Research on the Individualized Requirement of Clothing Based on Rough Set Theory

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Abstract. In modern E-commerce scenarios falls, the competition of each clothing enterprise is intense. The customers' individual requirement of clothing is getting higher and higher. Each customer has their own different consumption preferences. Enterprises have to find ways to understand the customers' consumption preferences and realize the customer value to enhance the competitiveness. This text aims to make enterprises understand the customers' individual requirement in time by using the data processed though questionnaire and rough set theory. And enterprises can provide production and marketing auxiliary decision-making effectively. The results show that the main factors affecting the customer value is the customer factor. Size most closely affected the customers' consumption preferences. Color, version and material are equally affected the customers' consumption preferences.

Keywords: rough set; clothing; individualized requirement.

1. Introduction

With the arrival of Internet era, E-commerce has been gradually won people's favor for its cheapness, rapidity and convenient shopping advantage. Customer is the most valuable asset for the clothing enterprise. To realize the customer value is an effective way to enhance the customer loyalty. In modern E-commerce scenarios falls, the customers' individual requirement of clothing is getting higher and higher. Each customer has their own different consumption preferences. And clothing has many different attribute features. In order to strengthen competitive advantages for the enterprises, clothing enterprise must take the different strategy to satisfy the customers' individual requirement and realize the customer value. Enterprises have to find ways to solve the problem to strengthen competitive advantages for the enterprises. Therefore, to study the customers' individual requirement of clothing in modern E – commerce scenarios must first from analyzing factors that affect customer value. Enterprises not only must understand the customers' individual requirement and consumption preferences in time, but also should analyze the relationship between the customers' consumption preferences and clothing attributes. Enterprises as we continue to meet customer individual requirements for improving the competitiveness.

There are many domestic experts have been carried out a number of related researches on the individualized requirement of clothing. Wu Xuemeng et al. [1] analyzed the individualized requirement of clothing from the perspective of art and design. She described the changing process of the clothing requirement and the direction of clothing individualization which the modern people most attention to. Zhejiang Textile and Fashion College reflect the individual requirement of the apparel industry through the introduction of organic light color material [2]. At the same time, in modern E-commerce scenarios falls, Pang Yali et al. [3] analyzed the competitiveness of clothing enterprises and the factors of customer value. The level of the competitiveness of enterprises largely depends on customer loyalty and satisfaction. That is to say, the competitiveness of the enterprise depends on whether it can deliver higher customer value. Wu Yueting [4] researched the consumption preferences of clothing fabric. She analyzed consumer psychology and preferences from consumers purchasing behavior, color, texture, pattern, and so on. It provides the basis for the clothing fabric development and operation of the market.

This paper mainly selects the data processed though questionnaire to study the customer value and consumer preference for men's shirts. And this paper uses rough set theory to analyze the main factor

of customer value and discuss the relationship between the customers' consumption preferences and clothing attributes. Enterprises can understand the customers' individual requirement and consumption preferences in time, and it can provide production and marketing auxiliary decision-making effectively.

2. Summary of rough set theory

Rough set theory is introduced by Pawlak in 1982. It is a mathematical tool for dealing with vagueness and uncertainty. This theory is mainly used to discover patterns from incomplete data, so it is the basis of machine learning, knowledge acquisition, and the reasoning of uncertain information form. Rough set theory has received a lot of attention on areas in both of real-life applications and the theory itself.

2.1 Definition of rough set theory

In rough set theory [5-7], decision depends on knowledge. Knowledge is regarded as the division of the domain and the ability to classify objects. The accuracy of knowledge is caused by the granularity of knowledge in the domain.

Definition 1 let U be a non-empty set, we called it a domain. $X \subseteq U$ is a concept or category of domain U. Among them:

$X_i \subseteq U, X_i \neq \varnothing, X_i \cap X_j = \varnothing, i \neq j$, and $i, j = 1,2, \ldots, n$.In order to standardize, we believe that the empty set is a concept, and we called it empty concept.

Definition 2 let U be a non-empty set and S an equivalence relation on U. $U/S = \{X_1, X_2, \ldots X_n\}$ represents a classification of S, it is called a knowledge about U. $\forall x \in U$, $[x]_S = \{y|xSy, y \in U\}$ indicates the equivalence class of element x under the relational S. The pair $K = (U, S)$ is called an approximation space.

Definition 3 let U be a non-empty set and S an equivalence relation on U. If$P \subseteq S$, and $P \neq \varnothing$, P is still an equivalence relation on the domainU. We call $\cap P$ the non-discernible relationship, it is recorded as $IND(P)$.And:

$\forall x \in U, [x]_{IND(P)} = [x]_P = \bigcap_{\forall R \in P}[x]_R , U/IND(P) = \{ [x]_{IND(P)} \mid \forall x \in U\}$

Definition 4 The information system can be formally represented as a 4-tuple: $IS = (U, A, V, f)$, where $U = \{X_1, X_2, \ldots X_n\}$ is called the domain of the universe, and it is a non-empty set. $A = \{a_1, a_2, \ldots, a_n\}$ Is a finite set of attributes/criteria. $V = \bigcup_{a \in A} V_a$ Is set of attribute values. V_a is the domain of the attribute/criterion a . $V = \bigcup_{a \in A} V_a$ and f: U x A is a total function such that $f(x, a) \in V_a$ for each$a \in A$, $x \in U$ called the information function. The set A is usually divided into set C of condition attributes and set D of decision attributes.

Definition 5 Rough set theory is an extension of set theory, in which a subset of a universe is described by a pair of ordinary sets called the lower and upper approximation. Let U be a non-empty set and P an equivalence relation on U. The pair (U, P) is called an approximation space. $\forall x \in U$, we define operations $\underline{P}$ and $\overline{P}$ as:

$$\underline{P}(X) = \{ x| [x]_P \subseteq U, (\forall x \in U)\} \quad (1)$$

$$\overline{P}(X) = \{ x| [x]_P \cap X \neq \varnothing, x \in U \} \quad (2)$$

If $\underline{P}X = \overline{P}X$, then X is a crisp set on U about P. If $\underline{P}X \neq \overline{P}X$, then X is a rough set on U about P. $\underline{P}X$ Is called the lower approximation of X and $\overline{P}X$ is the upper approximation of X.

2.2 Dependence and importance of attribute

Definition 6 let $IS = (U, C \cup D, V, f)$be a decision system, set C be a condition attributes and set D be a decision attributes. We define the positive region of the decision attribute under the condition attribute for:

$$POS_C(D) = \bigcup_{X \in U/D} \subseteq (X) \quad (3)$$

$POS_C(D)$ Indicates that the classification U/C based on knowledge C can be exactly assigned to a collection of objects U/D class.

Definition 7 the dependence of decision attribute D on the conditional attribute C is defined as:

$$\mu_C(D) = \frac{|POS_C(D)|}{|U|} (\ 0 \leq \mu_C(D) \leq 1) \quad (4)$$

The dependence $\mu_C(D)$indicates it could actually include in the classification decision U/D object accounted for on domain objects in the aggregate number ratio under conditional attribute$C$, it is the expression of the dependency degree of condition attributes to decision attribute.

Definition 8 Compared with the decision attribute set D, the important degree of the conditional attribute can be different in the whole conditional attribute set. If the dependency of the collection of decision attributes is changed little whether the existence of a in the conditional attribute set or not, it can be considered that the important degree of conditional attribute a is not high. Based on this view, the importance of conditional attribute a on decision attribute D is defined as:

$$\sigma_{(C,D)}(a) = \mu_C(D) - \mu_{C-(a)}(D) \quad (5)$$

3. Research on the customers' individual requirement of men's shirts based on Rough Set Theory

The core idea of researches on individual requirement of clothing based on rough set theory is calculating dependent degree and importance degree of the index attribute which based on the relational data model. Enterprises can understand the customers' individual requirement and consumption preferences in time, and it can provide production and marketing auxiliary decision-making effectively.

3.1 Data source

This paper mainly takes influential factors of the customer value and individual requirement of size, color, version, material of shirts to design the questionnaire. This paper use the data processed though questionnaire, preprocess data, and research the problem by using the customer characteristic and the male shirt attribute data. We deduct the missing values from the questionnaires and the invalid questionnaires. Results 350 questionnaires were and 310 effective recalled. Effective questionnaire is 88.6%

3.2 Case researches based on rough set theory

The influencing factors of customer value. Customer is the most valuable asset for the clothing enterprise. In modern E-commerce scenarios falls, the customers' individual requirement of clothing is getting higher and higher. The competition of each clothing enterprise is intense. In order to strengthen competitive advantages for the enterprises, clothing enterprise should take the different strategy to satisfy the customers' individual requirement and realize the customer value.

Customer value refers to the difference between the customers' profits and the customer's expense when they purchase goods. The factors that affect customer value mainly include the following aspects:

(1) Customer factor

Customer factor is divided into customer economic conditions and customer consumption preference. The customer's economic condition can not only determine its payment ability, but also can decide the material, clothing brand of clothing, etc. Different customers have different consumer preferences, such as size, color, version material and so on.

(2) Relationship factor

The customer value not only changes in the different stages of the use of the product, but also will be gradually comprehensive, abstract and focused on the results and goal oriented with the deepening of the relationship.

(3) Enterprise factor

The customer can become the assets of the enterprise only when the enterprise satisfies its individual requirement. The generous benefits are obtained only when enterprise realized customer value. Therefore, the enterprise should design the clothing product and provide services according to the customers' individual requirement.

When the customer preferences change, enterprises should enable the redesign of new products and services to keep up with the changes of customers' individual requirement. Otherwise the customer will drain to other enterprise. Only when the enterprise meets the customers' individual

requirement, the enterprise can establish good relationship with customers, obtain the customer satisfaction and loyalty and improve the customer's transfer cost. Thus enterprise can enhance its competitiveness.

Analysis of customer value. Through the design of the questionnaire, we investigate the influence degree of customer factor, relationship factor and enterprise factor to customer value which respondents considered. In order to realize the customer value better, this paper use the data processed though questionnaire, preprocess data, and analyze the consumer preference of the men's shirt. We extracted the data of 12 respondents as sample data to analyze the problem. This can be set to the discourse domain of $U = \{x_1, x_2, x_3, x_4, x_5, x_6, x_7, x_8, x_9, x_{10}, x_{11}, x_{12}\}$, x_1, x_2, x_3, x_4, x_5, x_6, x_7, x_8, x_9, x_{10}, x_{11}, x_{12} separately represents 12 sample data. Attribute set is $A = \{C, D\}$, the condition attributes is C= customer factor, relationship factor, enterprise factor. The influence degree of customer factor, relationship factor and enterprise factor to customer value was divided into high, medium and low grades. The decision attributes is D= whether it affects customer value or not. In order to analyze the main factors that affect customer value, only when two of the influence degree of customer value have reached "low" standard, we think that the customer value is not realized. Concrete influence degree values are shown in table 1:

Table 1 Decision table of influence customer value

ID	The condition attributes			The decision attributes whether it affects customer value or not
	customer factor	relationship factor	enterprise factor	
1	medium	medium	medium	Yes
2	high	medium	low	Yes
3	high	medium	medium	Yes
4	high	medium	medium	Yes
5	high	medium	medium	Yes
6	high	medium	medium	Yes
7	low	low	medium	No
8	high	low	medium	Yes
9	high	medium	medium	Yes
10	high	medium	medium	Yes
11	high	medium	medium	Yes
12	high	medium	medium	Yes

Hypothesis C_1 = customer factor, C_2= relationship factor, C_3= enterprise factor, Then:

$U/\{C_1\} = \{\{x_1\}, \{x_2, x_3, x_4, x_5, x_6, x_8, x_9, x_{10}, x_{11}, x_{12}\}, \{x_7\}\}$;

$U/\{C_2\} = \{\{x_1, x_2, x_3, x_4, x_5, x_6, x_9, x_{10}, x_{11}, x_{12}\}, \{x_7, x_8\}\}$;

$U/\{C_3\} = \{\{x_1, x_3, x_4, x_5, x_6, x_7, x_8, x_9, x_{10}, x_{11}, x_{12}\}, \{x_2\}\}$;

$U/C - \{C_1\} = \{\{x_1, x_3, x_4, x_5, x_6, x_9, x_{10}, x_{11}, x_{12}\}, \{x_2\}, \{x_7, x_8\}\}$;

$U/C - \{C_2\} = \{\{x_1\}, \{x_2\}, \{x_3, x_4, x_5, x_6, x_8, x_9, x_{10}, x_{11}, x_{12}\}, \{x_7\}\}$;

$U/C - \{C_3\} = \{\{x_1\}, \{x_2, x_3, x_4, x_5, x_6, x_9, x_{10}, x_{11}, x_{12}\}, \{x_7\}, \{x_8\}\}$;

$U/C = \{\{x_1\}, \{x_2\}, \{x_3, x_4, x_5, x_6, x_9, x_{10}, x_{11}, x_{12}\}, \{x_7\}, \{x_8\}\}$;

$U/D = \{\{x_1, x_2, x_3, x_4, x_5, x_6, x_8, x_9, x_{10}, x_{11}, x_{12}\}, \{x_7\}\}$.

Because: $POS_C(D) = \{x_1\} \cup \{x_2\} \cup \{x_3, x_4, x_5, x_6, x_9, x_{10}, x_{11}, x_{12}\} \cup \{x_7\} \cup \{x_8\}$

$= \{x_1, x_2, x_3, x_4, x_5, x_6, x_7, x_8, x_9, x_{10}, x_{11}, x_{12}\}$

So D is dependent on C, that is to say the decision whether it affects customer value or not can rely on customer factor, relationship factor and enterprise factor. And the relation is valid:

$POS_{C-\{C_1\}}(D) = \{x_1, x_2, x_3, x_4, x_5, x_6, x_9, x_{10}, x_{11}, x_{12}\} \neq POS_C(D)$;

$POS_{C-\{C_2\}}(D) = \{x_1, x_2, x_3, x_4, x_5, x_6, x_7, x_8, x_9, x_{10}, x_{11}, x_{12}\} = POS_C(D)$;

$POS_{C-\{C_3\}}(D) = \{x_1, x_2, x_3, x_4, x_5, x_6, x_7, x_8, x_9, x_{10}, x_{11}, x_{12}\} = POS_C(D)$.

It can be obtained:
$\mu_{C-\{c_1\}}(D) = 0.833;$
$\mu_{C-\{c_2\}}(D) = 1;$
$\mu_{C-\{c_3\}}(D) = 1;$
$\mu_C(D) - \mu_{C-\{c_1\}}(D) = 0.167;$
$\mu_C(D) - \mu_{C-\{c_2\}}(D) = 0;$
$\mu_C(D) - \mu_{C-\{c_3\}}(D) = 0.$

In the following formul $\mu_{C-\{c_i\}}(D) = \frac{|POS_{C-\{c_i\}}(D)|}{|U|}\left(0 \le \mu_{C-\{c_i\}}(D) \le 1, i = 1,2,3,4\right)$, $\mu_{C-\{c_i\}}(D)$ indicates the values of that decision attribute dependence on condition attribute after we remove the i index; in the formula$\sigma_{(C,D)}(a) = \mu_C(D) - \mu_{C-(a)}(D)$, the smaller value of $\sigma_{(C,D)}(a)$ indicates that the smaller evaluation system dependence on the i index, the less important index. In order to determine which kind of factors has the most effect on whether it affects customer value or not, we analyzed the influence degree of customer factor, relationship factor and enterprise factor to customer value which respondents considered. Seen from the calculation of the influence degree of each factor, customer factor had the greatest influence on the customers' consumption preferences, and it is the main factor in deciding whether it affects customer value or not.

Analysis of relationship between customers' consumption preferences and properties of men's shirts. The customers' consumption preference is refers to the customer produced special trust on specific apparel goods, stores, or trademark. They often go to a certain store regularly or repeated to buy the same trademark or brand goods. Size, color, version, material and other properties of men's Shirts affect customers choose clothing. Through the design of the questionnaire, respondents rated the Influence degree of the shirt attributes on the customers' consumption preferences, the score of the attributes was scored by percentile. That is $C_{ij} \in [0,100]$. We give each of the results of the respondents as a line and we will get a two-dimensional data table. According to the data processed though questionnaire, we sampled the results of 12 respondents as sample data to analyze the problem.

We can use the four-quad IS=(U,A,V,f)to represent them through the data. Discourse domain is $U = \{x_1, x_2, x_3, x_4, x_5, x_6, x_7, x_8, x_9, x_{10}, x_{11}, x_{12}\}$. x_i separately represents the customers' consumption preferences for shirts. Attribute set is A={C, D), the condition attributes is $C = \{a_1, a_2, a_3, a_4\}$, a_i separately represents size, color, version and material; the decision attributes is D= {d}, it represents the degree of customers' consumption preferences. The specific scores are shown in table 2:

Table 2 The scores of each attribute

ID	size	color	version	material	the degree of preferences
1	61	58	59	73	low
2	76	62	50	75	medium
3	79	71	64	74	medium
4	78	58	75	77	medium
5	70	88	89	94	medium
6	87	85	80	78	medium
7	96	82	84	88	high
8	79	72	87	66	medium
9	70	68	73	64	medium
10	73	77	56	63	medium
11	67	79	49	69	medium
12	72	65	59	85	medium

In order to make the data clearly visible, we transform the above attribute score table into figure 1.

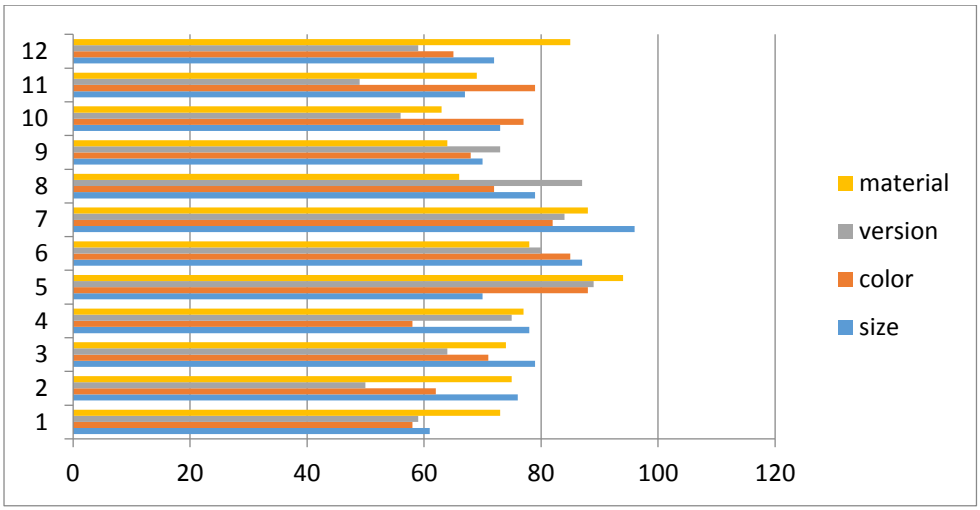

Figure 1 The scores of each attribute

Because of the collected data are continuous, and the basic theory of rough set is the set theory, when we deal with practical problems, we need to discretize the collected data. The method of the natural division of segmentation is applied to divide the continuous attribute values into several ranges, and we give a standard value in each range, thus we discretize the continuous attribute values. We divide the influence degree of different size, color, version and material on the behavior of the customers purchasing shirts into 1, 2, 3 grades. And 1—80～100,2—60～79,3—＜60. Decision table is shown in table 3 after discretization:

Table 3 Decision table

ID	size	color	version	material	the degree of preferences
1	2	3	3	2	low
2	2	2	3	2	medium
3	2	2	2	2	medium
4	2	3	2	2	medium
5	2	1	1	1	medium
6	1	1	1	2	medium
7	1	1	1	1	high
8	2	2	1	2	medium
9	2	2	2	2	medium
10	2	2	3	2	medium
11	2	2	3	2	medium
12	2	2	3	1	medium

$$U/\{a_1\} = \{\{x_1, x_2, x_3, x_4, x_5, x_8, x_9, x_{10}, x_{11}, x_{12}\}, \{x_6, x_7\}\};$$
$$U/\{a_2\} = \{\{x_1, x_4\}, \{x_2, x_3, x_8, x_9, x_{10}, x_{11}, x_{12}\}, \{x_5, x_6, x_7\}\};$$
$$U/\{a_3\} = \{\{x_1, x_2, x_{10}, x_{11}, x_{12}\}, \{x_3, x_4, x_9\}, \{x_5, x_6, x_7, x_8\}\};$$
$$U/\{a_4\} = \{\{x_1, x_2, x_3, x_4, x_6, x_8, x_9, x_{10}, x_{11}\}, \{x_5, x_7, x_{12}\}\};$$
$$U/C - \{a_1\} = \{\{x_1\}, \{x_2, x_{10}, x_{11}\}, \{x_3, x_9\}, \{x_4\}, \{x_5, x_7\}, \{x_6\}, \{x_8\}, \{x_{12}\}\};$$
$$U/C - \{a_2\} = \{\{x_1, x_2, x_{10}, x_{11}\}, \{x_3, x_4, x_9\}, \{x_5\}, \{x_6\}, \{x_7\}, \{x_8\}, \{x_{12}\}\};$$
$$U/C - \{a_3\} = \{\{x_1, x_4\}, \{x_2, x_3, x_8, x_9, x_{10}, x_{11}\}, \{x_5\}, \{x_6\}, \{x_7\}, \{x_{12}\}\};$$
$$U/C - \{a_4\} = \{\{x_1\}, \{x_2, x_{10}, x_{11}, x_{12}\}, \{x_3, x_9\}, \{x_4\}, \{x_5\}, \{x_6, x_7\}, \{x_8\}\};$$
$$U/C = \{\{x_1\}, \{x_2, x_{10}, x_{11}\}, \{x_3, x_9\}, \{x_4\}, \{x_5\}, \{x_6\}, \{x_7\}, \{x_8\}, \{x_{12}\}\};$$
$$U/D = \{\{x_1\}, \{x_2, x_3, x_4, x_5, x_6, x_8, x_9, x_{10}, x_{11}, x_{12}\}, \{x_7\}\};$$

Because:

$$\mathrm{POS}_C(\mathrm{D}) = \{x_1\} \cup \{x_2, x_{10}, x_{11}\} \cup \{x_3, x_9\} \cup \{x_4\} \cup \{x_5\} \cup \{x_6\} \cup \{x_7\} \cup \{x_8\} \cup \{x_{12}\} = \{x_1, x_2, x_3, x_4, x_5, x_6, x_7, x_8, x_9, x_{10}, x_{11}, x_{12}\}$$

$\mu_C(\mathrm{D}) = \frac{|POS_C(\mathrm{D})|}{|\mathrm{U}|} = \frac{8}{8} = 1$, so D is dependent on C, that is to say the customers' consumption preferences can rely on size, color, version and material. And the relation is valid:

$\mathrm{POS}_{\mathrm{C}-\{a_1\}}(\mathrm{D}) = \{x_1, x_2, x_3, x_4, x_6, x_8, x_9, x_{10}, x_{11}, x_{12}\} \neq \mathrm{POS}_C(\mathrm{D})$;

$\mathrm{POS}_{\mathrm{C}-\{a_2\}}(\mathrm{D}) = \{x_3, x_4, x_5, x_6, x_7, x_8, x_9, x_{12}\} \neq \mathrm{POS}_C(\mathrm{D})$;

$\mathrm{POS}_{\mathrm{C}-\{a_3\}}(\mathrm{D}) = \{x_2, x_3, x_5, x_6, x_7, x_8, x_9, x_{10}, x_{11}, x_{12}\} \neq \mathrm{POS}_C(\mathrm{D})$;

$\mathrm{POS}_{\mathrm{C}-\{a_4\}}(\mathrm{D}) = \{x_1, x_2, x_3, x_4, x_5, x_8, x_9, x_{10}, x_{11}, x_{12}\} \neq \mathrm{POS}_C(\mathrm{D})$;

It can be obtained:

$\mu_{\mathrm{C}-\{a_1\}}(\mathrm{D}) = 0.833$;

$\mu_{\mathrm{C}-\{a_2\}}(\mathrm{D}) = 0.667$;

$\mu_{\mathrm{C}-\{a_3\}}(\mathrm{D}) = 0.833$;

$\mu_{\mathrm{C}-\{a_4\}}(\mathrm{D}) = 0.833$;

$\mu_C(\mathrm{D}) - \mu_{\mathrm{C}-\{a_1\}}(\mathrm{D}) = 0.167$;

$\mu_C(\mathrm{D}) - \mu_{\mathrm{C}-\{a_2\}}(\mathrm{D}) = 0.333$;

$\mu_C(\mathrm{D}) - \mu_{\mathrm{C}-\{a_3\}}(\mathrm{D}) = 0.167$;$\mu_C(\mathrm{D}) - \mu_{\mathrm{C}-\{a_4\}}(\mathrm{D}) = 0.167$.

In order to determine which kind of factors has the most effect on the customers' consumption preferences; we should analyze the customers' preference for men's shirts. From the above results can be seen size has the most effect on the customers' consumption preferences, and color, version and material are equally affected the customers' consumption preferences.

4. Conclusion

This paper hypothesized that the factors of influence are limited. And this paper research the customers' individual requirement of clothing by using the data processed though questionnaire and rough set theory. We can get the following conclusions:

(1) This paper first determines the factors that affect customer value. That is customer factor, relationship factor and enterprise factor. Through the analysis of the degree of customer value, we conclude that the customer factor has the greatest impact on the customers' consumption preferences, and it is the main factor in deciding whether it affects customer value or not. To better survive and develop, each clothing enterprises should fully identify the customers' individual requirement and customers' consumption preferences, and accordingly make a variety of individual recommendation.

(2) In order to determine which kind of factors has the most effect on the customers' consumption preferences; we analyze the customers' preference for men's shirts. From the above results can be seen size has the most effect on the customers' consumption preferences, and color, version and material are equally affected the customers' consumption preferences.

In this paper, we use a handful of random data of questionnaires to analyze the questions. Factors that affect customer value and the clothing attribute influencing the customers' preference are limited. It may make the results and the actual situation have some error.

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