

# An Evaluation Model of Experiment System of Sensory Evaluation

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## Abstract

Sensory evaluation has been widely used in many fields. This paper analyzes the major composition of an experiment system of sensory evaluation. The method of fuzzy comprehensive evaluation is applied in building a model for evaluating rationality of the experiment system, and an application of this model is presented by an example.

**Keywords:** sensory evaluation, experiment system, rationality, fuzzy comprehensive evaluation

## 1. Introduction

Since 1975, Sensory evaluation was put forward by the food union of America, and it has been widely used in many fields, such as food product, cosmetic, automobile design, risk management, investment, human resource management, safety and so on (Stone and Sidel, 2004; Zeng, 2004). This concept is defined as follows (Stone and Sidel, 2004).

Sensory evaluation is a scientific discipline used to evoke, measure, analyze and interpret reactions to chose characteristics of products or materials as they are perceived by the senses of sight, smell, taste, touch and hearing.

It plays an important role in sensory evaluation to optimize experiment designs, and that is using less number of test to obtain available data as possible, by using intelligent technologies (Ruan and Zeng, 2004). In a process of sensory evaluation, evaluators determine the quality level of each sample according to the results of comparison between any two samples. The evaluation order of samples is not optimized in traditional practice. It's obvious that the cost of evaluation is strongly related to the number of tests, if the number of samples is large, the number of test is very large also, and the quality of test is influenced by the number of samples, along with increasing samples' quantity, the quality of test often drops. For evaluating  $n$  samples, if we use the method of test of pairs, the number of tests is  $n(n-1)/2$ . Therefore, it's useful to

optimize this evaluation order through experiment designs by developing a heuristic strategy, and the number of tests can be largely reduced while the evaluation precision is not changed significantly (Liu etc, 2006).

Before optimizing experiment methods of sensory evaluation, we should evaluate the reasonability of experiment system. There are many factors and links, which include the preparation of evaluation, execution, result handling and application etc., affect the validity of sensory evaluation's data, therefore it's necessary to synthesize the influence of reasonability of different factors for the evaluation experiment.

This paper aims at evaluating the reasonability of experiment system in sensory evaluation. It's very difficult to measure each factor that affects experiment system using the method of numeral. The reasonability of experiment system in sensory evaluation is concerned with many factors with fuzzy. As we known, the method of fuzzy comprehensive evaluation is widely used in many evaluation fields, such as engineering, project, risk, economics and management etc. This paper applies this method in analyzing the reasonability of experiment system in sensory evaluation, and the application of this model is illustrated by one example.

The organization of this paper is as follows, an experiment system in sensory evaluation is introduced in section 2; it includes three stages and nine factors. An evaluation model of experiment system in sensory evaluation is presented in section 3; the method of fuzzy comprehensive evaluation is put forward in this section. One example of evaluating the reasonability of experiment system in sensory evaluation is presented in section 4. Section 5 is conclusions that explain the advantage of evaluating the reasonability and some suggestions of experiment system in sensory evaluation.

## 2. An experiment system in sensory evaluation

The course of sensory evaluation is defined as a system that includes three compositions, i.e. input,

transfer and output, and the major function of this system is to get the information that is helpful to make a decision. In the ambient conditions, the experiment system of sensory evaluation is composed of evaluation object, quantity table, evaluator, synthetic method, result application, feedback and policymaker etc. The experiment system of sensory evaluation is shown as Fig.1.

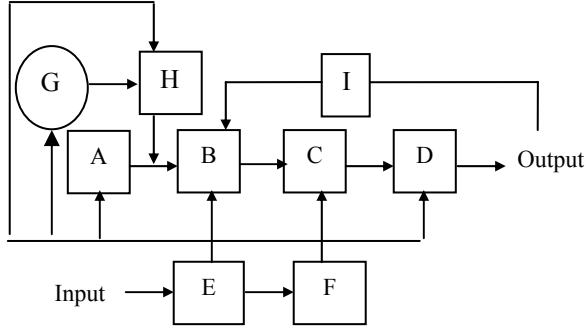


Fig.1: The experiment system of sensory evaluation.

The symbol of A, B, C, D, E, F, G, H and I in Fig.1 stands for evaluator, evaluation object, synthetic method, result application, condition, policymaker, expert, quantity table and feedback respectively.

The major composition of experiment system in sensory evaluation is analyzed as follows.

A. Evaluator. The evaluator of sensory evaluation includes ordinary customer and short time trained customer. It's proved that the evaluator selected stochastically is helpful to improve the reasonability of evaluation.

B. Evaluation object. The evaluation object includes products or service that will be evaluated. It's helpful to improve the effectiveness of evaluation by preconditioning the evaluation object.

C. Synthetic method. The information of evaluation is affected greatly by the synthetic method. It will get the different support information of decision using different synthetic method; therefore synthetic method should be reasonable and adaptable.

D. Result application. The major goal of experiment of sensory evaluation is how to improve the quality of products or service through the information of evaluation.

E. Condition. This is the basic factor that forms the experiment system of sensory evaluation. It's necessary to forecast the change of experiment condition.

F. Policymaker. The policymaker of experiment of sensory evaluation includes decision maker and organizer. The knowledge, ability, attitude and justice of the policymaker are important influence for the

reasonability of the experiment system of sensory evaluation.

G. Expert. The expert of experiment of sensory evaluation includes operating field expert and knowledge field expert. The major role of expert is to establish the quantity table and accomplish the evaluation of expert.

H. Quantity table. This is the objective foundation of experiment of sensory evaluation. The basic demanding of the quantity table is objectiveness and operability.

I. Feedback. The feedback of experiment of sensory evaluation includes the course of application and the self of experiment system. It's an important link to improve the effectiveness of experiment of sensory evaluation.

### 3. An evaluation model of experiment system in sensory evaluation

In this paper, we apply fuzzy technology to build the evaluation model of experiment system in sensory evaluation.

#### 3.1. Fuzzy comprehensive evaluation

The model of fuzzy comprehensive evaluation of many factors with fuzzy message is shown as followings.

For one object evaluated, set up

(1) The factor sets of evaluation is  $U = \{u_1, \dots,$

$u_i, \dots, u_m\}$

(2) The power weight of U is  $W = (w_i)_{1 \times m}$ ,

have

$$\sum_{i=1}^m w_i = 1, w_i \in [0, 1], i=1, \dots, m.$$

(3) The term sets of evaluation is  $V = \{v_1, \dots, v_j, \dots, v_n\}$ .

(4) The matrix of single factor is  $R = (r_{ij})_{m \times n}$ ,

here  $r_{ij}$  denotes the degree of factor evaluated  $u_i$

belongs to the term  $v_j$ .

(5) The result matrix is  $C = (c_j)_{1 \times n}$ , and then  $W \circ R = C$

Here,  $\circ$  is a synthetic operand.

(i) if  $\circ$  is  $(\vee, \wedge)$ , then

$$c_j = \bigvee_{i=1}^m (w_i \wedge r_{ij}), j=1, \dots, n$$

(ii) if  $\circ$  is  $(\vee, \bullet)$ , then

$$c_j = \bigvee_{i=1}^m (w_i \cdot r_{ij}), j=1, \dots, n$$

(iii) if  $\circ$  is  $(+, \wedge)$ , then

$$c_j = \sum_{i=1}^m (w_i \wedge r_{ij}), j=1, \dots, n$$

(iv) if  $\circ$  is  $(+, \bullet)$ , then

$$c_j = \sum_{i=1}^m (w_i \cdot r_{ij}), j=1, \dots, n$$

When the factors with fuzzy is too much, we usually adopt multistage fuzzy comprehensive evaluation model. This paper presents two levels fuzzy comprehensive evaluation model, and the more level model is similar to get.

Set up

(1) The factor sets of evaluation is  $U=\{u_1, \dots,$

$u_i, \dots, u_m\}$ .

According to one rule, divide  $U$  to subsets, set

$$U_k = \{u_{k_1}, \dots, u_{k_r}\}, k=1, \dots, s, \text{ meet to}$$

$$(i) \sum_{k=1}^s k_r = m,$$

(ii) if  $k \neq p$  ( $k, p \in \{1, \dots, s\}$ ), then

$$U_k \cap U_p = \emptyset;$$

$$(iii) \bigcup_{k=1}^s U_k = U,$$

(2) The power weight of sub sets cluster of

evaluation  $\{U_1, \dots, U_k, \dots, U_s\}$  is  $W = (w_i)_{1 \times s}$ ,

The power weight of sub sets of evaluation  $U_k$  is

$$W_k = (w_{k_1} \dots w_{k_r})_{1 \times k_r}, k=1, \dots, s,$$

(3) The term sets of evaluation is  $V=\{v_1, \dots, v_j, \dots,$

$v_n\}$ ,

(4) The matrix of single factor of sub sets  $U_k$  is  $R_k$ ,

$k=1, \dots, s$ .

(5) The matrix of result of sub sets  $U_k$  is  $C_k$ ,

$$W_k \circ R_k = C_k$$

$$k=1, \dots, s;$$

$$\text{and } R = (C_1 \dots C_k \dots C_s)^T;$$

(6) The matrix of result of factor sets  $U$  is  $C$ ,

And

$$W \circ R = C$$

## 3.2. Index system of evaluation

This paper presents an index system of evaluation of experiment system in sensory evaluation that is shown as Table 1.

The 1 <sup>st</sup> index	The 2 <sup>nd</sup> index
1.Evaluator	1.1 Governing power
	1.2 Justness
	1.3 Knowledge
	1.4 Investing degree
2.Evaluation object	2.1 Goal of evaluation
	2.2 Sample difference
	2.3 Sample number
	2.4 Sample quality
3.synthetic method	3.1 Mathematic method
	3.2 Replying to conflict
	3.3 Data lose
4.Application and feedback	4.1 Application
	4.2 Feedback
5.Condition	5.1 External condition
	5.2 Internal condition
6.Policymaker	6.1 Justness
	6.2 Investing degree
	6.3 Knowledge
	6.4 Ability
7.Quantity table	7.1 Degree of effect
	7.2 Degree of trust

Table 1: index system of sensory evaluation.

The 2<sup>nd</sup> index can be subdivided into the 3<sup>rd</sup> index according to the practice. The explanation of the 2<sup>nd</sup> index of evaluator in Table 1 is as following.

1.1 Governing power denotes the evaluator's governing power in the field of evaluation.

1.2 Justness denotes the evaluator's justness of evaluation.

1.3 Knowledge denotes the evaluator's knowledge of evaluation.

1.4 Investing degree denotes the evaluator's investing degree of evaluation.

In the same way, we can explain the others of the 2<sup>nd</sup> index in Table 1.

Moreover, It's one of key problems of determining the power weight of the 1<sup>st</sup> index and the 2<sup>nd</sup> index using a special method also, such as AHP, Delphi, and so on.

## 4. One example

We invited an expert to evaluate one experiment system of sensory evaluation according to the Fig.1 and Table 1.

The course of evaluation experiment system includes four steps that are as follows.

Step 1, the expert established the term sets, and set up to adopt five levels quantity table.

Step 2, the expert according to the Table 1 gave the matrix of single factor.

$$\tilde{R}_1 = \begin{pmatrix} 0.7 & 0.3 & 0 & 0 & 0 \\ 0.7 & 0.3 & 0 & 0 & 0 \\ 0.8 & 0.2 & 0 & 0 & 0 \\ 0.8 & 0.2 & 0 & 0 & 0 \end{pmatrix}$$

$$\tilde{R}_2 = \begin{pmatrix} 0.9 & 0.1 & 0 & 0 & 0 \\ 0.8 & 0.2 & 0 & 0 & 0 \\ 0.8 & 0.2 & 0 & 0 & 0 \\ 0.9 & 0.1 & 0 & 0 & 0 \end{pmatrix}$$

$$\tilde{R}_3 = \begin{pmatrix} 0.6 & 0.4 & 0 & 0 & 0 \\ 0.4 & 0.6 & 0 & 0 & 0 \\ 0.9 & 0.1 & 0 & 0 & 0 \end{pmatrix}$$

$$\tilde{R}_4 = \begin{pmatrix} 0.7 & 0.3 & 0 & 0 & 0 \\ 0.8 & 0.2 & 0 & 0 & 0 \end{pmatrix}$$

$$\tilde{R}_5 = \begin{pmatrix} 0.7 & 0.3 & 0 & 0 & 0 \\ 0.9 & 0.1 & 0 & 0 & 0 \end{pmatrix}$$

$$\tilde{R}_6 = \begin{pmatrix} 0.8 & 0.2 & 0 & 0 & 0 \\ 0.8 & 0.2 & 0 & 0 & 0 \\ 0.9 & 0.1 & 0 & 0 & 0 \\ 0.9 & 0.1 & 0 & 0 & 0 \end{pmatrix}$$

$$\tilde{R}_7 = \begin{pmatrix} 0.9 & 0.1 & 0 & 0 & 0 \\ 0.9 & 0.1 & 0 & 0 & 0 \end{pmatrix}$$

Step 3, the expert established the matrix of power weight of each evaluation factor through different methods. To illustrate the model and evaluation method, we set up to adopt the same power weight for each index.

Step 4, to determine the result of evaluation, the key problem in this step is to choose the fuzzy operand according to the application. As the whole evaluation of experiment system, we adopt the operand as (+, •), and as for improvement evaluation, we adopt the operand as (∨, ∧). In this sample, we choose the operand as (+, •), and the result of evaluation is as following.

$$\tilde{C} = (0.8 \quad 0.2 \quad 0 \quad 0 \quad 0)$$

According to the principle of the most membership, we can get the result of evaluation of experiment system being very good.

## 5. Conclusions

This paper applied the fuzzy technology in building an evaluation model of experiment system in sensory evaluation. There are two aspects of role for this working, firstly, it's useful to improve the quality of data of sensory evaluation, and the secondly, the cost of experiment was decreased. Because there are many factors that affect the effectiveness of sensory evaluation, it's necessary to study the reasonability by accumulating evaluation data and referring to the expert on the field to do according to the specific experiment system in sensory evaluation.

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