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Bayesian Rough Set Model in Hybrid Kansei Engineering for Beverage Packaging Design

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***Abstract*— Human evaluation have common shortage to capture vagueness and uncertainty while input multivariate data due to characteristics such relationship between packaging design attributes and customer requirement and perception about the package. In Kansei Engineering (KE), customer perceptions about a product tend to define the product value and this considered as whole of product attribute. The main objective of this work is to provide the designer with a robust formulation to make relationship between design element and customer perception. Then we proposed decision rules in order to get affective knowledge in bottle packaging design by using Bayesian Rough set method. This paper provided a construction of decision rules between design elements and customer perceptions such as slim shape of bottle body and bright colored of bottle cap to describe a modern bottling design. The result showed that Bayesian Rough Set model effectively extracted the decision rules of human evaluation data in designing beverage bottle from the intuition of customer perception. In conclusion our approach supported the design processes and eased the designer tasks.**

Keywords—Human evaluation, Kansei engineering, Bayesian Rough set, bottle packaging, decision rules

I. INTRODUCTION

Today, customizable design discriminate competitiveness between companies, enhancing the quality and penetrating customer perception with better and unique products. The problem faced by designer is how to match their product by developing preferred product for generic user or the specific one perception. This is not easy task to capture, as there is diversity of customer, and increasing risk to define market segmentation, which means lost chance to share market profit. So the question is how to define the most effective technique for customer perception, so that the designer easily follows steps in product design based on customer preferences.

Customer preferences and behavior analysis are part of Kansei engineering (KE) approach. In short, the essential of KE is how to unite Kansei (feeling, affection and emotion) with engineering aspects. Furthermore, KE is a methodology in product development which translates customers need and want about a product into technical language, dus KE is based on customer feeling, impression and demand. This is psychological aspect which delivers the required product design parameter being aimed for [1, 2]. Therefore, KE is a subjective estimation from customer on existing products or product innovative solutions, other mean the customer voice involved at early phase on product development.

Customer perception is not easy to capture, because every peoples have different words to express one object. Hence, the user perception is a very complex thing involving many scientific fields, such as mathematic, mechanical engineering, economics, industrial engineering, psychology and ergonomics. Schutte, Eklund *et al.* [3] state that some methodology has done for long time to quantifying link between product properties and user perception. However, still have a lack to embracing all domains in product development in order to quantify the impact a certain product property.

The exploration of Kansei word to beverage bottle packaging design actually is not easy to define, although the data sets get from customer respond. After the data construct in form decision tables, the next problem is vagueness to clearly define specific relation for conditional attributes and decision attribute. Moskowitz et al [6] explained that beverage packaging design is a unique one because in packaging should consider elements attribute with any information about product and other have functionality as protection. Each event evaluation of decision tables confirms a condition-decision relationship. This explains what specifies element design will ever when conditions are satisfied. Other while, we cannot justify any data in decision tables as reference because available knowledge is not properly classified. For example, Kansei word to attribute decision are beautiful and the other not beautiful, while the data set on information objects show that conditional attribute evaluated have indiscernible or similarity value. This means we need to know approximations to construct behavior of customer statement about a product. As mention by Moskowitz et al [6] that customer decides buying any product real time on desk, so that designer should produce an attractive packaging base on knowledge.

Thus, in packaging design purpose the relational rule between attribute i.e. conditional and decision attribute. These mean beverage packaging designs need methods to handle uncertain or inconsistent data. By so that decision rules between human evaluation data and design elements of product can extraction. Due to characteristic of beverage packaging design, the purpose we will verification and validation this method to explore IF-THEN decision rule for bottle packaging design. Here, Nishino et al [17, 18, 19] had developed Bayesian Rough set model to solving problem in uncertainty and ambiguousness

This paper is constructed as follows: Section 2 described related work and section 3 described Bayesian Rough Set methodology. Section 4 presents an application example of proposed method to bottle packaging design. In section 5, main conclusions are covered.

II. Related work

KE was developed by Nagamachi in the early 1970s in Japan, and spread to the USA and Europe period 1990s. Actually, KE have sixth type, i.e. category classification, KE system, hybrid KE system, KE modeling, virtual KE and collaborative KE designing. KE type-1 is a fundamental technique in KE [2]. This domain is formulating Kansei word from customer and it is correlated to design specification or physical properties of product. However, the main challenge in affective design understands implicit affective necessity from user in one side and how to design product base on customer important. In fact, customer mind-set in a way linguistic-implicit such as words beautiful, convenience, safe, and environmental friendly have different meaning when industrial engineer try implemented this perception to shape design formal object [5].

Packaging design in the beverage industry has two main functions, namely to provide protection for consumption in the safe at a certain time and marketing functions. The food product character gives dimension to packaging functionality. Jedlicka [6] mentions three types of information designers need to capture the visual system, namely packaging design, descriptions and relationships. Moskowitz *et al* [6] stated in packaging design challenge is whether the characteristic-attribute-element design that is able to attract the attention of consumer, and whether packaging is able to perform the function in accordance with its properties. Calver [8] stated that the challenges in the packaging industry show designers generate strongly about it and visualize the product in the form of simple and effective, leaving a positive perception to the consumer or buy other among similar products.

Chen *et al* [9] and Calver [10] mentioned the properties of the packaging material and affective perception influence consumer decisions such as hardness, abrasive, softness, smoothness and warm. Barness *et al* [11] reported no effect the form of packaging to the consumer purchasing preferences. Calver [10] describes the design elements are divided into structural packaging design and graphic surface, again in the top of the form and function, material and completion, branding and typography, image and color. Moskowitz *et al* [6] states the basic idea is the packaging design set of layers (silos), where each layer has several alternative options (elements).

Moskowitz *et al* [6] stated that attribute form elements such as logo design, nutrition and health statement, style (style), picture (image), aroma (flavor) and color. Qing *et al* [10] conducted a study of traditional Chinese design food packaging (moon cake) with a focus on elements of text, graphics, color and layout. Wang *et al* [11] stated the visual elements of packaging design is the word, graphics, colors, trademarks, shape, size, texture. Orth and Malkewitz [12] conducted research for wine packaging with design elements, label and typography.

Bayesian Rough set model is aimed at data analysis problems involving uncertainty, imprecise or incomplete information. This method had applied in many research areas such as pattern recognition, machine learning, knowledge acquisition, data mining and economic forecasting [13]. Bayesian Rough set model useful in KE to identify the relational rules between human evaluation data and design elements. Human evaluation data as refer to customer-perceived product development and product value from customer perspective. As human values constructed to develop a product, usually is difficult in early step because heterogeneous population, contradictive between generalization versus customization, and uncertainty–inconsistency in market segmentation. The uncertainty came from ambiguity, approximation and like hood.

Ahmady [14] argued that vagueness results from imprecise nature of belonging and non-belonging of elements to a set of interest. This is consequence from approximating a set by subset, which is set of universe. For example, when someone think some product as attractive and other one state unattractive, this consequence uncertainty matter for engineer, due to product attribute perception. Ahmady [14] said for solving this problem, a designer have to perform approximation through reduction and generalization.

Pawlak [15] explained that in Rough Set method, condition attributes in universe of discourse cannot be representative knowledge. Because decision attribute have different value as data set resulted from perspective evaluated customer. Therefore, to clear definition based on attribute data, rough set consider two crisp set, its lower approximation and upper approximation. Lower approximation consists of all objects that surely belong to concept, and upper approximation contains all objects that possibly belong to concept [16]. In case, the attribute decision have different value, even though condition attribute have same value, available knowledge cannot classified as belonging one approximation. Therefore, boundary region arise to specified concept both approximation. Nishino, Nagamachi et al [17] explained that in case much ambiguous data and handle linearly inseparable, Rough Set method more effective to decision rules extraction for evaluation coffee flavor.

There are two serious problems in applying Bayesian Rough Set model to extraction of Kansei decision rules. First, human evaluation data such as sense or feeling is dependent on individual perception and cognition, so that the ambiguity or inconsistency of decision appears in the variation of individual evaluation to product set. The second problem is what decision rule is interesting for Kansei design, general rule or specific. Pawlak [16] stated that Bayesian Rough set basically has characteristic prior and conditional probabilistic, information system and approximation sets, rough membership function, decision language and properties of decision rules.

III. Methodology

The formulation of decision rule of beverage packaging design is obtained with apply variable prediction Bayesian

Rough set method which had developed by Nishino [17, 18, 19]. This method has strength to solve vagueness, can construct deterministic decision table using average score among evaluator but still limited application in KE. We arrange format data table with input element-element properties of beverage packaging design. We give a questionnaire to respondent in order to evaluate some sampling product. After that we make decision table to input elements attribute. From table we are looking for discernibility of each event.

This method has basic concept, i.e., decision system tables, set approximation, information gain, and discernibility matrix and evaluation measure of decision rules. The design of decision rule acquisition of beverage packaging design is illustrated on figure 1. Here we describe each step as follow.

Step 1. Define data set with making decision table with respect to conditional attribute and decision attribute beverage packaging design. Formally, we have object set U is the set of evaluation events U={x_{11},...,x_{mn}}for the universe denoted of n-evaluators to m-products. Each attribute of A has a domain of its design attribute values, A ={a_1,...a_k,...a_p} which is called conditional attributes. Conditional attributes which maybe color, shape, size,image of products. A set of decision class/attribute is D={D_1,.., D_j..., D_r} where D_j={x|d(x)=j}, j= 0,1,2. Partition of U by attribute set A are describe equivalence class. For instances, evaluation events from x_{11} to x_{34} constitute an equivalence class E_1= {x_{11},...x_{34}}, which has the same attribute value with regard to every conditional attribute set A. In fact, evaluation events x_{ji} are equivalent classes because the same product has same attribute value.

Step 2. Identify approximation. The lower approximation D_* and upper approximation D^* of concept *D= {x:d=1}* are defined using equivalence class E_1 partitioned by design attribute sets A as follows

$$D_* = \{E_i | E_i \subseteq D\} \quad (1)$$

$$D^* = \{E_i | E_i \cap D \neq \emptyset\} \quad (2)$$

Calculate the probabilistic of each product base on customer respond. The evaluation data include at least two important probabilistic views. One is conditional probability *$P(D_j|E_j)$* related to decision dependent on conditional attributes of product and other is prior probability of decision, which assumed as without knowing of the data set *$P(D_j)$*. According Nishino [17, 18, 19] conditional probability and prior probability can be definite as the following:

$$P(D_j|E_j) = \frac{card\ (D_j \cap E_i)}{card(E_i)} \quad (3)$$

$$P(D_j) = \frac{card\ (D_j)}{card(U)} \quad (4)$$

Step 3.

Step 4 Calculate information gain. The information gain was defined as below

$$g_{(i,j)} = 1 - P(Y)/P(Y|E_i) \quad (5)$$

or

$$g_*(i,j) = \frac{P(D_j|E_i) - P(D_j)}{1 - P(D_j)}$$

Nishino, Nagamachi et al [17] explained that information gain related that the large increment of *$P(D_j|E_j)$* more than *$P(D_j)$* should take larger information gain when *$P(D_j)$* is low, otherwise same increase of *$P(D_j|E_j)$* should take smaller information gain when *$P(D_j)$ is high*

Step 5. Calculate positive, negative and boundary region. Three kind of approximation region of concept with respect to attribute can be defined according to lower approximation and upper approximation, respectively

$$POS^\beta(D_j) = \cup\{E_j | G_{pos}(D_j|E_j) | E_j \geq \beta\} \quad (6)$$

$$= \cup\left\{E_j | P(D_j|E_j) \geq \frac{P(D_j)}{1-\beta}\right\} \quad (7)$$

$$N\ EG^\beta(D_j) = \cup\left\{E_j P(D_j|E_j) \leq \frac{P(D_j)-\beta}{1-\beta}\right\} \quad (8)$$

$$BND^\beta(D_j) = U\left\{E_j | P(D_j|E_j) \epsilon (\frac{P(D_j)-\beta}{1-\beta}, \frac{P(D_j)}{1-\beta}\right\} \quad (9)$$

Step 6. Define discernible entry elements in the matrix. The formulation of decision matrix as below

$$M_{ij}^\beta(D_j) = \{\vee ak = v_{ik} | a_k(E_i) \neq a_k(E_j) \forall a_k \in A\}, \quad (10)$$

$$POS^{\beta-rule}(D_j) = \vee_{E_i \in POS^\beta(D_j)} \wedge_{E_j \notin POS^\beta(D_j)} M_{ij}^\beta(D_j) \quad (11)$$

The value $M_{ij}^\beta(D_j)$ is the set of all attribute-attribute value pairs that discern product set E_i and E_j. The image of the a decision matrix from appropriate regions is shown below.

TABLE 1. A DECISION MATRIX FROM APPROPRIATE REGIONS

		$NEG^\beta(D_j)$	**$BND^\beta(D_j)$**
		E_{N1}..E_j	**E_{B1}... E_{Bn}**
$POS^\beta(D_j)$	E_{p1}	.	
	.	.	
	.	.	
	E_i	.... $M_{ij}^\beta(D_j)$	
	.		
	.		
	E_{Pm}		

The table above describe m x n matrix, rows of which are product set *Ei (i=1,…,m)* belonging to approximated POS region and columns set Ej(j=1,…,n) belonging NEG and BND class.

Nishino, Nagamachi et al [18] mention β should be less than the residual of the prior probability.

Step 7. Calculate certainty, coverage and strength measure to evaluation measure of decision rule.

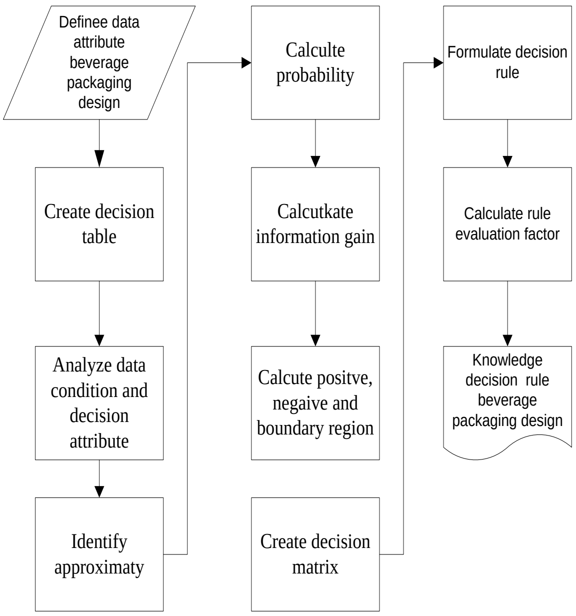
$$cer(Cond_k : D_j = \frac{\sum E_j Cond|E_i|P((D_j|E_i)}{\sum_{Ei \in Condk}|E_j|} \quad (12)$$

$$Cov(Cond_k : D_j = \frac{\sum_{E_j \epsilon Cond_k}|E_j|.P(D_j|E_j)}{|D_j|} \quad (13)$$

$$\sigma(Cond_K : D_j = \frac{\sum_{E_j \epsilon Cond_k}|E_j|.P(D_j|E_j)}{|E|} \quad (14)$$

Slezak and Ziarko [20] explained Bayes positive region defined area of universe where the probability of X is higher than prior probability. The prior probability refers to information data available before. Bayes negative region defined an area of universe where the probability of X lowers than prior probability.

FIGURE 1. THE FRAMEWORK OF DECISION RULE ACQUISITION OF BEVERAGE PACKAGING DESIGN



IV. COMPUTATIONAL EXPERIMENT

A. *Identification of attribute bottle packaging design*

Product attribute set of bottle packaging design are consist of shape of body, color of body, color of bottle cap, practically of the handle, word of label/typography, color of label, image of label. The attribute was taken from any source literature [5;6;11;24;25;26]. Next, we arranged the attributes in form decision table, as illustrate in table 1. In table 1, we can see the five equivalence classes E_1, E_2, E_3, E_4 and E_5, which this also indicate the number of product of beverage packaging design we observed.

Furthermore, the event evaluator and values of conditional and decision attributes is represented on table 1, 2, 3. For example, in table 1 we can see that product attribute shape of body can be robust, attractive and slim with values {0, 1, 2} respectively. As we assumed from literature review about respond consumer beverage design that Kansei word to decision attributes are modern and uniqueness, $V_d = \{0,1\}$.

In this paper we deployed hypothetical data. We assume that we have collecting 20 data event evaluator from customer. There are five products and four human evaluators. In table 1 product $E_1\{x_{11}\}$ is evaluated as modern.

For instances from $E_1\{x_{11}\}$ the customer respond if the shape of body is slim and color of body is bright and color of bottle cap bright and practically handle is practice and word label is high readability and label color is bright and image label is medium attractive then the customer said this packaging is modern.

TABLE 1.DECISION TABLE FOR CONDITIONAL AND DECISION ATTRIBUTE OF BOTTLE PACKAGING

product	event	element design							decision attribute
		shape design				label design			
		shape of body (a_1)	color of body (a_2)	color bottle cap (a_3)	practically handle (a_4)	word (a_5)	color (a_6)	image (a_7)	
E1	x11	2	1	0	1	2	0	1	0
	x12	2	1	0	1	2	0	1	0
	x13	2	1	0	1	2	0	1	0
E2	x12	2	1	1	0	1	2	0	1
	x22	2	1	1	0	1	2	0	1
	x23	2	1	1	0	1	2	0	1
E3	x13	1	2	1	0	0	2	2	1
	x23	1	2	1	0	0	2	2	1
	x33	1	2	1	0	0	2	2	1
E4	x14	1	0	2	0	0	1	2	0
	x24	1	0	2	0	0	1	2	0
	x34	1	0	2	0	0	1	2	0
E5	x14	1	0	1	1	1	2	0	1
	x24	1	0	1	1	1	2	0	1
	x34	1	0	1	1	1	2	0	1

TABLE 2. THE PROPERTIES AND VALUES OF CONDITIONAL ATTRIBUTES

Conditional attribute	Evaluation values		
	0	1	2
shape of body	robust	attractive	slim
color of body	bright	saturation	hue
color bottle cap	bright	saturation	hue
practically handle	not practice	practice	
word	low readability	appropriatness	high readability
color	bright	saturation	hue
image	low attractive	medium attractive	high attractive

TABLE 3. THE PROPERTIES AND VALUES OF DECISION ATTRIBUTES

decision attribute	Evaluation values	
	0	1
decision attribute	modern	uniqueness

B. *Extraction method of decision rules from approximate regions*

The evaluation data prior probability and conditional probability has explained on table 1. We applied concept properly reflect vagueness of Kansei words. The conditional probability is probability of decisions dependent on attributes of product E_i. The prior probability is probability of decision class *D*.

TABLE 4.PRIOR PROBABILITY AND CONDITIONAL PROBABILITY

Prior probability $P(D_j)$	***Conditional probability $P(D_j\|E_j)$***	
$P(D_0) = 6/15 = 0.4$	$P(D_0\|E_1)=2/3=0.67$	$P(D_1\|E_1)= 1/3= 0.33$
$P(D_1) = 9/15 = 0.6$	$P(D_0\|E_2)=0/3 = 0$	$P(D_1\|E_2)= 3/3 =1$
	$P(D_0\|E_3)=1/3 =0.33$	$P(D_1\|E_3)= 2/3 = 0.66$
	$P(D_0\|E_4)= 3/3 = 1$	$P(D_1\|E_4)= 0/3 = 0$
	$P(D_0\|E_5)= 0/3 = 0$	$P(D_0\|E_5)= 3/3 = 1$

This information gain has values as below
Case 1 $P(D_j)$=0.4 and $P(Dj|E_i)$ = 0.6 so $g(i,j)$ = 0.6
Case 2 $P(D_j)$=0.6 and $P(Dj|E_i)$ = 0.67 so $g(i,j)$ = 0.1

With using case from table, if assumed that β = 0.2 so we calculate positive, negative and boundary region as follow:

$$POS^{0.2}(D_0) = \cup \left\{ D_0 | P(D_0|E_i) \geq \frac{P(D_0)}{1-\beta} = \frac{0.4}{1-0.2} = 0.5 \right\} = E_1 \cup E_4$$

The calculating $POS^{0.2}$ (D_0) while refer to product E_1 and E_4, because probability value more than 0.5 ,i.e. 0.67 and 1.

$$NEG^{0.2}(D_0) = \cup \left\{ E_i | P(D_0|E_i) \leq \frac{0.4-0.2}{1-0.2} = 0.25 \right\} = E_2 \cup E_5$$

The calculate $NEG^{0.2}$ (D_0) will get to product $E_{2,}$ and E_5, because the probability small than 0.25, with value 0.

$$BND^{0.2}(D_0) = \cup \left\{ E_i | P(D_j|E_i) \in \left(\frac{0.4-0.2}{1-0.2}, \frac{0.4}{1-0.2} \right) = E_3 \right\}$$

After defining the region where we get the possibly belongs of each product set *Ei (i=1,…, m)*, we used discernibility matrix to create decision rule.

TABLE 6. THE DECISION MATRIX WITH RESPECT TO POS 0.2 (D_0)

		$NEG^{0.2}(D_0)$	$BND^{0.2}(D_0)$
		E_2 E_5	E_3
$POS^{0.2}$ (D_0)	E_1	$a_3=0 \vee a_4=1 \vee a_5=2 \vee a_6=0 \vee a_7=1$ $a_1=2 \vee a_2=1 \vee a_3=0 \vee a_5=2 \vee a_6=0 \vee a_7=1$	$a_1=2 \vee a_2=1 \vee a_3=0 \vee a_4=1 \vee a_5=2 \vee a_6=0 \vee a_7=1$
	E_4	$a_1=2 \vee a_2=1 \vee a_3=1 \vee a_5=1 \vee a_6=0 \vee a_7=0$ $a_3=2 \vee a_4=0 \vee a_5=0 \vee a_6=1 \vee a_7=2$	$a_3=2 \vee a_4=1 \vee a_5=0 \vee a_6=1 \vee a_7=2$

From table 6 we can get the following rules as follows
R_1 : if a_1=2 and a_3=0 then d = 0 {E_1}
R_2 : if a_1=2 and a_4=1 then d = 0 {E_1}
R_3 : if a_1=2 and a_5=2 then d = 0 {E_1}
R_4 : if a_1=2 and a_6=0 then d = 0 {E_1}
R_5 : if a_1=2 and a_7=1 then d = 0{E_1}
R_6 : if a_2=1 and a_3=0 then d=0 {E_1}
R_7 : if a_2=1 and a_4=1 then d=0 {E_1}
R_8 : if a_2=1 and a_5=2 then d=0 {E_1}
R_9 : if a_2=1 and a_6=0 then d=0 {E_1}
R_{10} : if a_2=1 and a_7=1 then d=0{E_1}

TABLE 7. THE DECISION MATRIX WITH RESPECT TO POS 0.2 (D_1)

		$NEG^{0.2}(D_1)$	$BND^{0.2}(D_1)$
		E_1 E_4	E_3
$POS^{0.2}$ (D_1)	E_2	$a_3=1 \vee a_4=0 \vee a_5=2 \vee a_6=1 \vee a_6=2 \vee a_7=0$ $a_1=2 \vee a_2=1 \vee a_3=1 \vee a_5=1 \vee a_6=2 \vee a_7=0$	$a_1=2 \vee a_2= \vee a_5=1 \vee a_7=0$
	E_5	$a_1=2 \vee a_2=0 \vee a_3=1 \vee a_5=1 \vee a_6=2 \vee a_7=0$ $a_3=1 \vee a_4=1 \vee a_5=1 \vee a_5=0 \vee a_6=2 \vee a_7=0$	$a_2=0 \vee a_4=1 \vee a_5=1 \vee a_7=0$

From table 7 we get rules as follows

R_{36} : if a1=2 and a3=1 then d=1 {E2,E5}
R_{37} : if a1=2 and a4=0 then d=1 {E2}
R_{38} : if a1=2 and a5=1 then d=1 {E2}
R_{39} : if a1=2 and a6=1 then d=1 {E2}
R_{40} : if a1=2 and a7=0 then d=1 {E2}
R_{41} : if a3=1 and a5=1 then d=1 {E2,E5}

The symbols at the end of decision rules indicated that the equivalence classes matching with condition part of the rule.. The rule indicates that properties of element design will constructive what peoples think about a product. Other word, the rules predict the human evaluation from any product design element.

For instances, R_1 are mean if 'shape of body' is slim and 'color of bottle cap' is bright then product will describing is modern. The other example in context D_1, R41 are mean if 'color bottle cap' is bright and 'word of label design' is low readability then product will describing is uniqueness. From decision matrix with respect to decision class (D_1) realize that condition part of rule 36 and 41 is matching with product E2 and E5.

Extraction rules evaluation factors

To convert the above rule represented as certain deterministic one into uncertain probabilistic rule we can use rule evaluation factors. The evaluation factors can define by using number evaluation to product $|E_i|$ and effects of products on decision $P(D_j|E_i)$.

Evaluation factors for extraction rules, for example the rule R_1 has the following values of three factors.
Since $Cond_1$ = {E1}, the computing

$$cer(E_1; D_o) = \frac{|E_1| P(D_0|E_1)}{|E_1|} = \frac{3}{3} = 1$$

The certainty factors means the ratio of the number of events satisfied with if - then rule to the number of events satisfied with the condition part $cond_k$ of $cond_k$ of the rule. Here, certainty factors for product E_1 with decision attribute modern is 1. This means confidence factors of decision to predict the human evaluation from any product design element.

$$cov(E_1; D_0) = \frac{3}{6} = 0.5$$

The coverage factors are means the ratio of number events satisfied with constructed rule to the number of the events satisfied with D_j. Here (E_1;D_0) we get coverage is 0.5. The value shows degree to which $Dj \rightarrow cond_k$., i.e. the inverse of rule holds

$$\sigma(E_1; D_0) = \frac{3}{15} = 0.2$$

The strength factor can be used to evaluate the set of decision rules. For this case$(E_1; D_0)$ the strength is 0.2, which means the ratio of the number events satisfied if then rule to all the events.

Evaluation factors for extraction rules by considering D_1, we get result as shown in table 8.

TABLE 8. THE RULE EVALUATION FACTORS WITH RESPECT TO POS 0.2 (D_1)

D_1	certainty	coverage	strength
R_{36}	1	0.67	0.4
R_{37}	1	0.3	0.2
R_{38}	1	0.3	0.2

The R_{36} has higher value of coverage and strength than R_{37} and R_{38}. This mean more general rule with 67% will indicated by shape of body slim and color bottle cap bright has modern concept packaging design.

V. CONCLUSION

The Bayesian Rough Set model effectively extracted decision rules from set of product which evaluation event give its respont are useful to anticapte ambigous. The result shown that this method enabled to derive rule from human evaluation data. The constructed rule represents some pattern related to the customer responses about element properties of bottle packaging design. The obtained decision rules between design element and customer perception are obviously important for packaging design such as slim shape of body bottle and bright colored of cap bottle to describe a modern bottle design. The knowledge result from point of element design and decision attribute clearly support the designer tasks. For future works it is required to integrate digitally fine arts of labeling and shapes into our current work.

REFERENCES

[1] Nagamachi M (2002). "KE as a Powerful Consumer-Oriented Technology for Product Development." Applied ergonomics 32: 289-294.

[2] Nagamachi M (2011). Kansei/Affective Engineering, CRC Press.

[3] Schutte STW, Eklund J, Axelsson JRC ,Nagamachi M (2004). "Concepts, Methods and Tools in KE." Theoritical issues in ergonomic science **5**: 214-231.

[4] Nagamachi M ,Lokman AM (2011). Innovations of KE, CRC Press.

[5] Jedlicka W (2009). Packaging Sustainability Tools, Systems and Strategies for Innovative Package Design. USA, John wiley and sons.

[6] Moskowitz HR, Reisner M, Kawlor Jb ,Deliza R (2009b). Packaging Research in Food Product Design and Development, Wiley-Blackwell.

[7] Calver G (2004). What Is Packaging Design, Roto Vision SA.

[8] Chen X, Barnes CJ, Childs THC, Henson B ,Shao F (2010). "Materials Tactile Testing and Characterisation for Consumer Product Affective Packaging Design." Journal material and design 30: 4299-4310.

[9] Barnes C, Southe C ,Henson B (2003). The Impact of Affective Design of Product Packaging Upon Consumer Purchase Decisions, DPP1 03: ACM 1-58113-652.

[10] Qing H, Kai Z ,Chen MR (2012). Packaging Design Research and Analysis Based on Graphic Visual. IPCSIT. Singapore. 28.

[11] Wang KC ,Chen SM (2007). "Product Form Design Using Anfis-KE Model." IEEE.

[12] Orth UR ,Malkewitz (2006). Packaging Design Research and Analysis Based on Graphic Visual. International wine business research Monplier.

[13] Zhang H, Zhou J, Miao D ,Gan C (2012). "Bayesian Rough Set Model, a Further Investigation." International journal of approximate reasoning 53: 541-557.

[14] Ahmady A (2010). Rough Set KE: Multiple User, Multiple Kansei. Doctoral, Wichita state university.

[15] Pawlak Z (1999). Decision Rules, Bayes Rule and Rough Sets. RSFDGrC, Berlin, Springer.

[16] Pawlak Z (2002). The Rough Set View on Bayes Theorem. AFFS. Berlin, Springer**:** 106-116.

[17] Yao Y (2008). "Probabilistic Rough Set Approximations.International journal of approximate reasoning 49: 255-271.

[18] Nishino T, Nagamachi M ,Sakawa M (2006). "Acquisition of Kansei Decision Rules of Coffee Flavor Using Rough Set Method." KE International **5**: 41-50.

[19] Nishino T, Nagamachi M ,Tanaka H (2005). Variable Precision Bayesian Rough Set Model and Its Application to Human Evaluation Data. RSFDGrC, Berlin, Springer.

[20] Nishino T, Satsuta R ,Nagamachi M (2008). Identification of Customer Latent Kansei Needs and Product Design by Rough Set Based Approach. Hiroshima international university.

[21] Nagamachi M (2006). KE and Rough Set Model. RSCTC, LNAI, Springer.

[22] Nagamachi M, Okazaki Y ,Ishikawa M (2006). "KE and Application of the Rough Sets Model." Journal Systems and contol Engineering 220.

[23] Slezak D (2005). "Rough Sets and Bayes Factor." Transaction on rough set III, Springer: 202-229.

[24] W.Y.Wang R ,Chou M-C (2010). "The Comprehension Modes of Visual Elements: How

[25] Chen X, Mckay A, Pennington Ad ,Chau HH (2004). Package Shape Design Principles to Support Brand Identity. IAPRI World Conference on Packaging 1-14.

[26] Wang,R.W and Chou M.C. (2013). Findability of commodities by consumers. Innovative Journal of Business and Management.