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ABSTRACT

In this paper, the author applied the concept of the Markov chain and divided sales procedures into several indexes and states; use the state index for connecting success in sales and customer relations into Pfeifer's method, establish a mathematical model, and demonstrate its result. In order to increase profits and decrease the cost of sales for the company, we further classify customers and propose different sale strategies. Case study and analysis are provided to elaborate the approach and its contribution to sales and CRM (customer relationship management) strategy.
Keywords: CRM, Relationship model, Selling process, Markov Chain

1. INTRODUCTION

Customer relationship modeling is always a popular topic for research. Sheng Peng conducted a thorough analysis, from the aspect of psychology, on the "customer person" in the process of selling.

He[1] considered that the selling is sales to people- to key customer people (KP, who are responsible for or have a direct controlling relation with the purchasing), no matter to a plant or a family. In the case, a selling is involved several factors, besides the enterprise's "selling points", customer's "purchasing point", more important, a good salesperson should also supply a KP with some "selling points" in KP's group, those selling points should be not only accepted by the KP from his heart, but also can be accepted by KP's group members, even more, some of the key ideas may let the KP believe the purchasing can bring him more respect in his group, and the KP is willing to declare the purchasing suggestion in the public. In such cases, the selling will be success in very large probability. He also thought that a sales process should be able to measured, it should never be managed in a "black box", managers can't handle the sales process and know the result only when it is out from the other side of the box. Such things happen because there is no state index set in the sales process, Sheng set up three indexes to help solving the problem.

Also to solve the problem, Reichheld, F.F[6] consider that only one index is needed: "You simply need to know what your customers tell their friends about you". Morgan[7] and Kristensen[8] do not agree with his idea.

With regard to the customer relations mathematic model and the aspect of analysis, though many papers involving in the topic, most of them are methods based on the contacting and sales result information analyzing, only a few of them are modeling inside the process. Blattberg and Deighton[2] proposed an LTV(Life Cycle Value) model to compute the cost of acquiring and maintaining customers. In order to help managers to optimize their sales, Bronnenberg[3] made an attempt to model and analyze consumer relationships using the Markov chain (MC); Based on supposed several states, Pfeifer and Carraway[4] constructed several CRM models with MC, and computed and analyzed different sales strategies within given parameters with profit as the objective, but they do not given more detailed computing and analysis to their model, also omitted that the supposed states can help salespeople improve their work; Jain and Singh[5] conducted a thorough survey of the area, describing the current and future trends.

In this paper we will introduce Sheng's indexes and apply the indexes into Pfeifer's[4] Markov model, then adopt different sales strategies, and a little detailed computing, to test the model, and analyze the benefit to the enterprise. In the analysis the customer classifying method will be employed, the results computed, and various scenarios compared.

2. THE SALES STATE INDEX, SELLING PROCESS, KNOWLEDGE, AND MARKOV MODEL

2.1 The Sales State Index, Selling Process Classification and Knowledge Management

In order to measure a sales process, Sheng[1] set up three index sets, based on the relationship between salesperson and KP, from connection relation, attitude to product, and confidence to product sides. Each index and states are given as following:

Connection index (To customer): Has nothing to say (low), and only says the official words (middle), the conversation is valid (good), and no secrets are kept from each other (high);

Attitude index (To product): basically not approve the product(low), basically approve the product(middle), and approve the product very much (high)

Confidence index (To product): approval given on a case-by-case basis (low), approval given with appropriate examination (middle), approval given in big or important situations (high).

Such indexes are index with "operating concept", they can not only help salespeople make sure their sales state, but also supply them with an improved direction. For example, if your state is three "high" in the three sides, the selling will be success in very large probability; If your state is three "middle", it is hard to say your sales result, what you should to do is to improve your relation with KP, in the three given sides, in order to get better state and have larger sales success probability; If your state is three "low", you can get success, but in a small probability.

Not as a traditional CRM system, the system built with such concept aims the data on KP's information, customer purchasing point (PP), sales point in his group (SP), customer views on criteria (VOC) and so on. Such indexes classify a whole sales process into states, and its operating concept about states normalize salespeople's sales state description and unify salespeople's understanding to each given sale state; make sales managers monitor his people selling easily; locate the state and direct the further improvement direction, and so on. Under such concept, we notice that a customer is not just a customer, but a separated decision process. Its system is **a special knowledge management system**, what it stores is "human" intelligence and analysis result, not just sales results, because its unified state description makes such management possible. With such system, enterprise managers and researchers can classify customers not only from sales result data, but also from the KP's character, PP, SP, and VOC, they can get more deeper and wider customer information, and what they get is the reason, not a statistical estimation, why customer buy or not buy their product. So such system can help the enterprise manage, share, accumulate, its salespeople's sales knowledge and key customer information. We think that a system built with such concept should be a real customer knowledge management system (more detail information can be seen from Sheng[1]).

2.2 Markov Chain Modeling

Based on the concept given above, we can discuss several sales strategies**,** when we separated a sales process in to several states, each with its sales success probability. **Which scenario will be better, selling in large probability or selling in any chance?** Following is the discussion by means of Pfeifer's MC model[4]. In order to simplify our discussion, we enlarge one of those index sets and use it to model the state of a sales process. The confidence index set divides a sales process into the following five states: 5(former custom-er), 4(no approval in one-on-one situations), 3(approval in one-on-one situations), 2(approval in small catcall situations), 1 (approval in big or important situations). Obviously, state 1 holds the greatest probability of success. These relation states within a sales process are shown in Fig.1.

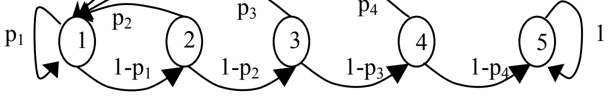

Fig 1 A sale procedure with given sale states

Pfeifer's model[4] is a model of the relationship between the sales and its customers (we set states following the thought). When the trading began, the relationship between the salesperson and the customer can be in any state in Fig.1, and the sale can be successful in any state, but the probability is different. Suppose the income of a successful sale is N=40, and the cost of the sale is 4. The probability of one sale succeed is the corresponding p_i. If the sale succeeds, the enterprise will obtain the benefit of N-M; if not, the enterprise will lose M, and the probability of the relationship going back one state is $1-p_i$. Obviously, $p_i < p_{i-1}$, $p_j=1$, $i=1,2,\ldots,j$, with j as the state number, state 5 indicating no connection. Suppose also that the cost of the sale is entered just before the deal is made.

The matrix P is a one-step transition matrix, R is a reward vector, V is the expected net present value[4].

$$P=\begin{bmatrix} p_1 & 1-p_1 & 0 & 0 & 0 \\ p_2 & 0 & 1-p_2 & 0 & 0 \\ p_3 & 0 & 0 & 1-p_3 & 0 \\ p_4 & 0 & 0 & 0 & 1-p_4 \\ 0 & 0 & 0 & 0 & 1 \end{bmatrix}; \quad R=\begin{bmatrix} N-M1 \\ -M2 \\ -M3 \\ -M4 \\ 0 \end{bmatrix}; \quad V=\begin{bmatrix} v1 \\ v2 \\ v3 \\ v4 \\ 0 \end{bmatrix}$$

Here M1=M2=M3=M4=M. In fact, the element of probability in the transition matrix (including in the result matrix P^2, P^3, P^4, etc.) represents the corresponding relationship between enterprise and customer after one or more sales. If required, we can set some threshold value or make hypothesis test to those elements which alert their relationship in case a problem occurs or the relationship is broken.

To be more precise, suppose that there is a discount rate to the present value after each purchase. Here, the discount rate is d=0.2. Thus, the expected net present value vector in j time of the sale, is(1):

$$V^j=\sum_{i=0}^{j}[(1+d)^{-1}P]^i R = I*R+[(1+d)^{-1}P]R+[(1+d)^{-1}P]^2 R+\ldots+[(1+d)^{-1}P]^j R$$

In order to simplify the results, we often use an infinite horizon to describe the purchase. From (1), we can get the expected net present value as follows:

$$V=\lim_{j\to\infty}V^j=[I-(1+d)^{-1}P]^{-1}R \qquad (2)$$

Supposed i=4, p_1=0.3, p_2=0.2, p_3=0.15, p_4=0.05, then:

$$V^4=\begin{bmatrix}50.115 & 4.22 & 0.592 & -1.98 & 0\end{bmatrix}^T$$

$$V=\begin{bmatrix}52.32 & 5.554 & 1.251 & -1.82 & 0\end{bmatrix}^T \qquad (2')$$

The result shows that, in this case, 25% customer (in state 1) makes the 90% profit of the enterprise. The negative expected value –1.98, in state 4, means sales enterprise shouldn't sell in such customer relationship, because the success probability is too small. How to solve the problem? Classifying customer is one way to improve the condition.

3. CLASSIFYING ANALYSIS

The purpose of the analysis is to determine the profit of the sale enterprise, and the object of the research is to see the effect produced by different sale strategies adopted to different customers, after having divided customers into different types. In many cases, the sale enterprise does not hope to gain much from the first or second trade, but hopes to make money over a given period of trading. Therefore, for ease of analysis, we assume an infinite case for the sale. In this case, the negative value in the V vector of equation 2 means that if the first connection with the customer is at the corresponding state, no profits can be obtained from the sale even if the customer makes an infinite number of purchases. This is because the success rate in the state is too small or the sales cost is too high, relative to its income. We also transform equation 2 into 3 in the following analysis, to avoid the computation of d and the inverse operation in equation (2). We then have:

$$[I-(1+d)^{-1}P]*V=R \qquad (3)$$

Though there are 5 states in Fig.1, from the perspective of sales, there are only **two kinds of customers: relationship and no relationship customers (or former customer[4]).**

3.1 Sales Strategies for Two Kinds of Customers

3.1.1 The General Result for the Two Kinds of Customers Scenario

From equation (3), the sale enterprise's expected net present value equation is:

$$\begin{bmatrix} (1-\frac{p_1}{1+d})v1-(\frac{1-p_1}{1+d})v2 \\ (\frac{-p_2}{1+d})v1+v2-(\frac{1-p_2}{1+d})v3 \\ (\frac{-p_3}{1+d})v1+v3-(\frac{1-p_3}{1+d})v4 \\ (\frac{-p_4}{1+d})v1+v4 \\ 0 \end{bmatrix} = \begin{bmatrix} N-M \\ -M \\ -M \\ -M \\ 0 \end{bmatrix} \qquad (4)$$

then

$$\begin{bmatrix} v1 \\ v2 \\ v3 \\ v4 \end{bmatrix} = \begin{bmatrix} v1 \\ (\frac{p_2}{1+d})v1-M+(\frac{1-p_2}{1+d})v3 \\ (\frac{p_3}{1+d})v1-M+(\frac{1-p_3}{1+d})v4 \\ (\frac{p_4}{1+d})v1-M \end{bmatrix} \qquad (5)$$

the result:

$$v1=\frac{N-(1+q1+q1q2+q1q2q3)M}{1-p1-q1p2-q1q2p3-q1q2q3p4} \qquad (6)$$

therefore:

$$v4=\frac{N*p4-M(1+q1+q1q2+q1q2q3)*p4}{1-p1-q1p2-q1q2p3-q1q2q3p4}-M$$

among them:

$$pi=\frac{p_i}{1+d},\ qi=\frac{1-p_i}{1+d},\ pi+qi=\frac{1}{1+d}\ \text{(i=1,2,3,4).}$$

- From equation (4) and (2'), we notice that the response of customers in different states to same input M is very different, p_1=0.3, and p_4=0.05. From Markov chain's concept, we can see custom -ers in state4 as one time purchasing customers (OTPC), and ones in state1 as familiar ones. In order to compare easily, supposing we can increase sales cost to promote OTPC's success rate, to think it as linear relation simply, M4=(p1/p4)M, the result shows, in one side, the cost to acquire a new customer is as much as (p1/p4) times to retain a familiar one.

- From equation (5), we can get: **v1>v2>v3>v4**.
  For: v4=p4*v1-M;
  v3=(p3*v1-M)+q3*v4>(1+q3)*v4;
  v2=(p2*v1-M)+q2*v3>v3
  v2<(p2*v1-M)+q2*v1=(p2+q2)*v1-M<v1

The v2's first item is p2*v1, so **v1>>v2** and v3,v4, when p2 is small.

That means, under the given suppose, the better the relation is, the more the selling gets. The best relation customer will supply most of the sales profit.

- If the aim is to obtain greater benefits, Σvi= max , at least, each vi⩾0 (i=1,2,3,4). From (5), each vi is related to its pi, and in this case, p4 is the least, so if v4⩾0, then other vi⩾0 (i=1,2,3). From (6), we can get the threshold p4 and M as following:

$$p4\geq\frac{M(1-p1-q1p2-q1q2p3)}{N-M(1+q1+q1q2)}$$

$$M\leq\frac{N*p4}{(1+q1+q1q2)*p4+(1-p1-q1p2-q1q2p3)}$$

The Fig2 shows the relation between them, to the given data, the threshold p_4 in (2') should be p_4=p4*d=0.09, so in (2'), v4<0. By the same way, we can get each threshold p_i and M (i=1,2,3).

3.1.2 The Modified Strategy 1 for the Two Kinds of Customers Scenario

Under the given condition, Sales enterprise should modify its sales strategy to avoid losing money. The

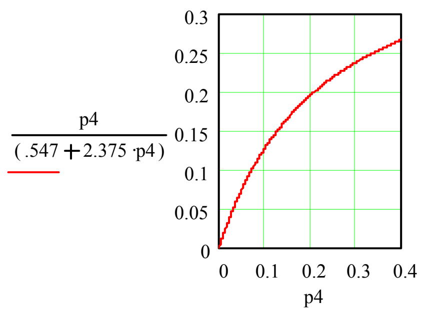

Fig 2 The relation between threshold p4 and M

modified strategy 1 is to take no sales action to customers in state 4, and treat them as no relation customers.

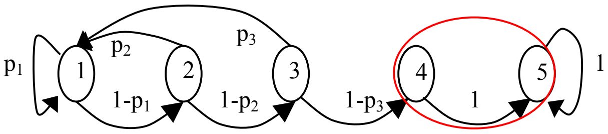

Fig. 3 The state figure of Scenario (7)

When p4 < M/v1, in formula (5) v4<0; i.e. sales to customers in state 4 (no approval in one-on-one cases) can never yield a profit. So stopping sales to them and treating them as customers in state 5 is a new sales strategy (see Fig.3, p4=0, the corresponding M=0, V4=0). Putting those results to formula (5), we have:

$$V=\begin{bmatrix} v1 & p2*v1-M+q2*v3 & p3*v1-M & 0 & 0 \end{bmatrix}^T \quad (7)$$

Compared with formula (5), there is no negative v4 in v3, which is in (7), so v3 in scenario (7) is better than that in (5); for the same reason, the v2 in scenario (7) is also better than that in (5). This means that, whether single vi or total profit(Σi) is involved, scenario (7) is better than that scenario (5). If v4>0, the conclusion is different. Considered the (2') data, we have the result: $V=\begin{bmatrix} 53.149 & 6.621 & 2.644 & 0 \end{bmatrix}^T$, it's better than (2').

The result means that enterprise should not sell in the very small success probability case.

3.1.3 Improved Strategy 2 for Two Kinds of Custom -ers

Furthermore, we can take no sales action for customers in state 3,4, and to treat them as no relation customers, as our strategy 2.

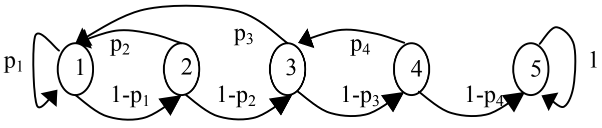

Fig. 4 The state in improved Scenario (9)

Similar to the previous analysis (Fig.3, also suppose p3=0, corresponding M=0), taking the condi- tion in formula (5), we get an improved scenario. In this case, the solution is:

$$V=\begin{bmatrix} v1 & p2*v1-M & 0 & 0 \end{bmatrix}^T \quad (8)$$

Compared with formula (7), the scenario is better than that of (7) only when v3<0. Otherwise, it will be worse than scenario (7), because, in this case, v3 can obtain profit. To the data given in (2'), we have result: $V=\begin{bmatrix} 51.574 & 4.596 & 0 & 0 \end{bmatrix}^T$, the result is not as good as (7), for the p_3 in scenario (7) is great its threshold p_3.

From the above analysis, we can see that the sales strategy is available, because the sales enterprise can gain greater benefits, in the case of its environment not changed.

3.2 The Sales Strategy for Multiple Types of Custom –ers

The case in Fig.3 is not realistic enough, because the enterprise should put some money into improving its relationships with its customer and bring it to a higher state: when the enterprise has made too few successful sales. Therefore, in order to reduce sales costs, we can divide both customers and sales costs into three types: sales cost M, retain cost H(<M), and 0.

3.2.1 Sales Strategy 1 for Three Kinds of Customers

A lower cost H is used for the case of improving customer relationships in order to reduce costs. Customers are classified into three types, such as 1,2,3;4; and 5; and the sales cost for state 4 is H (Fig.4). The difference with that of earlier is that current p4 is much great than before, because the current p4 is not the probability of making a successful sale, but the state of increasing one. vi (i=1,2,3,4) is still the present net value of each state. From equation (3), we can obtain the sale enterprise's expected net present value equation for the case of infinite purchases, as follows:

$$\begin{cases} v1 = p_1(N-M)-(1-p_1)M \\ v2 = p_2(N-M)-(1-p_2)M \\ v3 = p_3(N-M)-(1-p_3)M \\ v4 = p_4(v3-H)-(1-p_4)*0 \end{cases}$$

The transition matrix P and reward vector is:

$$P=\begin{bmatrix} p_1 & 0 & 0 & 0 & 1-p_1 & 0 & 0 & 0 \\ 0 & p_2 & 0 & 0 & 0 & 1-p_2 & 0 & 0 \\ 0 & 0 & p_3 & 0 & 0 & 0 & 1-p_3 & 0 \\ 0 & 0 & 0 & p_4 & 0 & 0 & 0 & 1-p_4 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix} \quad R=\begin{bmatrix} N-M \\ N-M \\ N-M \\ v3-H \\ -M \\ -M \\ -M \\ 0 \end{bmatrix}$$

From equation (3), we obtain the expected net present value as follows. The symbols are the same as those in

$$V=\begin{bmatrix} \frac{(N-M)-q1*M}{1-p1} & \frac{(N-M)-q2*M}{1-p2} & \frac{(N-M)-q3*M}{1-p3} & \frac{v3-H}{1-p4} & 0 \end{bmatrix}^T \quad (9)$$

(6). Because formula (7) can be shown as following:

$$V=\begin{bmatrix} v1 & (p2+q2*p3)v1-(1+q2)M & p3*v1-M & 0 \end{bmatrix}^T$$

and to prove which is larger((7) or (9)) is a little hard,

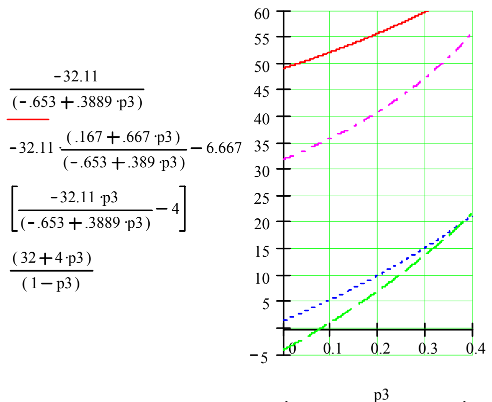

Fig.5 Comparing scenario (7) with scenario (9)

so we can deal with it by Fig.5 (with the data in (2')), the first three formulas are v1,v2,v3 in (7), and the fourth one(the line in the Fig middle) is the v3 in scenario (9), the other two is: v1 =44.89, v2=40, when p3 varying from 0 to 0.4, so ∑vi in scenario (9) is much better than that ∑vi in scenario (7) (note: we haven't consider the v4 in scenario (9) in the analysis). $V=\begin{bmatrix}44.89 & 40.00 & 37.90 & 49.47 & 0\end{bmatrix}^T$ is the (9) result with the data in (2'), except p4=0.3/1.2.

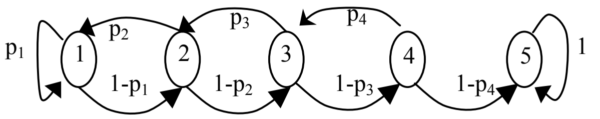

Fig. 6 The state in an improved Scenario (10)

The result means that enterprise should improve the relationship with customer first, and reduce the sales chance under too low success probability case.

3.2.2 Characteristics of the Transition Matrix

In a transition matrix with structure as such P, all customers will finally become no connection customers. Because when $p_{ij} \geqslant 0$ in the matrix P, there must be a steady limit probability vector. Suppose this vector is W and that $W=(W1,W2,W3,W4,W5)^T$. We then have a steady limit probability equation $W = P^T * W$. For the character of matrix P, we obtain the first two lines as: $\begin{cases} p_1W_1 + p_2W_2 = W1 \\ (1-p_1)W_1 = W_2 \end{cases}$. From the simultaneous equations, we have: $\begin{cases} p_2W_2 = (1-p_1)W1 \\ W_2 = (1-p_1)W_1 \end{cases}$ Because p2⩾0, then, W1=W2=W3=W4=0; ∑Wi=1, so W5=1.

The result means that a transition matrix with such a structure will result in decreased relationship as the trading time increases; finally, all customers will become no connection customers (steady state). The Pfeifer's calculation of P, P^2, P^4 also shows similar characters[4].

3.2.3 Sales Strategy 2 to Three Kinds of Customers

We can improve our sale strategy further, and propose a more conservative sales strategy: the enterprise should only conduct its sales in state 1,2.

The sales enterprise may require a regulation that the product must be sold at the high relation state, i.e. where there is a high probability that the sale will be a success—in "approval in small catcall situations" and "approval in big or important situations." Therefore, by inputting H sales cost, each success in state 3,4 can increase the step of the state forward by one state; each failure can set the relationship back by one state; and the sales action can only occur in states 1 and 2 with a cost of M. This strategy is exactly like the one that classifies customers into the following three types: 1,2; 3,4; 5, only now Fig.5 is changed to Fig.6. This is a typical random walk model. Hence, we can establish the equation by using formula (3):

$$\begin{cases} v1 = p_1(N-M_1)-(1-p_1)M_1 \\ v2 = p_2(N-M_2)-(1-p_2)M_2 \\ v3 = p_3(v2-H)-(1-p_3)H \\ v4 = p_4(v3-H)-(1-p_4)*0 \end{cases};$$

The transition matrix P and reward vector are:

$$P=\begin{bmatrix} p_1 & 0 & 0 & 0 & 1-p_1 & 0 & 0 & 0 \\ 0 & p_2 & 0 & 0 & 0 & 1-p_2 & 0 & 0 \\ 0 & 0 & p_3 & 0 & 0 & 0 & 1-p_3 & 0 \\ 0 & 0 & 0 & p_4 & 0 & 0 & 0 & 1-p_4 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix} \quad R=\begin{bmatrix} N-M_1 \\ N-M_2 \\ v2-H \\ v3-H \\ -M_1 \\ -M_2 \\ -H \\ 0 \end{bmatrix}$$

The expected net present value is equation (3) after the purchase (Suppose $M_1=M_2=M$).

$$V=\begin{bmatrix} \frac{(N-M)-q1*M}{1-p1} & \frac{(N-M)-q2*M}{1-p2} & \frac{(v2-H)-q3*H}{1-p3} & \frac{v3-H}{1-p4} & 0 \end{bmatrix}^T \quad (10)$$

Comparing with scenario (9), there is no change in v1,v2 of scenario (10). The value of p3, p4 changes (the change will result in v3's numerator becoming larger and its denominator becoming smaller), but the change in v3 results in a change in v4. If we can prove v3 in (10) is better than v3 in (9), then we can say scenario (10) is better than scenario (9). We have:

$$\frac{v2-(1+q3)H}{1-p3} - \frac{N-(1+q3)M}{1-p3} > \frac{v2-(1+q3)M}{1-p3} - \frac{N-(1+q3)M}{1-p3} = \frac{v2-N}{1-p3}$$

Notice that, we use M instead of H for the comparing.

$$\frac{v2-N}{1-p3} = \frac{\frac{N-(1+q2)M}{1-p2}-N}{1-p3} = \frac{p2*N-(1+q2)M}{(1-p2)(1-p3)};$$

When $\frac{p2}{1+q2} > \frac{M}{N}$,the v3 in (10) is better than v3 in (9). Consider H, we can say that the scenario (10) is better than scenario (9). Also we can get result:

$$V=\begin{bmatrix}44.89 & 40.00 & 51.64 & 67.79 & 0\end{bmatrix}^T$$

(Here: p4=p3=0.3/1.2), it looks better than that in scenario (9).

4. CONCLUSION

In the paper, we analyzed the customer relation- ship, set up the sales state index for the sales process, and modeled the relationship by introducing the concept of the MC based on the given state index; and presented the results of our analysis of the model. Pfeifer [4] pointed out that such an approach can also be applied to analyzing the problem of "Recency," "Frequency", and "Monetary."

The proposed approach here is to model the relationship with the MC by using various indexes, analyze the relationship between cost and the probability of making a successful sale in terms of benefits obtained, test different sales strategies on the model and present the corresponding solution.

The analysis results show us that the most conservative sales strategy is much better than the normal strategy.

That means, in the case of small sales success probability, the sales enterprise shouldn't sell in any state at any chance, but to improve the relationship with customer first and prepare to sell in the high success probability state.

ACKNOWLEDGEMENT

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