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Wuhan International Conference on e-Business

Summer 6-19-2015

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Abstract: Customers are the important strategic resources for the companies in E-commerce market, understanding customer's consumption characteristics as soon as possible becomes more important for companies to win in a competitive online market. The paper tries to construct a model to represent the customer's consumption characteristics based on a little information about this customer's purchase behavior. In the model, the attributive combinations and their orderings of the products were found to reflect the customer's purchase decision. An example arranged in the paper illustrates that the model can be a good tool for the companies to understand a customer or a group of similar customers' consumption characteristics.

Keywords: the consumption characteristics model, the customer, incomplete information situation, E-commerce

1. INTRODUCTION

With E-commerce technologies are widely used, each company has to meet more competitors in his market. It is harder for the companies to survive in such competitive environment. Among the critical resources supporting the normal operation of a company, customers always be valued by the strategic layer of the company.

Online shopping changes people's consumption pattern and influences the market, companies can take advantage of online shopping data from the customer to understand the customer's consumption needs and preference. When a company gets more effective data from the customer, it can understand the customer in deeper level, then it is possible for the company to develop better products or provide better services to satisfy the customer's demand, thus, it is a way to attract more customers to form a bigger market. Many evidences, for example, some "small is beautiful" online stores, from "A&I woman bag" to "ELWING woman clothing", prove a reasonable principle "who owns the customers, who wins the world".

In recent world, big data technologies are developed rapidly. Lots of devices were invented to collect data from the customers, data mining technologies such as the cluster analysis, artificial neural network, genetic algorithm, and so on, make it is easier to find more hidden truth of the customers. However, utilizing big data technologies requires more time and costs, so, most companies, especially the small and micro businesses, need the other tools except big data technologies to help them to understand their customers. More often, those companies are in an incomplete information environment, they also need effective tools or methodologies suitable for such condition. Although, there are not enough methods designed for this field, it is a challenge for the researchers and the managers to find new theories or technologies to understand the customers earlier. This paper aims to find a new way to understand a customer or a group of similar customers in a little information situation and tries to build a consumption characteristics model to reflect the customer's purchase decision.

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2. LITERATURE REVIEW

To companies in a competitive market, satisfying customers and providing surpassing products or services is a key to win. Researches about customers in E-commerce are more concerned by recent researchers, most of them are about the purchase decision, purchase behavior and consumption of the customer.

Among several aims of customer researches, to understand the important factors affecting the customers purchase decision is the most attractive one. In this line, researches conducted by the experts from the multiple majors, such as psychology, environment, resource, and so on, all of them tries to realizethe goal by different professional technologies. For example, Li Jie used multiple regression analysis method to find that the online review content given by the customer can affect his satisfaction[1]; MoutusyMaity and MayukhDass used experiment method and behavioral decision theory to provide the evidence that media richness can affect the consumer decision-making and the channel choices [2], Carter. M used the empirical test to find the relationship among the customer loyalty, the switching costs and the trust in E-commerce environment[3]. Various methods and the multiple perspectives make the researches in this line appear fruitfully.

To analyze the customer's purchase behavior, researchers usually conduct market survey, then, use statistic method to find the potential regular pattern of the customer's purchase behavior and its trend of the development. For example, LV Xiao-Ling used shopping basket model and Enterprise Miner to find the characteristics of different kind of online shopping customers and the relevance between the products[4]. Safa, NS used the factor analysis, the regression analysis and the path analysis to show that the technological factors affect E-satisfaction mostly and the organizational factors affect E-trust mostly [5]. Jiang L researched the customer behavior based on the convenience perceived by the customer when he went shopping online[6]. Schwaig KS used the survey method and thestatistic method to find the truth that the invasion of the information privacy is concerned by the consumers[7].

Researches focus on the consumption of customers usually aim to find the consumption characteristics of a group of customers in certain market so as to give the suggestions for companies to develop the market. Those researches, in general, get the conclusions by the statistic methods based on the data from the market survey. For example, Shao Xianbao analyzed the mobile communication market formed by Xi'an university students, revealed the consumption characteristics of those students and the development of the market, then provided available suggestions for companies to exploit the university market[8].

Although there are more and more researches let us understand customers clearly based on complete information. However, in incomplete information situation, there are few researches about customers. Among a few of theories or approaches can deal with problems in such situation, the Bayesian equilibrium game and the hypergame methods are the shiny stars, some researches[9-15] used those tools to provide valuable findings to us. Because of the difficulties of the scientific decision-making based on incomplete information, researching customers in such kind of environments is a huge challenge to attract more attentionsofthe researchers in the world.

3. THE CUSTOMER'S CONSUMPTION CHARACTERISTICS MODEL IN INCOMPLETE INFORMATION SITUATION IN E-COMMERCE

The design idea of building the consumption characteristics model of the customer under incomplete information situation in E-commerce is inspired by the academic thoughts of the internal model mentioned by Prof. Kijima [12]. An internal model can represent an intelligent agent's decision for playing game with other intelligent agents. When a agent doesn't know complete information about other agents, his internal model then turns to a game in which some necessary information to form a game is not real but perceived by the agent. The customer's consumption characteristics model in incomplete information situation represents a customer's

consumption characteristics in the seller's eyes, namely, the perceived image of the customer. Few purchase information and browse behavior of a customer are necessary to construct the model. The main task of building this model is to find the product attributive set in customer's mind and their ordering. In many cases, product attributes and their orderings are the main factors can affect the customer's purchase decision.

3.1 Perceivethe attributive setof the products in a customer's mind

Suppose a seller doesn't know the customer's consumption strategies and the preference of her strategies except a little information about the customer's first purchase order or her web browsing track. In this situation, the seller has no way to ask the customer for her needs, so he has to perceive the factors that would affect her decision on her purchase in his web store.

From the sellers'perspective, he thinks that the attributes of the products would be the elements of the customers' purchase decision criteria, if the attributes of a certain product satisfy the customer's need, then it could be bought by the customer in high probability.

To perceive the attributive set of the products in a customer's mind, let Wrepresent the set of the products sold in a web store, $W'$is the subset of Wrepresents the browsed or bought products by the customer. The seller supposes that both the customer and he see the same product attributive set denoted as $A = \{A_1, A_2, \cdots, A_k\}$in which A_k represents the attribute k of the products included in W', $\forall k \in K$. Let $a_i = \{a_{i1}, a_{i2}, \cdots, a_{iv}\}$ be the domain set of the attribute$A_i$known by the seller, then anattributive vector for the product j can be described as $v_j = (a_{j1}^*, a_{j2}^*, \cdots, a_{jk}^*)$ in which $j \in W'$, $a_{jk}^*$is the most suitable value of the attribute k of the product j, $v_j \in a_1 \times a_2 \times \cdots \times a_k$.

Construct the matrix$B_s = (b_{ij})_{sv \times sv} \in P(a_s \times a_s), s \in K$.

$$b_{ij} = \begin{cases} \sum_{r \in W'} 1 & , \quad \text{if } \{i, j\} \in A^r \\ 0 & , \quad \text{if } \{i, j\} \notin A^r \end{cases} \quad i = 1, 2, \cdots, sv, j = 1, 2, \cdots, sv, r \in W' \tag{1}$$

Based on those matrices, use the "Small-Column and Large-Row" arrangement method (for short, SCLR method) [16] can find the ordering of the attributive values. For example, if the attribute i has three values$\{a_{i1}, a_{i2}, a_{i3}\}$in its domain, then the ordering$a_{i2} \succ a_{i3} \succ a_{i1}$means that $a_{i2}$is the most favorite value by the customer when she thinks about this attribute, soa_{i2}can represent the customer's opinion on this attribute.

Thus, for all the attributes in A, the favorable attributive value are drawn to be combined to set up a strategic set $S_{cs} = \{s_{cs1}, s_{cs2}, ..., s_{csm}\}$ for the customer. Because some attributive combinations combined by unfavorable attributive values don't belong to S_{cs}, so S_{cs} is smaller than $S \in \prod A_i, i = 1, 2, ..., k$.

3.2 Find the ordering of the attributive combinations in the customer's strategic set

The ordering in a set can be regarded as a kind of preference. After the customer's strategic set is obtained, we can find the ordering of each items based on the below rules:

◆ If an attribute has n values, each value has a number that reflects its favor level by the customer, in another words, the most favor value has the number n, the less favor value has the number n-1, the lest favor value has the number 1.

◆ If an attribute combination reflects the product bought by the customer, then this combination has a large number decided by the seller.

◆ If an attributive combination reflects the product just browsed by the customer, then this combination has a small number decided by the seller.

Based on the above rules, the numbers of each attributive combinationare summed to give the ordering of

the attributive combinations by comparing them.

3.3 Construct the customer's consumption characteristics model

When the attributive combinations and their ordering are found, then that information can be organized to form the customer's consumption characteristics model as Figure 1 shows.

The attributive combinations S_{cs}	The ordering of each attributive combination
S_{cs1}	Integer 1
S_{cs2}	Integer 2
$\vdots$	$\vdots$
S_{csm}	Integer m

Integer m represents the ordinal number of the attributive combination S_{csm}

Figure 1. The customer's consumption characteristics model

The data in this model can be updated when the seller has more information about the customer. More accurate data can let this model represent a customer or a group of similar customers more accurately.

4. AN EXAMPLE OF THE MODEL APPLICATION

Let A be the seller who sells 6 kind of woman Jeans in his web store and B be the customer who visited the web store and bought 2 pair of Jeans. To construct the model of B's consumption characteristics, A defines an attributive set $P =$ {PRICE, MATERIAL, STYLE} for those Jeans in which $PRICE =$ {25.99,42.99,73.99}, $MATERIAL =$ {"Fabric", "Tencel", "Pure cotton"}, $STYLE =$ {"Low-Rise", "High-Rise", "Straight-Leg", "Boyfriend"}.

Based on the knowledge of the Jeans, A can set the attributive vector for each kind of the Jeans(Table 1).

Table 1.The attributive vectors for all kind Jeans

The code of Jeans	The attributive vector of Jeans
Jean151	(25.99, "Pure cotton", "High-Rise")
Jean152	(25.99, "Fabric", "Low-Rise")
Jean153	(42.99," Fabric", "Straight-Leg")
Jean154	(42.99,"Tencel", "Boyfriend")
Jean155	(73.99,"Tencel"," Straight-Leg")

All A knows about B are that, after B visited the web pages of Jean155, Jean 153, Jean152 and Jean 154, she bought Jean152 and Jean 154 finally. According to this information, A could construct the analysis matrix B^{PRICE} (Figure 2), $B^{MATERIAL}$ (Figure 3) and B^{STYLE} (Figure 4) by the equation (1).

B^{PRICE}	25.99	42.99	73.99
25.99	1	-1	0
42.99	1	1	1
73.99	0	-1	0

Figure 2. The Matrix of B^{PRICE}

$B^{MATERIAL}$	Pure cotton	Fabric	Tencel
Pure cotton	0	-2	-2
Fabric	2	1	0
Tencel	2	0	1

Figure 3. The Matrix of $B^{MATERIAL}$

B^{STYLE}	High-Rise	Low-Rise	Straight-Leg	Boyfriend
High-Rise	0	-1	-2	-1
Low-Rise	1	1	-1	0
Straight-Leg	2	1	0	1
Boyfriend	1	0	1	1

Figure 4. The Matrix of B^{STYLE}

Followed the analysis steps of the SCLR method [16], A could find B 's preference about the price, the material and the style of the Jeans sold in his web store. From the above matrices, A would know that B regards $42.99 \succ 25.99 \succ 73.99$,Fabric $\approx$ Tencel $\succ$ Pure cotton ,Boyfriend $\succ$ Straight-Leg $\succ$ Low-Rise $\succ$ High-Rise, so, A could perceive B 's strategic set as S_{ba} ={{25.99, "Fabric", "Low-Rise"},{42.99, "Tencel", "Boyfriend"},{42.99,"Fabric", "Straight-Leg"}}, and then build B 's consumption characteristics model as Figure 5.

The attributive combinations of Jeans in B's mind			The ordering of each attribute combination
PRICE($)	MATERIAL	STYLE	
25.99	Fabric	Low-Rise	2
42.99	Fabric	Straight-Leg	3
	Tencel	Boyfiend	1

Figure 5. B's consumption characteristics model

Based on this model, A could understand that B preferred the fabric and Tencel Jeans with no more than \$42.99, and, probably, she had the potential need for Straight-Leg Jeans.

5.   CONCLUSIONS

In E-commerce, the customers are one of the important resources to the companies like the other resources, such as the money and the products. To understand the customers is a very tough task to all companies, especially in an incomplete information situation. This paper tries to build a consumption characteristics model to represent the consumption decision of the customer in an incomplete information situation. With the key attributive combinations and their orderings found based on a little information, the model can help the companies understand each customer or a group of similar customers more and earlier, an example illustrates that the model can be a good tool to understand the customer's purchase decision. Further researches will focus on programming the model and finding the way to embed the model to a game which is played by a company and a customer when they need to make a deal.

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