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The Customer Choice Model of commercial retailers based on MarKov Analysis

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ABSTRACT

As a highly competitive industry, it is an increasingly fierce competition for commercial retailers to win customers. How to improve one's ownership of customers has already become the key point for the commercial retailers to survive and develop. In this paper, we use the method of MarKov Analysis to construct an analysis model suitable to analyze the customer choice for the commercial retailers. It can provide a certain theoretical support and reference to companies in aspect of customer choice. At last, an application of this model is demonstrated through a case study.

Key words: Commercial Retailers; MarKov Analysis; Customer Choice

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INTRODUCTION

With the rapid development of social economy and the improvement of household consumption, the industry of commercial retail has developed into a highly competitive industry. The increasingly fierce market competition makes the commercial retailers be aware of the value and importance of customers acutely. How to improve the loyalty of the existing customers, retain and attract more customers, as well as increase the scale of customers, has become to be the key point for the commercial retailers to survive and develop.

At present, besides the theoretical analysis, the researches pay more attention to the quantitative and model analysis, in order to provide better decision support to enterprises in the aspect of customer choice. By the Multi-attribute Decision Making method, Liu Guoqiang, etc. proposes a kind of choice method for enterprises' credit-customers [1]. Based on constructing the evaluation model for credit sale risk with deviation maximization, the related financial data of the credit-customers is analyzed as well as the qualitative attribute of the credit sale risk. Then, considering both the quantitative and qualitative evaluation results, the credit-customers are sorted and filtered. According to the current status of key account management of logistics enterprises, Meng Fang, etc. analyzes the point of how to determine the scientific attributes to choose and evaluate the major clients [2]. Based on AHP method, they design a multi-index system to select and evaluate major clients of logistics enterprises. Based on theory of repeat purchase, Lv Xiaoling, etc. propose a choice method of customers with bipartite prediction and give an application through a case study [3]. Zhao Xiaohui, etc. study the customer's collaborative features in the development of collaborative products based on two basic theories, demand collaborating and design collaborating [4]. They divide the collaborative customers into 4 types according to their roles in the development of collaborative products and construct the evaluation index system of collaborative customers. They propose a selection and evaluation method of collaborative customers based on fuzzy clustering and incidence matrix. Finally, an application is performed through a case study. Based on discrete choice models and the data got from interviews and questionnaires, Guo Jie, Li Yongzhuang discuss the consumers' preference of liquid milk products through analyzing a number of factors of the individual characteristics of consumers [5]. From the view of brand awareness, Li Xianghui, Zhou Chitian

analyze the factors that drive consumers' choice, then, construct a new decision model for customer choice and perform a case study [6]. Base on AHP method, Wei Shen analyzes a number of influencing factors considered when consumers choose supermarkets, and sort the factors according to their importance [7]. His analysis provides decision support to supermarkets in aspect of making effectively competitive strategies.

In these studies, various quantitative methods are used to analyze the factors that influence customers' choice, to evaluate and select customers, to study decision-making of customer choice, and so on. But there is little analysis about customer choice of commercial retailers. The customers of commercial retailers are of certain stability and their purchase behavior is a repeated random behavior. Thus, it is of great significance for commercial retailers to analyze customers' purchase behavior and make effective customer choice decisions. In this paper, we propose a cost-benefit customer choice model for commercial retailers based on MarKov Analysis, in order to provide theoretical support and decision reference to enterprises when choosing customers.

INTRODUCTION OF MARKOV MODEL

MarKov Analysis is an analysis method proposed by Russian mathematician, MarKov, in 1907, and then it is improved and constructed by Mote-Carlo. This method is mainly used to analyze the future development trend of random events. That means predict the future state and trend of a variable according to its current state and trend in order to predict the possibly changes in a particular time in the future and make the appropriate decisions. MarKov Process is a typical random process. In the process, each system state can be represented by a random variable. Each state has a certain occurrence probability, called state probability. When the system changes from one state to another state, there is a transition probability. This transition probability can be calculated according to its closely former state. It has no connection with the original state and the former MarKov Process. In the MarKov Process, time and states can be continuous or discrete. The MarKov Process with time discrete and state discrete is called MarKov chain. In the MarKov chain, the state transition of each time is controlled by a matrix of state's transition probability. There are three obvious characteristics in the MarKov chain. (1) The process is discrete. It mainly displays into that the development process of system is discrete in the course of time and has multiple finite states. (2)The process is random. The development process of system transfers from one state to another is totally random. The possibility of state's transition is represented by the historical transition probability of the system. (3) The process is a MarKov process. The transition probability of system state is only related to the current state, has nothing to do with the previous state of the system. In the process of transfer, the state of certain system factors in phase t is only related to that of phase t-1, and has nothing to do with the system state before phase t-1.

MarKov Analysis can be used to predict and describe the future of a system and its steady behavior, and also can be extended to Markov decision process. In these models, people can make decisions that could influence the transition probability and the future system behavior in each phase. At present, MarKov Analysis has been widely applied to many areas, such as business, education, economy, etc. [8]-[11].

DESCRIPTION AND ASSUMPTIONS OF PROBLEM

For the commercial retailers, customers are a very important kind of asset. The customers' purchase is the most important source of profit for commercial enterprises. If enterprises want to survive and develop rapidly in the fierce market competition, they must pay more attention to the role and value of customers, and keep eyes on the competitiveness of competitors in the same industry and the transferring of customers. Then they should take measures as many as possible to retain and attract more customers and improve the ownership of customers continuously.

Generally, the purchase process of customer in commercial retailers can be viewed as a random process. Which enterprise customers will choose depends on many factors, such as shopping environment, quality of merchandise, price, customers' habits, etc. Considering these factors, after one shopping the customer may choose to shop in the enterprise continuously or to shop in another enterprise. In a period, the enterprise that customers choose to shop the next time is only related to that of this time, and has nothing to do with customers' shopping history. Thus, the purchase process of customers is discrete, stochastic and is of Markov processes. So we can use MarKov Analysis to analyze and predict customers' purchase process and make decisions.

For customers, they usually choose commercial retailers in a certain area to shopping. After shopping in an enterprise, there will be a certain percentage of customers retained to shopping in the enterprise continuously, while the other part will transfer to other enterprises. Also part of the customers shopping in other enterprises will choose to shop in this enterprise. For enterprises, in order to retain and attract more customers, improve the ownership of customers and increase its sales, they will take some appropriate measures to improve customers' loyalty and change their purchase behavior. Among these measures, the most commonly used is promotion which will increase cost. In that case, enterprises need to make a trade-off between the increased cost of promotion and the

benefit it will bring. In the following, it will use MarKov Analysis to construct an analysis model of customers' choice for enterprises in the purpose of providing decision reference.

In order to simplify problems and make the process of analysis simpler and clearer, we make the following assumptions:

(1) There are two commercial retailers in the region, S1 and S2.

(2) The purchase of customers in the region will be always completed in the two commercial retailers, which mean they will choose one retailer from S1 and S2.

(3) The transition probability of customers' purchase behavior between phases can be calculated by statistics and it is a constant.

CONSTRUCTION OF CUSTOMER CHOICE MODEL

When a customer goes shopping, he/she will choose either S1 or S2. We named each shopping of customer event. In that way, for each event the customer will choose either S1 or S2. That choose a specific retailer for shopping at one time is a system state. Because there are two commercial retailers to be chosen for customers in each event, the system has two states.

State 1: Customers choose S1 for shopping.

State 2: Customers choose S2 for shopping.

When the purchase process goes into future, the transition probability of customers' state from one phase to the next phase is shown in table 1.

Table 1: the transition probability between S1 and S2

Current event	Next event	
	S1	S2
S1	P_{11}	P_{12}
S2	P_{21}	P_{22}

P_{ij} is the probability when state i of a certain phase transfers into state j of the next phase. For example, P_{11} is the probability when customers continuously choose S1 in the next shopping; P_{12} is the probability when customers transfer from S1 to S2 in the next shopping. We use the transition probability matrix P to indicate the transition behavior of system state.

The transition probability matrix: $P=\begin{bmatrix} p_{11} & p_{12} \\ p_{21} & p_{22} \end{bmatrix}$

Those customers choose a specific commercial retailer for shopping in a certain phase is a system state. In this paper, we use $\pi_i(t)$ to represent the state probability of enterprise i at phase t, for example $\pi_1(2)$ means the state probability of the first enterprise at phase 2. It is known that the value of $\pi_1(2)$ is only related to the system state of the closely former phase $\pi_1(1)$ and the transition probability matrix. That is:

$$\pi_1(2) = \pi_1(1) \begin{bmatrix} p_{11} & p_{12} \\ p_{21} & p_{22} \end{bmatrix}$$

Considering the two commercial retailers, the state probability of the system at phase 2 is:

$$[\pi_1(2)\ \pi_2(2)] = [\pi_1(1)\ \pi_2(1)] \begin{bmatrix} p_{11} & p_{12} \\ p_{21} & p_{22} \end{bmatrix}$$

At the phase (n+1), the state probability of the system is:

$$[\pi_1(n+1)\ \ \pi_2(n+1)]=[\pi_1(n)\ \ \pi_2(n)]\begin{bmatrix} p_{11} & p_{12} \\ p_{21} & p_{22} \end{bmatrix}$$

When n is becoming bigger and bigger, the state probability of the system will tend to stable, that means the value of state probability in phase n and phase (n+1) will be very close to be equal. Thus, we can draw the following equations in order to calculate the steady-state probability of the two commercial retailers.

$$[\pi_1\ \ \pi_2]=[\pi_1\ \ \pi_2]\begin{bmatrix} p_{11} & p_{12} \\ p_{21} & p_{22} \end{bmatrix} \qquad ①$$

$$\pi_1+\pi_2=1 \qquad ②$$

According to equations ① and ②, we can calculate the steady-state probability of the two commercial retailers, π_1 and π_2.

$$\pi_1=\frac{p_{21}}{1-p_{11}+p_{21}}$$

$$\pi_2=\frac{1-p_{11}}{1-p_{11}+p_{21}}$$

From the above, it can be known that the steady-state probability of the two commercial retailers is only related to the transition probability of the system and has nothing to do with its initial state probability. Enterprises can take promotions to change the transition probability, so as to change the final steady-state probability.

Assuming the total quantity of customers is C within the region. Enterprise S1 takes certain promotions to improve its ownership of customers. In each phase, the cost of promotions is R and the probability of customers shopping in enterprise S1 continuously after promotions is expected to increase P_d. At the same time, the probability of customers transferring from enterprise S2 to enterprise S1 is expected to increase p_f. Each customer can bring an average profit of W to the enterprise every phase.

Then we can know the steady-state probability of the two commercial retailers after promotions, π_1' and π_2'.

$$\pi_1'=\frac{(p_{21}+p_f)}{1-(p_{11}+p_d)+(p_{21}+p_f)}$$

$$\pi_2'=\frac{1-(p_{11}+p_d)}{1-(p_{11}+p_d)+(p_{21}+p_f)}$$

When state is stable, the increased quantity of customers of enterprise S1 is: $C*(\pi_1'-\pi_1)$

The increased profit of enterprise S1 every phase is: $PA=W*C*(\pi_1'-\pi_1)-R$

When PA >=0, Promotions are feasible economically. When PA <0, Promotions are not feasible economically.

CASE STUDY

There are two commercial retailers and total customers of 13,000 in a certain region. By actual survey, the transition probability of purchase of customers between the two commercial retailers each phase is shown in table 2.

Table 2: transition probability between the two commercial retailers

Current event	Next event	
	A	B
A	0.8	0.2
B	0.1	0.9

In the name of increase the rate of owning customers, commercial retailer A decides to take promotions to improve the loyalty of its own customers as well as retain and attract more customers. It is predicted that the demanded input is about 100000 each phase. After promotions, its own transition probability is expected to increase 10% and the transition probability from commercial retailer B to A is expected to increase 5%. The income brought by each customer is expected to be 50 each phase. Based on these, determine whether the promotions are feasible.

Before promotions, the steady-state probability of commercial retailer A is: π_1=0.1/ (1-0.8 +0.1)=1/3=0.33

After promotions, the transition probability of purchase of customers between the two commercial retailers is shown in table 3.

Table 3: transition probability between the two commercial retailers after promotions

Current event	Next event	
	A	B
A	0.9	0.1
B	0.15	0.85

According to table 3, after promotions, the steady-state probability of commercial retailer A is:

$\pi_1^{'}$=0.15/ (1-0.9 +0.15) =0.6

The increased customer share of commercial retailer A is: 0.6-0.33=0.27

The increased quantity of customers of commercial retailer A is: 13000*0.27=3510

The expected income of commercial retailer a brought by the increased customers each phase is: 3510*50=175500

The increased net income of commercial retailer an each phase is: 175500-100000=75500

Because the net income of each phase is above 0, it can determine that the promotion is feasible for the commercial retailer A.

CONCLUSION

The purchase behavior of customers of commercial retailers can be seen as a Markov chain. In this paper, we take two commercial retailers for example, and construct a simple model suitable for enterprises to conduct customer choice based on Markov analysis. The model can makes a trade-off between the cost and income of customer choice, so it can provide scientific decision reference to enterprises. The model is verified through a case study. Although we analyze two enterprises in this paper, the ideas and methods are suitable for multi enterprises. After a certain expansion, it can provide decision reference to enterprises in the aspect of customer choice.

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