership matrix R:**

$$R = \begin{pmatrix} R_1 \\ R_2 \\ \vdots \\ R_m \end{pmatrix} = \begin{pmatrix} r_{11} & r_{12} & \cdots & r_{1n} \\ r_{21} & r_{22} & \cdots & r_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ r_{m1} & r_{m2} & \cdots & r_{mn} \end{pmatrix} \quad (6)$$

Where:

$R_i$ = The evaluation results of the factor of No. i

$r_{ij}$ = The membership degree of that the evaluation factor of No. i responds to the evaluation grade of No. j, which reflects the relation between fuzzy evaluation factors and evaluation grade with membership representation

n = No. of evaluation grades in the evaluation set

m = No. of the evaluated factors

**To make the fuzzy comprehensive evaluation:**

- **To make first-level fuzzy comprehensive evaluation:** According to the index weight w which can be calculated by a fuzzy consistent matrix and established evaluation membership matrix R, fuzzy algorithm is used for comprehensive operations. And after normalization processing is done, membership vector S of the factor U responding to the evaluation set V can be obtained:

$$S_i = w_i \bullet R_i = \{w_{i1}, w_{i2}, \ldots, w_{ij}\} \bullet \begin{pmatrix} r_{11} & r_{12} & \cdots & r_{1n} \\ r_{21} & r_{22} & \cdots & r_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ r_{m1} & r_{m2} & \cdots & r_{mn} \end{pmatrix} \quad (7)$$

Where:

$w_i$ = Internal weight of the first-level evaluation index $U_i$ (i = 1, 2, 3, 4)

$R_i$ = The membership matrix corresponding to the first-grade evaluation index $U_i$ (i = 1, 2, 3, 4)

• = Operation symbols of the fuzzy synthesis

- **To make second-level fuzzy comprehensive evaluation:** Second-level fuzzy comprehensive evaluation can be made by the following formula (8):

$$A = W \bullet S \quad (8)$$

Where:

W = The weights among the first-level $U_i$ (i = 1, 2, 3, 4)

S = The membership vector S of the factor U corresponding to the evaluation set V

• = Operation symbols of the fuzzy synthesis

A = The total evaluation vector

**To determine the grade of evaluation:** In order to facilitate comparison, the comprehensive evaluation results should be converted to score, which can be calculated by the formula (9):

$$F = A \bullet V^T \quad (9)$$

Where:

A = The total evaluation vector

$V^T$ = Transposed matrix of rating scores matrix

• = Operation symbols of the fuzzy synthesis

F = The final evaluation score

## CALCULATION CASE OF MARKETING SIMULATION PRACTICE QUALITY EVALUATION

**To establish an evaluation index system of marketing simulation practice course quality:** The selection of evaluation indicators is a complicated process of system analysis, which includes many influencing factors. In order to make a more objective, accurate and complete evaluation of marketing simulation practice teaching quality, we must select evaluation index of marketing simulation practice teaching quality from all-round, multi-angle. In addition, the choice of the index must also comply with the following principles: (1) The scientific principle, (2) Meaning clarity principle, (3) Operability principle (4) The relative independence and relevance principle. In accordance with the hierarchical structure of the Analytic Hierarchy Process (AHP), the author establishes the corresponding evaluation index system, which is shown as Table 2.

**To establish a priority judgment matrix:** According to statistics data, views and analysis of the experts, the

Table 2: Evaluation index system of marketing simulation practice course quality

| First-level indicators | NO | Scale second-level indicators | NO |
|---|---|---|---|
| Content of courses | $U_1$ | Training materials and training guide book | $U_{11}$ |
| | | Key highlights | $U_{12}$ |
| | | Introduction of academic dynamic | $U_{13}$ |
| | | Linking theory with practice | $U_{14}$ |
| Teaching attitude | $U_2$ | Preparation, unscripted lecture | $U_{21}$ |
| | | Patient instruction training, strict requirements | $U_{22}$ |
| | | Actively exploring new teaching methods and implementation | $U_{23}$ |
| | | The classes on time | $U_{24}$ |
| Teaching method | $U_3$ | Good at motivating the enthusiasm that students participate in class | $U_{31}$ |
| | | Focus on heuristic education | $U_{32}$ |
| | | Make full use of multimedia means | $U_{33}$ |
| | | The integrated use of a variety of teaching methods | $U_{34}$ |
| Teaching effect | $U_4$ | Training skills | $U_{41}$ |
| | | Scores level of training test | $U_{42}$ |
| | | The completion of training report | $U_{43}$ |
| | | Evaluation of students | $U_{44}$ |

FAHP method is used to determine the relative importance of the various indexes by comparison with each other on the base of qualitative analysis of various factors. Then we can establish the priority judgment matrices that denote the relatively important degree in the index system, in which $F_0$ denotes the priority judgment matrix of the first-level indexes and $F_1$~$F_4$ denotes the priority judgment matrix of second-level indexes in every first-level indexes:

$$F_0 = \begin{pmatrix} 0.5 & 0.5 & 0.3 & 0.1 \\ 0.5 & 0.5 & 0.2 & 0.1 \\ 0.7 & 0.8 & 0.5 & 0.3 \\ 0.9 & 0.9 & 0.7 & 0.5 \end{pmatrix} \quad F_1 = \begin{pmatrix} 0.5 & 0.8 & 0.6 & 0.9 \\ 0.2 & 0.5 & 0.3 & 0.6 \\ 0.4 & 0.7 & 0.5 & 0.8 \\ 0.1 & 0.4 & 0.2 & 0.5 \end{pmatrix}$$

$$F_2 = \begin{pmatrix} 0.5 & 0.7 & 0.9 & 0.8 \\ 0.3 & 0.5 & 0.8 & 0.6 \\ 0.1 & 0.2 & 0.5 & 0.3 \\ 0.2 & 0.4 & 0.7 & 0.5 \end{pmatrix} \quad F_3 = \begin{pmatrix} 0.5 & 0.6 & 0.9 & 0.7 \\ 0.4 & 0.5 & 0.8 & 0.6 \\ 0.1 & 0.2 & 0.5 & 0.3 \\ 0.3 & 0.4 & 0.7 & 0.5 \end{pmatrix}$$

$$F_4 = \begin{pmatrix} 0.5 & 0.8 & 0.9 & 0.6 \\ 0.2 & 0.5 & 0.7 & 0.4 \\ 0.1 & 0.3 & 0.5 & 0.2 \\ 0.4 & 0.6 & 0.8 & 0.5 \end{pmatrix}$$

**To construct the fuzzy consistent matrix A:**

$$A_0 = \begin{pmatrix} 0.5000 & 0.5125 & 0.3875 & 0.3000 \\ 0.4875 & 0.5000 & 0.3750 & 0.2875 \\ 0.6125 & 0.6250 & 0.5000 & 0.4125 \\ 0.7000 & 0.7125 & 0.5875 & 0.5000 \end{pmatrix} \quad A_1 = \begin{pmatrix} 0.50 & 0.65 & 0.55 & 0.70 \\ 0.35 & 0.50 & 0.40 & 0.55 \\ 0.45 & 0.60 & 0.50 & 0.65 \\ 0.30 & 0.45 & 0.35 & 0.50 \end{pmatrix}$$

$$A_2 = \begin{pmatrix} 0.5000 & 0.5875 & 0.7250 & 0.6375 \\ 0.4125 & 0.5000 & 0.6375 & 0.5500 \\ 0.2750 & 0.3625 & 0.5000 & 0.4125 \\ 0.3625 & 0.4500 & 0.5875 & 0.5000 \end{pmatrix} \quad A_3 = \begin{pmatrix} 0.50 & 0.55 & 0.70 & 0.60 \\ 0.45 & 0.50 & 0.65 & 0.55 \\ 0.35 & 0.35 & 0.50 & 0.40 \\ 0.40 & 0.45 & 0.60 & 0.50 \end{pmatrix}$$

$$A_4 = \begin{pmatrix} 0.5000 & 0.6250 & 0.7125 & 0.5625 \\ 0.3750 & 0.5000 & 0.5875 & 0.4375 \\ 0.2875 & 0.4125 & 0.5000 & 0.3500 \\ 0.4375 & 0.5625 & 0.6500 & 0.5000 \end{pmatrix}$$

**To determine the weight set:**

The weight set among first-class indexes:

$$w_0 = \{0.2000, 0.1917, 0.2750, 0.3333\}$$

Internal weight of the first-level evaluation index $U_1$:

$$w_1 = \{0.3167, 0.2167, 0.2833, 0.1833\}$$

Internal weight of the first-level evaluation index $U_2$:

$$w_2 = \{0.3250, 0.2667, 0.1750, 0.2333\}$$

Internal weight of the first-level evaluation index $U_3$:

$$w_3 = \{0.3083, 0.2750, 0.1750, 0.2417\}$$

Internal weight of the first-level evaluation index $U_4$:

$$w_4 = \{0.3167, 0.2333, 0.1750, 0.2750\}$$

**To establish a priority judgment matrix:** According to the purpose of teaching evaluation quality, the author establishes an evaluation set including 4 levels:

$$V = \{v_1, v_2, v_3, v_4\} = \{\text{Excellent, good, medium, poor}\}$$

**To establish the evaluation membership matrix R:** The main body of objects who participate in the evaluation includes the school management department, college and department leadership and training teachers. By means of issuing questionnaires, participants complete questionnaires to take the above evaluation rating on the quality of practice teaching in accordance with the second-index evaluation score and on the basis of assessment membership grade can be established.

Specific approach is described as follows: According to the given decision evaluation, every one of the evaluation group has one and only one decision reviews which is responding to evaluation factor $U_{1i}$(i = 1, 2, 3, 4). Suppose the number of the evaluation group is N and the number of the level belonging to $V_j$ which is responding to the evaluation factor $U_{1i}$ is M, then evaluation membership $C_{ij}$ = M/N. The above line number of evaluation matrix is i, so the evaluation membership matrix $R_1$ can be constructed which is shown as follows:

$$R_1 = \begin{pmatrix} 0.35 & 0.40 & 0.25 & 0 \\ 0.42 & 0.48 & 0.10 & 0 \\ 0.25 & 0.20 & 0.42 & 0.13 \\ 0.55 & 0.35 & 0.10 & 0 \end{pmatrix}$$

By the same token:

$$R_2 = \begin{pmatrix} 0.65 & 0.35 & 0 & 0 \\ 0.55 & 0.30 & 0.15 & 0 \\ 0.38 & 0.30 & 0.32 & 0 \\ 0.75 & 0.25 & 0 & 0 \end{pmatrix} \quad R_3 = \begin{pmatrix} 0.53 & 0.32 & 0.15 & 0 \\ 0.48 & 0.32 & 0.20 & 0 \\ 0.35 & 0.30 & 0.25 & 0.10 \\ 0.50 & 0.35 & 0.15 & 0 \end{pmatrix} \quad R_4 = \begin{pmatrix} 0.55 & 0.30 & 0.15 & 0 \\ 0.40 & 0.35 & 0.25 & 0 \\ 0.46 & 0.32 & 0.22 & 0 \\ 0.70 & 0.22 & 0.08 & 0 \end{pmatrix}$$

**To make the fuzzy comprehensive evaluation:**

- **To make first-level fuzzy comprehensive evaluation:** According to the formula (7), the membership matrix $S_i$(i = 1, 2, 3, 4) can be obtained, in which the fact $U_i$ is responding to the evaluation set V:

$$S_1 = w_1 \bullet R_1 = \{0.3735, 0.3515, 0.2382, 0.0368\}, \; S_2 = w_2 \bullet R_2 = \{0.5994, 0.3046, 0.096, 0\}$$
$$S_3 = w_3 \bullet R_3 = \{0.4775, 0.3238, 0.1812, 0.0175\}, \; S_4 = w_4 \bullet R_4 = \{0.5405, 0.2932, 0.1663, 0\}$$

Table 3: Classification of quality grade evaluation

| Quality evaluation score | 90~100 | 80~90 | 70~80 | 0~70 |
|---|---|---|---|---|
| Grade | Excellent | Good | Mediate | Poor |

- **To make second-level fuzzy comprehensive evaluation:**

$$S = \begin{pmatrix} 0.3735 & 0.3515 & 0.2382 & 0.0368 \\ 0.5994 & 0.3046 & 0.096 & 0 \\ 0.4775 & 0.3238 & 0.1812 & 0.0175 \\ 0.5405 & 0.2932 & 0.1663 & 0 \end{pmatrix}$$

And $W = w_0 = \{0.2000, 0.1917, 0.2750, 0.3333\}$.

According to the formula (8):

$$A = w_0 \bullet S = \{0.5011, 0.3155, 0.1713, 0.0122\}$$

**To determine the grade of evaluation and analysis of results:** The quantification of evaluation grade is a comprehensive evaluation value. And it can be calculated by the weighted algebraic sum, in which the weight is membership degree. This method is better than the principle of maximum membership degree, because it does not give up membership in other classes and fully takes comprehensive information through a series of calculation operation.

Classification of quality evaluation is shown in Table 3 and we take the median score of evaluation grade as a representative from each grade:

$$V = \{v_1, v_2, v_3, v_4\} = \{95, 85, 75, 35\}$$

Therefore, the score of evaluation results of every second-level index respectively can be calculated as the following:

$$F_1 = S_1 \bullet V^T = \{0.3735, 0.3515, 0.2382, 0.0368\} \bullet \{95,85,75,35\}^T = 84.5130$$

By the same token:

$$F_2 = S_2 \bullet V^T = 90.0340,\ F_3 = S_3 \bullet V^T = 87.0880,\ F_4 = S_4 \bullet V^T = 88.7420$$

So the score of evaluation results of the first-level is calculated as the following:

$$F = A \bullet V^T = \{0.5011, 0.3155, 0.1713, 0.0122\} \bullet \{95,85,75,35\}^T = 87.6965$$

Then the above scores were compared with Table 3 and we can know that evaluation grade in course content, teaching methods, teaching effect belongs to "good" rating, evaluation grade in teaching belongs to "excellent" rating, finally the general result of evaluation grade belongs to "good" rating.

## CONCLUSION

Quality of marketing simulation practice is affected by many factors and it is difficult to have a comprehensive, accurate and quantitative evaluation. In this paper, based on marketing simulation practice teaching quality of our college as a comprehensive evaluation object, evaluation index system is established, which combines the advantage of FAHP and fuzzy comprehensive evaluation method, makes a comprehensive evaluation on the marketing simulation practice course quality, fully reflects the quality of practice teaching situation. To a certain extent, it solves better the complicate problem in the process of evaluation.

According to the actual calculation results, we can find that the overall quality of marketing simulation practice teaching is in good condition. The system shows good training effect and it can improve the students' ability to practice from the angle of practical simulation and achieve the expected teaching goal.

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