

# Comprehensive and Fuzzy Study of Performance Evaluation on Green Marketing in Enterprises\*

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**Abstract** From a view of corporate innovation, this paper probes into the basic contents of green marketing performance and describes a number of factors and conditions that influence green marketing performance. Meanwhile based on an analysis into characteristics of enterprises' green marketing performance, this paper constructs an index system for the comprehensive evaluation on enterprises' green marketing performance and delivers a model for the fuzzy evaluation of green marketing performance to underpin the improvement of innovative enterprises' green marketing performance.

**Key words** Green marketing; Performance; Index system; Fuzzy evaluation model

## 1 Introduction

Modern green marketing is originated from the researches carried out by a number of scholars on ecological marketing in middle 1970s. Green marketing has become the focus of corporate innovations for the worsening environmental issues and the reinforcing consumers' awareness of environment protection. Internationally, significance of green marketing has not been widely acknowledged until the end of 1980s to the beginning of 1990s, especially during 1991 to 1993. Morgan Mars and Lynda Monira defined the concept of environmental marketing direction, i.e., an enterprise shall attach importance to social morals, ethics, and responsibilities, and shoulder the task to create and sustain a healthy environment without endangering benefits of posterities. This concept is different from the traditional theory of production direction, promotion direction, and marketing direction<sup>[1]</sup>. In Chinese researchers' study on green marketing performance, Wei Mingxia had an opinion that green marketing performance are mainly expressed at three aspects, namely corporate performance, performance of ecological environment, and performance of social environment. These three aspects are an inseparable integrity. Wei Mingxia presented the correlation among these three aspects. The focus of researches is corporate performance, while performance of ecological environment is an important condition for researches of corporate performance, and social performance expresses the value of green marketing<sup>[2]</sup>. However, generally researches on green marketing performance lacked systematic evaluation and control. Therefore, one of the important tasks for modern enterprises to implement green marketing strategy is to construct an index system for the evaluation of green marketing performance and therefore to evaluate and control green marketing performance and conduct innovative green marketing activities in a scientific way, and thus to improve green marketing performance<sup>[4]</sup>.

## 2 Green Marketing Performance System

### 2.1 Classification of performance system

Green marketing performance system has four tiers for enterprises' marketing activities feature hierarchy<sup>[2]</sup>.

(1) Environmental super-system of enterprises' green marketing

Environmental super-system of enterprises' green marketing existing outside of enterprises is a target to be realized by enterprises' green marketing.

(2) Idea system of enterprises' green marketing

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Green marketing idea is the premise and foundation for enterprises to implement green marketing. The marketing strategy of enterprises shall show the requirements of four aspects, namely re-consumption of products, re-conducting of customer requirements, re-determination of marketing combination, and re-organization of enterprises.

(3) Executive system of enterprises' green marketing

Executive system of green marketing means enterprises' integrated green marketing activities conducted by green marketing idea. An important, internal security system for enterprises is used to implement green marketing.

(4) Control system of enterprises' green marketing

Control system of green marketing is the critical part to guarantee the normal running of green marketing system and to improve performance of green marketing.

**2.2 Performance index system**

The effects of green marketing have a direct influence on the sales performance of enterprises' innovation, even on the survival and development of enterprises' innovation. Thus enterprises shall estimate and evaluate the performance of green marketing activities they implemented. When to evaluate the performance of green marketing, we should note that the green marketing activities of enterprises are involving all the aspects of society and ecology. They have a potential, lasting influence. Therefore, green marketing performance is not the simple sum of one or several effects, but a comprehensive and integrative concept. Thus the evaluation on green marketing performance shall be a comprehensive evaluation of multiple tiers, factors, and targets. Only an index system designed from multiple aspects and levels can show exactly whether the green marketing performance of innovative enterprises is low or high. [5]

As shown in Table 1, an index system to evaluate enterprises' green marketing performance is structured based on the meaning of green marketing, features of its performance system, taking into account the principles of target-oriented, scientific, practical, systematic, hierarchical, comparative, comprehensive, and both qualitative and quantitative. [4]

**Table 1 Performance Index System of Enterprises' Green Marketing**

Tier of Target	Tier of Rules	Tier of Sub-rules	Tier of Index
Comprehensive Goodness of Green Marketing Performance	Corporate Performance	Corporate Profitability	Sales Profit Margin; Power of Cost Control
		Corporate Growth Potential	Sales Increase Rate; Market Share
		Corporate Image	Enterprise Fame; Acknowledged Reputation
		Corporate Culture	Staff's Green Awareness; Green Execution Power of Enterprise
		Corporate Competence	Competitors' Imitation Rate; Customers' Fidelity
	Performance of Ecological Environment	Resource Usage Rate	Effective Usage Rate of Resource; Resource Consumption Rate
		Environmental Protection Capacity	Clean Production Rate; Harmless Exhaust Rate
	Performance of Consumers	Customer Service Ability	Green Products Rate; Customer Satisfaction Rate
		Customer Influence	Green Consumption Rate; Green Products Recognition
	Social Performance	Social Influence	Brand Recognition; Environmental Influence
		Public Recognition	Social Return Rate; Media Attention Rate
		Service Level	Service Project Investment Rate and Satisfaction Degree

**3 Performance Evaluation Model of Enterprises' Green Marketing**

As the integrated evaluation on green marketing performance shall take into account many factors, the performance index system is quite complicated for many factors are of fuzzy type that features uncertainty and impreciseness. Using the performance index system of enterprises' green marketing shown in Table 1, we firstly took a comprehensive evaluation on each class of indices of different tiers, and then to undertake a higher comprehensive integration on evaluation results, i.e., to have a multi-tier fuzzy integrated evaluation. The basic steps are: [2]

Determine the evaluation subsystems that affect green marketing performance and mark them as  $V = \{V_1, V_2, \dots, V_n\}$ , totally  $n$  evaluation subsystems. For example: Performance Goodness = {Subsystem of Enterprise, Subsystem of Ecology, Subsystem of Society}.

Determine the evaluation rules that affect the performance of No.  $i$  ( $i=1,2,\dots,n$ ) evaluation subsystem and mark them as  $V_i = (V_{i1}, V_{i2}, \dots, V_{im})$  to indicate that No.  $i$  subsystem has  $m$  evaluation rules. For example: Social Performance = {Service Level, Social Direction, Public Effects}.

Determine the basic evaluation index set under No.  $j$  ( $j=1, 2, \dots, m$ ) rule that affects No.  $i$  evaluation subsystem and mark it as  $V_{ij} = \{V_{ij1}, V_{ij2}, \dots, V_{ijq}\}$  to indicate that No.  $j$  tier of rules of No.  $i$  evaluation subsystem has  $q$  basic evaluation indices. For example: Service Level = {Service Project Investment Rate, Product Return and Exchange Rate} .

Suppose the weight of each basic index in  $V_{ij}$  to be  $A_{ij} = \{a_{ij1}, a_{ij2}, \dots, a_{ijq}\}$ . The corresponding set of comments is  $U = \{U_1, U_2, \dots, U_p\}$ , totally  $p$  levels, for example  $U = \{ \text{Very Bad, Bad, Common, Good, Very Good} \}$ . The membership matrix for the membership degree of each basic index in  $V_{ij}$  is  $R_{ij}$ .

$R_{ij}$  indicates that in No.  $j$  rule of No.  $i$  evaluation subsystem, the membership of No.  $g$  ( $g=1,2,\dots,q$ ) basic index to the tier  $H$  ( $H=1,2,\dots,p$ ). Take the integration of the first tier on the basic evaluation indices of No.  $j$  tier of rules of No.  $i$  evaluation subsystem, i.e., the basic indices of  $V_{ij}$  using the original model of fuzzy comprehensive evaluation, we get the result of fuzzy integrated evaluation on No.  $j$  tier of rules of No.  $i$  evaluation subsystem as:

$$B_{ij} = A_{ij} \square R_{ij} = (b_{ij1}, b_{ij2}, \dots, b_{ijp}) \tag{1}$$

From Formula (1) we get the fuzzy evaluation matrix of No.  $m$  tier of rules in  $V_i$  as  $R_2$ :

$R_{2jH}$  means the membership of No.  $K$  ( $K=1, 2, \dots, j$ ) tier of rules of No.  $i$  evaluation subsystem to the tier  $H$  ( $H=1, 2, \dots, p$ ). Suppose the weight for each tier of rules in  $V_i$  as  $A_i = (a_{i1}, a_{i2}, \dots, a_{ij})$ , and take an integration of the second tier on the tier of rules of No.  $i$  subsystem, i.e., the tier of rules of  $V_i$ , we get the result of fuzzy integrated evaluation on No.  $i$  evaluation subsystem as:

$$B_i = A_i \square R_i = (b_{i1}, b_{i2}, \dots, b_{ip}) \tag{2}$$

From Formula (2) we get the fuzzy evaluation matrix of No.  $n$  evaluation subsystem of  $V$  as  $R_3$ :

$R_{3lH}$  means the membership of No.  $l$  ( $l = 1, 2, \dots, n$ ) performance goodness evaluation subsystem to the tier  $H$  ( $H=1,2,\dots,p$ ). Suppose the weight of  $V$  evaluation subsystem as  $A = (a_1, a_2, \dots, a_n)$ , we take an integration of the third tier on the performance goodness evaluation subsystem, i.e., evaluation subsystem of  $V$ , using the original model of fuzzy integrated evaluation. We get the result of fuzzy integrated evaluation of performance goodness as:  $B = A \square R = (b_1, b_2, \dots, b_n)$ .

Calculate out performance goodness of green marketing:

$$P = B \square C^T \tag{3}$$

Of which  $C$  is the row vector of fuzzy evaluation constituted of the representative value or mean value of each grade.

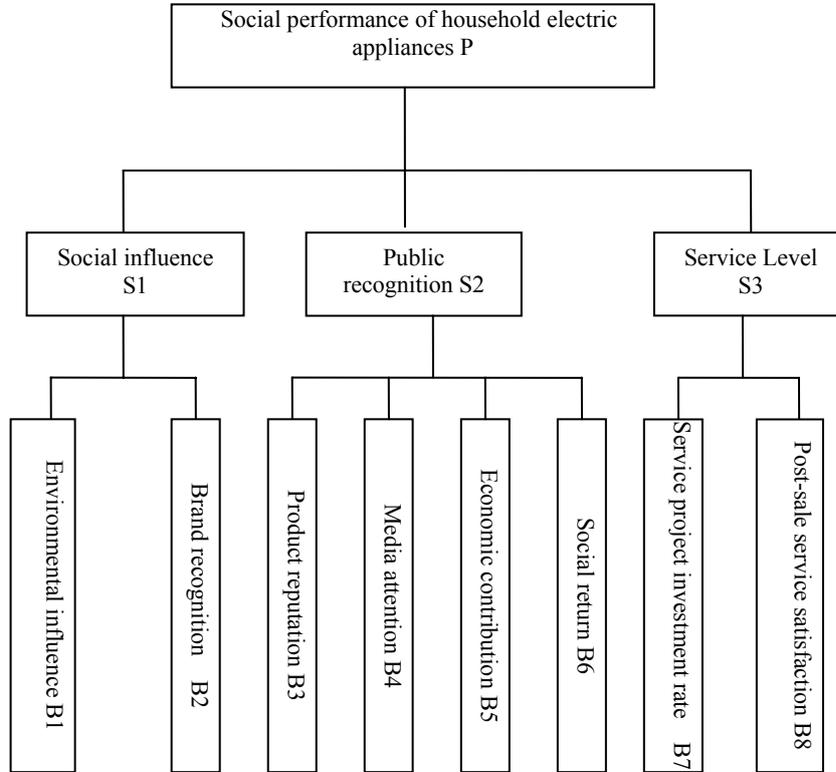
#### 4 Demonstrative Analysis

Consumers come directly to marketplaces of household appliances, so they are apt to form some kind of image towards such marketplaces. Performance goodness of these marketplaces influences directly the quantity of consumers and their consumption amount, and thus influences the survival and development of innovative enterprises. Therefore, this paper selects one marketplace of household appliances in western China for a comprehensive analysis on the performance goodness of this enterprise's green marketing. Selecting from corporate performance, performance of ecological environment, performance of consumers, and social performance, this paper evaluates the performance goodness of social performance as an example. According to the theory of green marketing, the enterprise has achieved outstanding social performance in social influence, public recognition, and service level. Below we used the fuzzy evaluation method to evaluate performance goodness.

We collected back 88 among 100 questionnaires presented to the company. Of these 88 questionnaires, 55 are valid, staying for 65% validity rate. Questionnaires were made to survey information and data such as marketplace's reputation (whether consumers know it), coverage of consumers, quality of sold products, media report frequency, donation for commonweal, paid-up taxes, post-sale service level of sold products, and management level of the enterprise's service department.

By collecting and combing the collected data, and taking into account relevant data of similar enterprises, together with the survey of some experts' comments, this paper constructed an index system with tiers as shown in Figure 1, and values of related indices were delivered.

**4.1 Construction of index system for social performance evaluation**



**Figure 1 Indices for Evaluating Social Performance of Household Appliances**

**4.2 Set and standardize values of basic indices**

Matrix  $X$  is delivered using the scale of 100-score based on the evaluated and elected data. Then

formula  $d_{ij} = \frac{x_{ij} - x_j^{\Delta}}{x_j^* - x_j^{\Delta}}$  ( $x_j^*$  is the optimal value of Index  $j$ ,  $x_j^{\Delta}$  the worst) is used to get the

matrix of benefits. Suppose: The ideal score is 100, the worst score is 50.

$$X = \begin{bmatrix} 80 & 89 & 93 & 87 & 82 & 91 & 88 & 84 \\ 81 & 83 & 91 & 82 & 85 & 88 & 80 & 81 \\ 80 & 79 & 84 & 80 & 78 & 81 & 82 & 76 \\ 88 & 84 & 87 & 86 & 80 & 79 & 86 & 87 \\ 70 & 81 & 89 & 83 & 84 & 80 & 89 & 82 \\ 86 & 79 & 78 & 81 & 86 & 83 & 75 & 83 \\ 75 & 81 & 83 & 76 & 89 & 91 & 84 & 85 \\ 72 & 88 & 87 & 83 & 86 & 85 & 81 & 80 \end{bmatrix} \Rightarrow D = \begin{bmatrix} 0.60 & 0.78 & 0.86 & 0.74 & 0.64 & 0.82 & 0.76 & 0.68 \\ 0.70 & 0.66 & 0.82 & 0.64 & 0.70 & 0.76 & 0.60 & 0.62 \\ 0.60 & 0.48 & 0.68 & 0.60 & 0.56 & 0.62 & 0.64 & 0.52 \\ 0.76 & 0.68 & 0.74 & 0.72 & 0.60 & 0.58 & 0.72 & 0.74 \\ 0.40 & 0.62 & 0.78 & 0.66 & 0.68 & 0.60 & 0.78 & 0.64 \\ 0.72 & 0.58 & 0.76 & 0.62 & 0.72 & 0.66 & 0.50 & 0.66 \\ 0.50 & 0.62 & 0.66 & 0.52 & 0.78 & 0.82 & 0.68 & 0.70 \\ 0.84 & 0.78 & 0.74 & 0.66 & 0.72 & 0.70 & 0.62 & 0.60 \end{bmatrix}$$

**4.3 Determine the weight value**

Get experts' calculation results on the importance degree of the second tier's indices, as shown in Table 2.

**Table 2 Statistics of Importance Degree of Second Tier's Indices**

Grade	Very Important	Important	To be Accounted	Insignificant
Social Influence	3	4	1	0
Public Recognition	5	3	0	0
Service Level	3	3	2	0

Importance degrees of different indices are got in Table 3 based on Table 2.

**Table 3 Values of Importance Degree**

Grade of Indices	Very Important	Medium	Important	Medium	To be Accounted	Medium	Low Significance	Medium	Insignificant
Quantitative Interval	8.5—9.5	7.5—8.5	6.5—7.5	5.5—6.5	4.5—5.5	3.5—4.5	2.5—3.5	1.5—2.5	0.5—1.5
Interval Median	9	8	7	6	5	4	3	2	1

Using the formula  $a_i = \frac{\sum_{j=1}^9 a_j \cdot f_{ij}}{\sum_{j=1}^9 f_{ij}}$  (of which the median of No.  $j_y$  grade's quantitative interval is  $a_i$ , while  $a_i$  is the value of importance degree of No.  $i_{ij}$  index,  $f_{ij}$  the quantity of experts' who evaluate No.  $i_{ij}$  as No.  $j_y$  grade), as shown in Table 4.

**Table 4 Importance Degree of Second Tier's Indices**

Index	Social Influence	Public Recognition	Service Level
Value of Importance Degree	7.5	8.5	7.25
Importance Degree	Important	Very Important	Important

Determine proportional scale

Here we use the relative comparison method to make the relative importance degrees of any two indices can be comparative. This comparison can be transferable in subjective judgment.

Proportional scale for the comparison of two factors:

$a_{ij} = \{1, 2, 3, 4, 5, 6, 7, 8, 9\}$  is used to indicate the relative importance degree when two factors are compared. 1 means the former and the latter has the same importance degree; 9 means the former is much more important than the later. The other numbers are used to indicate the importance differences between 1 and 9. Then the formula  $w_i = \frac{\sum_{j=1}^n a_{ij}}{\sum_{i=1}^n \sum_{j=1}^n a_{ij}}$  is used to calculate out the weight.

**P-S**

P	S1	S2	S3	Wp
S1	1	1/2	3	0.32
S2	2	1	4	0.56
S3	1/3	1/4	1	0.12

Wp means the weight of Tier S compared with the target tier P.

**S1-B**

S1	B1	B2	Ws1
B1	1	1/6	0.14
B2	6	1	0.86

Ws1 means the weight of basic indices B1 and B2 compared with Tier S1.

**S2-B**

S2	B3	B4	B5	B6	Ws2
B3	1	1/4	1/2	1/4	0.09
B4	4	1	2	1	0.36
B5	2	1/2	1	1/2	0.18
B6	4	1	2	1	0.36

Ws2 means the weight of basic indices B3-B6 compared with Tier S2.

**S3—B**

S3	B7	B8	Ws3
B7	1	3	0.75
B8	1/3	1	0.25

Ws3 means the weight of basic indices B7 and B8 compared with Tier S3.

**4.4 Determine the results of social performance evaluation**

The fuzzy integrated valuation method is used for evaluation with grades set as social performance  $0 < P \leq 0.2$  (very bad);  $0.2 < P \leq 0.4$  (bad);  $0.4 < P \leq 0.6$  (common);  $0.6 < P \leq 0.8$  (good);  $0.8 < P \leq 1$  (very good); of which P means the social performance of household appliances.

Standardized values are calculated out based on the scores given by experts. Based on grades scale of social performance, we got Table 5, which shows the membership degree of each index.

**Table 5 Evaluation**

Indices \ Grades	B1	B2	B3	B4	B5	B6	B7	B8
Very Good	1	0	2	0	0	2	0	0
Good	3	6	6	6	6	4	6	6
Common	3	2	0	2	2	2	2	2
Bad	1	0	0	0	0	0	0	0
Very Bad	0	0	0	0	0	0	0	0

Based on the weight and membership degree of indices mentioned above and using Formula (1), we calculated out the result of “social influence” for the integrated evaluation of social performance of household appliances’ marketplace as:

$$B_1 = \begin{bmatrix} 0.14 & 0.86 \end{bmatrix} \cdot \begin{bmatrix} 0.125 & 0.375 & 0.375 & 0.125 & 0 \\ 0 & 0.75 & 0.25 & 0 & 0 \end{bmatrix} = \begin{bmatrix} 0.018 & 0.698 & 0.268 & 0.018 & 0 \end{bmatrix}$$

Using the same way we calculated out the integrated evaluation result of “public recognition” as:

$$B_2 = \begin{bmatrix} 0.09 & 0.36 & 0.18 & 0.36 \end{bmatrix} \cdot \begin{bmatrix} 0.25 & 0.75 & 0 & 0 & 0 \\ 0 & 0.75 & 0.25 & 0 & 0 \\ 0 & 0.75 & 0.25 & 0 & 0 \\ 0.25 & 0.5 & 0.25 & 0 & 0 \end{bmatrix} = \begin{bmatrix} 0.113 & 0.653 & 0.225 & 0 & 0 \end{bmatrix}$$

Integrated evaluation result of “service level” is:

$$B_3 = \begin{bmatrix} 0.75 & 0.25 \end{bmatrix} \cdot \begin{bmatrix} 0 & 0.75 & 0.25 & 0 & 0 \\ 0 & 0.75 & 0.25 & 0 & 0 \end{bmatrix} = \begin{bmatrix} 0 & 0.75 & 0.25 & 0 & 0 \end{bmatrix}$$

From Formula (2), we calculated out the integrated evaluation of the second tier as:

$$\bar{P} = \begin{bmatrix} 0.32 & 0.56 & 0.12 \end{bmatrix} \cdot \begin{bmatrix} 0.018 & 0.698 & 0.268 & 0.018 & 0 \\ 0.113 & 0.653 & 0.225 & 0 & 0 \\ 0 & 0.75 & 0.25 & 0 & 0 \end{bmatrix} = \begin{bmatrix} 0.07 & 0.68 & 0.24 & 0.01 & 0 \end{bmatrix}$$

From Formula (3), we calculated out the result of fuzzy integrated evaluation of social performance of household appliances’ marketplace:

$$P = \begin{bmatrix} 0.07 & 0.68 & 0.24 & 0.01 & 0 \end{bmatrix} \cdot \begin{bmatrix} 0.9 \\ 0.7 \\ 0.5 \\ 0.3 \\ 0.1 \end{bmatrix} = 0.662$$

$0.6 < P = 0.662 \leq 0.8$ . Thus we know that the fuzzy integrated evaluation result of marketplace of household appliances is good, which indicates that the enterprise has a high goodness of social performance. However, the enterprise wants innovations to improve brand marketing and corporate responsibility, and thus to increase social influence of the enterprise in an overall way. Using the same way we can calculate out the fuzzy integrated evaluation results for corporate performance, performance of ecological system, and performance of consumers, and thus to get the performance goodness of green marketing of this marketplace of household appliances.

## 5 Conclusion

The fuzzy integrated evaluation model for green marketing performance collects and treats information based on the integral effects of green marketing activities of innovative enterprises. Based

on the fuzziness of performance evaluation, this model uses fuzzy mathematics as the methodological foundation, while an index system for green marketing performance evaluation is constructed to build single-factor evaluation matrix and weight fuzzy sets, and thus to calculate out the comprehensive evaluation on the performance goodness of green marketing. With the performance goodness we got, we may point out risks an enterprise faces and its defects to be amended. Therefore, it becomes possible for an enterprise to adjust and perfect its operational and managerial system<sup>[6]</sup>, realizing the true sustainable development in an innovative way.

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