Fuzzy Purchase Intention Model: An Extension of Fishbein & Ajzen Model

Daiki Wakayama* and Kazuhisa Takemura**
* Department of Management Science and Engineering, Akita Prefectural University
** Department of Psychology, Waseda University
* 84-4 Tsuchiya-Ebinokuchi, Honjo, Akita, 015-0055 JAPAN
**1-24-1 Toyama, Shinjuku, Tokyo, 162-8644 JAPAN
Email: dwakayam@akita-pu.ac.jp, kazupsy@waseda.jp

Abstract – **In this paper, fuzzy purchase intention model based on the Fishbein & Ajzen model [2] were proposed. In the proposed model, attitude, social norm and purchase intention were measured with vagueness by fuzzy rating method. The attitudinal and normative influences on purchase intention were analyzed by two kinds of estimation method: the possibilistic linear regression analysis and the fuzzy regression using the least square method. This paper showed that the fuzzy purchase intention model could examine two kinds of vagueness, one in consumer ratings of the causal factors and the other in consumer judgments of the relative importance of the attitudinal and normative components. Theoretical and practical implications for the proposed model were discussed.**

I. INTRODUCTION

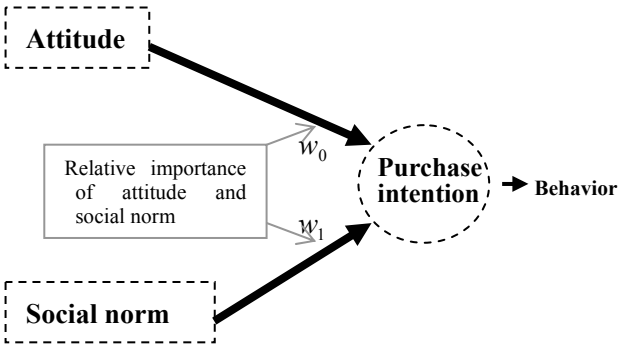
The Fishbein & Ajzen model (theory of reasoned action) has mainly argued in studies on consumer behavior by social psychological approach. Studies using the Fishbein & Ajzen model generally have focused a relative importance of the attitudinal and normative components in order to predict a consumer purchase intention [1, 2, 3, 6]. It is important for marketers as well as researchers to understand the components and the influences on consumer purchase intention, and to design effective marketing communications.

One limitation of purchase intention models such as Fishbein & Ajzen model is that they did not treat vagueness in consumer ratings and judgments of the relative importance among causal factors. For example, they did not treat the vagueness in rating and relationships between the purchase intension and each of the causal factors, in spite of the instructive discussions of many recent studies using fuzzy set theory [14].

In this paper, Fuzzy Purchase Intention Model based on the Fishbein & Ajzen model, which took two kinds of vagueness (one in evaluation and the other in judgment) into consideration to the Fishbein & Ajzen model were proposed. Then, this paper explained assumptions of the fuzzy purchase intention model and we demonstrated an example of an application to the data of a consumer study.

Ⅱ. FISHBEIN & AJZEN MODEL AND VAGUENESS

The fuzzy purchase intention model proposed by this study measures and analyzes the vagueness of evaluation, and the vagueness of judgment, on the basis of Fishbein & Ajzen model. Figure 2.1 shows a simplified description of the Fishbein & Ajzen model.



Note: Arrows indicate the direction of influence

Figure 2.1 A simplified description of the Fishbein & Ajzen model: "Relationships between attitude, social norm, and purchase intention" (Ajzen & Fishbein, 1980)

According to the Fishbein & Ajzen model, consumer's purchase intention is a function of two basic determinants. One is personal in nature and the other is reflecting social influence. The personal

factor is the individual's positive or negative evaluation performing the purchase behavior; this factor is termed "attitude" toward the purchase behavior. It simply refers to the person's evaluation that performing the behavior is rated on the following four evaluative semantic differential scales: foolish-wise, good-bad, harmful-beneficial, reward-punishing. The four rating scores are averaged and used as the value of attitude. The second determinant of intention is the person's perception of the social pressures put on him (or her) to perform or not perform the behavior in question. Since it deals with perceived social prescriptions, this factor is termed "social norm".

Fishbein & Ajzen claim that all effects on behavioral intentions are mediated by attitude toward the behavior and social norm.

The following are examples of the scales used to measure variables of purchase intention, attitude and social norm. It is called the scales as Fishbein & Ajzen's measure [2].

(1) Purchase intention

I intended to buy "Miller beer" for my own use in the next week.

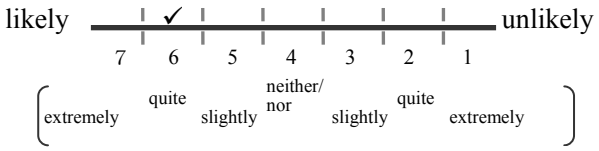


Figure 2.2 an example of purchase intention (intention to buy Miller beer, unipolar scale).

The response to the scale is scored +6 (✓ as indicated on unipolar seven-point-scale). The response of +6 means that a person who has a "quite positive" intention to buy "Miller beer".

The method of the point estimation ignores vagueness in rating, and the data of the responded score are interpreted with crisp number (not fuzzy).

The method of measuring attitude and social norm are shown in Fig 2.3 and Fig 2.4.

(2) Attitude toward the purchase behavior

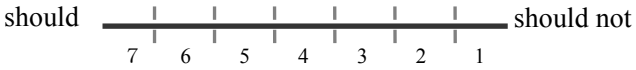
Buying "Miller beer" for my own use in the next week would

Figure 2.3 an example of attitudinal scale (e.g. foolish-wise, unipolar scale).

The attitudinal component is captured by 4 evaluative semantic differential scales, such as the foolish-wise (See Fig2.3), good-bad, harmful-beneficial, reward-punishing. They sort each item into one of seven categories that they are to consider to be at equal intervals along the evaluative dimension ranging from extremely unfavorable through neutral to extremely favorable. The averaged value of the attitudinal scores responded by each respondent is defined as a value of attitudinal component.

(3) Social norm

Most people who are important to me think I



buy "Miller beer" for my own use (in the next week).

Figure 2.4 an example of social norm (e.g. unipolar scale).

Social norm is defined as a person's belief that most of his/her important others think he/she should perform the purchase behavior in question.

Ⅲ. EXTENTION OF FISHBEIN & AJZEN MODEL

An extension of Fishbein & Ajzen model treating vagueness of evaluation is proposed.

For the measurement and representation of vagueness in judgment and decision making, the vagueness was treated as a random error which is represented by the probability theory. On the contrary, the vagueness is different from uncertainty due to randomness inherent in the probability system [10]. Recent studies for describing judgment and decision making assumed that a person evaluate the objects using natural languages which were inherently vague [14].

In order to measure the vagueness in evaluation, several fuzzy rating methods have been proposed and developed [8]. In this study, respondents select a representative rating point on a scale and indicate lower or upper rating points if they wish depending upon the relative vagueness of their judgment as shown in Figure 2.5, which method has been also called as fuzzy graphical rating method. The vagueness is represented by the interval between upper point and lower point.

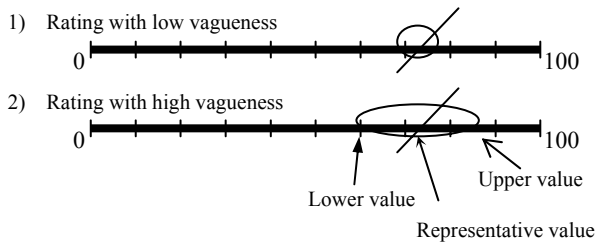


Figure 2.5 Example of responses marked by fuzzy rating (0-100 point scale)

Fuzzy rating data can be represented as fuzzy sets. Let X denotes a universal set, such as $X = \{x_1, x_2, \cdots\}$. A fuzzy set A is defined as follows.

$$\mu_A : X \to [0,1] \tag{1}$$

The membership function (μ_A) represents a grade of membership of x_i in A. An example of fuzzy rating data and its representation by the triangular fuzzy number are shown in Fig.2.6.

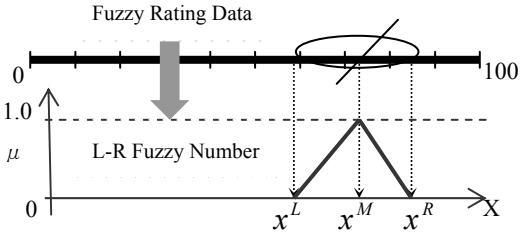


Figure 2.6 An Example of Fuzzy Rating Data (Scores) and Its Representation by the Triangular Fuzzy Number

A. Vagueness in Judgment of Relative Importance of Attitudinal and Normative Components

According to Ajzen & Fishbein theory, each component is given a weight (w_0, w_1) reflecting its relative importance as a determinant of the purchase intention under consideration. Since, no adequate procedures are available to directly assess individual weights of the attitudinal and normative components. The relative importance of each component was estimated by performing a multiple regression analysis; the standardized regression coefficients serve as estimates of the weights for the two components [2].

B. Estimation Methods of the Vagueness in Judgment of Relative Importance by Possibistic Linear Regression and fuzzy regression using least squares under linear constraints

In order to deal with the fuzzy rating data, it should be assumed that input-output data and parameters are the asymmetric fuzzy number, such as the L-R triangular fuzzy number. To examine the relations between represented by asymmetric fuzzy number, it would be useful to apply fuzzy linear regression analysis for input-output fuzzy data.

A set of fuzzy input-output data for i-th observation is defined by:

$$\left(Y_i; X_{i0}, X_{i1}, X_{i2}, \ldots, X_{im}\right) \quad i = 1,2,\cdots,n \tag{2}$$

where Y_i is a fuzzy dependent variable, X_{ij} is a fuzzy independent variable represented by an L-R fuzzy number, and $X_{i0} = 1$. For simplicity, it is assumed that Y_i and X_{ij} are positive for any membership value, $\alpha \in (0,1]$. Let $A_j \ (j = 0,1,\cdots,m)$ be a fuzzy regression parameter. Then Possibilistic linear regression model is expressed as the following formula.

$$Y = A_0 \oplus A_1 \otimes X_1 \oplus \ldots \oplus A_m \otimes X_m \tag{3}$$

where, $\otimes$ is the product operator based on the extension principle, and $\oplus$ is the summation operator based on the extension principle.

Let Z_i, $i = 1,2,\cdots,n$ be a fuzzy number of i-th estimated output. Then, the α-level set of Z_i can be expressed as an interval

$$Z_i = [z^L_{i(\alpha)}, z^R_{i(\alpha)}], \quad \alpha \in (0,1] \tag{4}$$

where $z^L_{i(\alpha)}$ is a lower value of i-th estimated output, and $z^R_{i(\alpha)}$ is an upper value of i-th estimated output, for any fixed degree α.

In possibilistic linear regression analysis, an equality indicator (h-value) between two fuzzy numbers is introduced, as follows,

$$Pos(Z_i = Y_i) \geq h, \quad i = 1,2,\cdots,n \tag{5}$$

where Pos is short for possibility, and h (h-value), which is between 0 and 1, is referred to as the degree of fit of the estimated fuzzy linear model (i-th estimated output) to the given data, and is subjectively selected by a researcher as an input. $Pos(Z_i = Y_i)$ is defined as the following equation [5]:

$$Pos(Z_i = Y_i) = \sup_{x \in R^1} \min(\mu_{Z_i}(x), \mu_{Y_i}(x)) \tag{6}$$

In order to estimate the fuzzy regression parameter, the following Linear Programming problem that minimize the objective function (7) subject to the constraints (8)-(16).

$$Min \sum_{j=1}^{m} \left\{ \left(z^{L}_{i(\alpha=1)} - z^{L}_{i(\alpha=0)} \right) + \left(z^{R}_{i(\alpha=0)} - z^{R}_{i(\alpha=1)} \right) \right\} \quad (7)$$

Subject to $$-z^{L}{}_{i(\alpha=h)} \geq -y^{R}_{i(\alpha=h)} \quad (8)$$

$$z^{R}{}_{i(\alpha=h)} \geq y^{L}_{i(\alpha=h)} \quad (9)$$

$$a^{L}_{j(\alpha=h)} \geq 0, a^{M}_{j(\alpha=1)} \geq 0, a^{R}_{j(\alpha=h)} \geq 0,\ j \in J_1 \quad (10)$$

$$a^{L}_{j(\alpha=h)} \leq 0, a^{M}_{j(\alpha=1)} \leq 0, a^{R}_{j(\alpha=h)} \geq 0,\ j \in J_2 \quad (11)$$

$$a^{L}_{j(\alpha=h)} \leq 0, a^{M}_{j(\alpha=1)} \geq 0, a^{R}_{j(\alpha=h)} \geq 0,\ j \in J_3 \quad (12)$$

$$a^{L}_{j(\alpha=h)} \leq 0, a^{M}_{j(\alpha=1)} \leq 0, a^{R}_{j(\alpha=h)} \leq 0,\ j \in J_4 \quad (13)$$

$$-a^{L}_{j(h)} + a^{M}_{j(\alpha=1)} \geq 0 \quad (14)$$

$$-a^{M}_{j(\alpha=1)} + a^{R}_{j(h)} \geq 0 \quad (15)$$

$$\begin{aligned} &j \in \{0, \cdots, m\} = J_1 \cup J_2 \cup J_3 \cup J_4, \\ &J_1 \cap J_2 = \phi, \quad J_2 \cap J_3 = \phi, \quad J_3 \cap J_1 = \phi, \\ &J_1 \cap J_4 = \phi, \quad J_2 \cap J_4 = \phi, \quad J_3 \cap J_4 = \phi \end{aligned} \quad (16)$$

where $a^{L}_{j(\alpha=h)}$ is lower value of h-level fuzzy coefficient for j-th attribute, $a^{M}_{j(\alpha=h)}$ is representative value of h-level fuzzy coefficient for j-th attribute, and $a^{R}_{j(\alpha=h)}$ is upper value of h-level fuzzy coefficient. Figure 2.7 shows a h value and a degree of fit of estimated value (Z_i) to the observation Y_i.

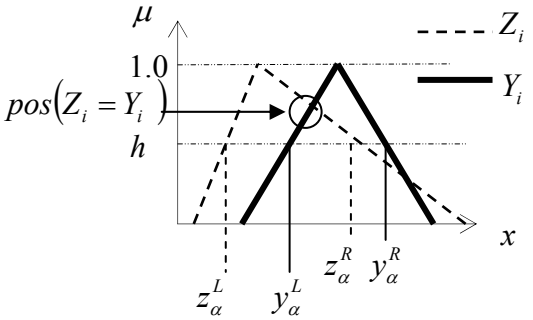


Figure 2.7 Selecting h value in possibilistic linear regression analysis and relation between i-th observation and i-th predicted value

In possibilistic linear regression analysis, however it is the way used widely and discussed, one problem is that the end-observations are influential in identifying the regression model [9, 13, 16].

One of the alternative estimation methods of identifying possibilistic regression model including such influential observations is a fuzzy linear regression using least squares under linear constraints [15]. The fuzzy linear regression analysis using least squares under linear constraints is to determine the fuzzy coefficients by solving the following problem:

$$\text{Min:} \quad \sum_{i=1}^{n} \left\{ y^{L}_{i(\alpha=0)} - z^{L}_{i(\alpha=0)} \right\}^2 + \sum_{i=1}^{n} \left\{ y^{M}_{i(\alpha=1)} - z^{M}_{i(\alpha=1)} \right\}^2 + \sum_{i=1}^{n} \left\{ y^{R}_{i(\alpha=0)} - z^{R}_{i(\alpha=0)} \right\}^2 \quad (17)$$

Subject to:

$$a^{L}_{j(\alpha=0)} \leq a^{M}_{j(\alpha=1)} \leq a^{R}_{j(\alpha=0)}, j = 0,1,\cdots,m \quad (18)$$

$$a^{L}_{j(\alpha=h)} \geq 0, a^{M}_{j(\alpha=1)} \geq 0, a^{R}_{j(\alpha=h)} \geq 0,\ j \in J_1 \quad (19)$$

$$a^{L}_{j(\alpha=h)} \leq 0, a^{M}_{j(\alpha=1)} \leq 0, a^{R}_{j(\alpha=h)} \geq 0,\ j \in J_2 \quad (20)$$

$$a^{L}_{j(\alpha=h)} \leq 0, a^{M}_{j(\alpha=1)} \geq 0, a^{R}_{j(\alpha=h)} \geq 0,\ j \in J_3 \quad (21)$$

$$a^{L}_{j(\alpha=h)} \leq 0, a^{M}_{j(\alpha=1)} \leq 0, a^{R}_{j(\alpha=h)} \leq 0,\ j \in J_4 \quad (22)$$

$$\begin{aligned} &j \in \{0, \cdots, m\} = J_1 \cup J_2 \cup J_3 \cup J_4, \\ &J_1 \cap J_2 = \phi, \quad J_2 \cap J_3 = \phi, \quad J_3 \cap J_1 = \phi, \\ &J_1 \cap J_4 = \phi, \quad J_2 \cap J_4 = \phi, \quad J_3 \cap J_4 = \phi \end{aligned} \quad (23)$$

To examine fuzzy coefficients for assessing the relative importance of the attitudinal and normative components and its vagueness, the both approaches are used.

The fuzzy regression analysis using least squares under constraints can reduce the impact of outliers and thus yield robust parameter estimates rather than possibilistic linear regression analysis can do.

Ⅳ. PSYCHOLOGICAL EXPERIMENT USING FUZZY RATING AND ESTIMATION OF VAGUENESS IN JUDGMENT

A. Overview

Attitude and social norm of mobile phone were measured using fuzzy rating method. The fuzzy purchase intention model, which is an extension of Fishbein & Ajzen model, was examined using the two types of fuzzy regression analyses [13,15] in which input and output variables are fuzzy numbers.

B. Material

According to the white paper on telecommunications by Ministry of Public Management, Home Affairs, Posts and Telecommunications in Japan [13], the rate of internet usages with mobile phone in Japan is the world's No.1 in 2002. In Japan, the mobile phone is considered to be a product, which used not only as a tool of telephone but also as a communication tool of e-mail and internet. The purchase behavior of this

kind of a product, in spite of its importance, is hardly examined from a view point of social psychology.

In this study, an *i*-mode type mobile phone was used, because *i*-mode type mobile phone was the most popular mobile phone at that time in Japan. The purchase intention of the phone is a product, which is often used between the user and his or her important person, such as a member of the family or the friend. It can be assumed that when a person chooses this kind of the product, purchase behavior would be strongly influenced by the social norm.

C. Subjects and Procedure

Subjects were 26 university students. At the beginning of the experiment, all subjects were given explanations about fuzzy rating method, and were instructed to rate representative values, lower values, and upper values within 0 and 100 for attitude scales and behavioral intention of buying behavior for mobile phone by indicating the points on the scales in questionnaire. Then, they completed the questionnaires containing measures of the variables of intentions, social norms and attitudes toward purchase, on the basis of Fishbein & Ajzen's measure.

D. Analysis and Results

All findings and conclusions presented in this paper are based on the subjects' responses and the results of the two kinds of regression analysis for fuzzy input-output data. The fuzzy coefficients were obtained by the possibilistic linear regression analysis and by the fuzzy regression analysis using least squares under constraints, as shown in Table 1 and Table 2 respectively.

As shown in Table 1, h-value increased as the degree of vagueness of the possibilistic linear regression model becomes larger. The h-value also increased as the representative value of attitude and its vagueness (wide spread of the Lower and Upper value) became smaller. On the other hand, the representative value of social norm was stable, and the spread of the fuzzy parameter became wider in social norm. It can be easily inferred that as the required h level becomes higher, the relative importance of the attitudinal component will decrease.

As shown in Table 2, the representative value of social norm was higher than that of attitude. The vagueness of the relative importance of attitude was higher than that of the social norm.

Table 1. h-value and fuzzy coefficient by possibilistic linear regression analysis

h-value		h >0	h =0.2	h =0.4	h =0.6
Degree of vagueness		1836.2	2384.2	3378.5	5374.1
Fuzzy Coefficient	Attitude(L)	0.18	0.02	0.00	0.00
	Attitude(M)	0.35	0.29	0.28	0.27
	Attitude(R)	0.52	0.57	0.56	0.53
	Social norm (L)	-0.08	-0.19	-0.41	-0.853
	Social norm (M)	0.40	0.41	0.41	0.40
	Social norm (R)	0.89	1.01	1.22	1.66

Note. Degree of vagueness, which is the objective function, corresponds to the sum of the estimated interval output. (L): Lower value, (M): Representative value, (R): Upper value.

Table 2. Results by fuzzy regression analysis using least squares

		Value	
degree of vagueness			341.4
Fuzzy Coefficient	Attitude(L)	Lower	0.00
	Attitude(M)	representative	0.019
	Attitude(R)	Upper	0.024
	Social norm(L)	Lower	0.80
	Social norm(M)	representative	0.80
	Social norm(R)	Upper	0.80

Note. Degree of vagueness is the sum of the estimated interval output, (L): Lower value, (M): Representative value, (R): Upper value

E. Discussion

We used the fuzzy rating method and the fuzzy regression analyses in order to measure the vagueness in rating of buying products by fuzzy set theory, and to measure the vagueness in judgment of the relative importance to weight high or low on causal factors such as the attitudinal and social norm components. The parameter estimates of possibilistic linear regression analysis were very sensitive to the existence of an outlier or large variation in the data set, because the possibilistic linear regression algorithm determines the representative values and spreads of regression parameters in such a way that every observation is fitted to the model in a certain degree (h-value). Thus, to examine relative importance, the fuzzy regression using least squares

was also used.

The results of the two analyses for fuzzy input-output data suggested that the subjects tended to be more influenced by significant others when they bought mobile phones than by attitude toward purchase.

V. CONCLUSION

In this paper, Fuzzy Purchase Intention Model based on the Fishbein & Ajzen model, which took two kinds of vagueness (one in evaluation and the other in judgment of weighting decisions) into consideration to the Fishbein & Ajzen model, was proposed.

In the proposed model, attitude, social norm and purchase intention were measured with vagueness by fuzzy rating method; the influences on fuzzy purchase intention were analyzed by two kinds of estimation method: the possibilistic linear regression analysis and the fuzzy regression using the least square method. The proposed model could use in marketing research as well as consumer behavior research.

There are, however, some limitations that surfaced in this research. Firstly, a refinement of methodology for determining a shape of membership function from fuzzy rating data and fuzzy parameter will be needed in the future research. Secondly, a refinement of data analysis methodology related to goodness of fit and h-value will be needed in the future research.

REFERENCES

[1] Ajzen, I., and Fishbein, M.: Attitudes and normative beliefs as factors influencing behavioral intentions, Journal of Personality and Social Psychology, 21,1, 1-9, 1972

[2] Ajzen I. and Fishbein M.: Understanding attitudes and predicting social behavior. Prentice-Hall, 1980.

[3] Bearden, W.O., and Woodside A.G.: Testing Variations of Fishbein's Behavioral Intention Model Within a Consumer Behavior Context, Journal of Applied Psychology, Vol.62, No.3, 352-357, 1977

[4] Bettman, James R.: Consumer Psychology, Ann. Rev. Psychol., 37, 257-289, 1986

[5] Dubois, D. and Prade, H.: Fuzzy Numbers: An Overview, in Analysis of Fuzzy Information, Vol.1,Bezdec, J.C.(ed) , CRC Press, 214-263, 1987

[6] Fishbein, M. and Ajzen, I.: Belief, attitude, intention and behavior - An introduction to theory and research, Addison-Wesley, 1975

[7] Glassman, M. and Fitzhenry, N.: Fishbein's Subjective Norm - Theoretical Consideration and Empirical Evidence, in Advances in Consumer Research, 3, 477-480, 1976

[8] Hesketh, B., Pryor, R., Gleitzman, M., and Hesketh, T.: Practical applications and psychometric evaluation of a computerised fuzzy graphic rating scale. In T.zetenyi(Ed.) , Fuzzy Sets in Psychology. New York: North Holland, 425-424, 1988

[9] Kim, K., Moskowitz, H., and Koksalan, M:Fuzzy versus statistical linear regression, European Journal of the Operations Research, 92, 417-434, 1996

[10] Klir, George J.: Is There More to Uncertainty Than Some Probability Theorists Might Have Us Believe? , International Journal of General Systems, 15, 347-378, 1989

[11] Ministry of Public Management, Home Affairs, Posts and Telecommunications: Heisei 14 version, A white paper on telecommunications, Gyosei, 2002 (in Japanese)

[12] Moskowitz, H., and Kim, K. :On Assessing the H value in Fuzzy Regression, Fuzzy Sets and Systems, 58, 307-327, 1993

[13] Sakawa, M. and Yano, H.: Fuzzy linear regression analysis for fuzzy input-output data, Information Sciences, 63, 191-206, 1992

[14] Takemura, K.: Psychology of Decision Making (in Japanese), Fukumura-Shuppan, 1996

[15] Takemura, K.: Vagueness in Human Judgment and Decision Making, In Z. -Q. Liu & S. Miyamoto (Eds.), Soft Computing and Human-Centered Machines, Springer, 249-281, 2000

[16] Wakayama D. and Takemura, K.: A Detection Method of Influential Observations for Possibilistic Linear Regression Analysis for Fuzzy Input-Output Data and Its Application, Journal of Japan Society for Fuzzy Theory and Systems, 13, 6 (Dec), 652-661, 2001 (in Japanese)

[17] Wakayama, D. and Takemura K.: Prediction of Consumer Behavioral Intention using A Measurement Method of Vagueness in Consumer Attitude and Social Norm, Journal of Japan Society of *Kansei* Engineering, 2, 1 (Feb), 65-72, 2002 (in Japanese)

[18] Wilkie,W.L.:Consumer Behavior (3rd ed. , John Wiley and Sons, 1994

[19] Wilson, D. T., Mathews, H.L., and Harvey, J.W., An empirical test of the Fishbein behavioral Intention model, Journal of consumer research, 1, March, 1975.