TARGET MARKET SELECTION USING MARKOV CHAINS

TANSU BARKER
UNIVERSITY OF CANTERBURY

SUMMARY

A marketing firm faces the problem of selecting the market it should serve after adding a new product to its line. Market analysis is used to identify the more lucrative alternative by incorporating the subjective estimates of the managers regarding environmental factors. Difficulties associated with data acquisition and problems of implementation are presented. Experiences with this firm indicate that the use of markovian analysis forces the marketing staff and the line managers to interact with each other and increases the probability of making better decisions in the long run.

1. THE PROBLEM

The firm, which we shall name Crystal, is one of the largest marketing companies in Turkey selling glassware through wholesalers and its own chain of retail outlets. The retail business amounts to about 15% of the annual sales and the wholesalers have been a loyal and stable link in the distribution system. After more than four decades of producing and marketing glassware, the company has acquired a chinaware factory and was faced with the problem of determining its target market.

Crystal Glass is a giant in the glassware business where the competitors are small partnerships. On the other hand, there is a well-established competitor in the china market which has as large a share of the chinaware market as the subsidiary Crystal has recently acquired. The two large companies represent about 90% of the wholesale china business.

Before the acquisition, the traditional glassware wholesalers had shown very little interest in the chinaware market which was controlled by a group of approximately 20 china wholesalers who were not handling glassware. Both the new subsidiary and the competitor had previously signed dealership agreements with the china wholesalers.

with approximately 7 stocking the competitor's brand. Crystal has already declared that after the agreements expired there would be no exclusive dealerships and anybody who could meet the minimum purchase requirement of one thousand dollars is welcome to purchase chinaware directly.

Shortly after the acquisition, the "dealers" adopted a wait-and-see attitude and deliberately restricted their purchases from Crystal. This was interpreted by some of the managers as a sign of possible future retaliation in the event that Crystal altered established distribution lines and practices of marketing chinaware. Crystal's recently acquired subsidiary had been plagued with financial troubles before the acquisition and the 13 "dealers" had won major concessions from the subsidiary. They are reluctant, as in the past, to see other wholesalers buying directly from the manufacturer. In fact, 4 of the 7 "dealers" doing business with the competitor are old customers of the subsidiary who started purchasing from the competitor in recent years because they could extract better terms-of-sale.

It is against this background that the management of Crystal Marketing Company, now including a portion of the subsidiary's sales personnel, was charged with the task of identifying its major target market and channel of distribution.

2. THE MODEL

The basic assumptions made in constructing the model are:

(1) Decisions will be made on the basis of the typical behaviour exhibited by different groups of customers.

(2) The average re-purchase cycle is approximately three weeks for all prospects.

(3) The typical wholesaler stocks only one brand of chinaware.

(4) It is unlikely, at least over a period of one year, for wholesalers to switch from one brand to the other after they replenish their stocks.

(5) All the larger dealers, 20 altogether, will stay in business and will not phase out their chinaware businesses.

(6) Wholesalers may be grouped and probabilities associated with purchasing behaviour may be assigned.
The first five assumptions are statements of the general character of the trade and there is strong agreement among the managers of Crystal that these can be taken for granted initially. It is agreed (assumption one) that decisions will be made on the basis of the potential of the group, and individual cases and interests will be secondary. The reason for this is that none of the individual wholesalers is big enough to pose a threat by himself. Assumption three is due to the fact that the variation in the colour of the two brands made it impossible to mix and match them, especially at the retail level.

A survey of the market showed that since the beginning of negotiations for the acquisition, major wholesalers had kept their stocks at a minimum in anticipation of the outcome (assumption four). Consequently the market is in a position to purchase large amounts and commit itself to one brand, at least for a period of approximately twelve months. Assumption five is supported by the fact that all of the wholesalers were in chinaware business for more than five years and there was no sign in the marketplace of their intent to quit trading. There is even concealed joy that a large and stable company was finally going to take over the ailing producer. Assumption six recognises wholesalers as "rational" purchasers whose behaviour is not governed by impulse. Hence, this assumption together with assumption four permit the assignment of constant transition probabilities for the short-term.

This situation may be structured as a finite absorbing Markov process. The two absorbing states are purchases from either one of the manufacturers. There are also four non-absorbing (transient) states which define discrete groups of wholesalers on the basis of their previous buying habits. The six states which are exhaustive and mutually exclusive are defined as follows:
<table>
<thead>
<tr>
<th>STATE</th>
<th>TYPE</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>S₁</td>
<td>Absorbing</td>
<td>Bought the brand produced by Crystal's subsidiary.</td>
</tr>
<tr>
<td>S₂</td>
<td>Absorbing</td>
<td>Bought competitor's brand.</td>
</tr>
<tr>
<td>S₃</td>
<td>Transient</td>
<td>Glassware wholesalers indicating HIGH interest in chinaware.</td>
</tr>
<tr>
<td>S₄</td>
<td>Transient</td>
<td>Glassware wholesalers indicating MEDIUM interest in chinaware.</td>
</tr>
<tr>
<td>S₅</td>
<td>Transient</td>
<td>Chinaware wholesalers buying from Crystal's subsidiary.</td>
</tr>
<tr>
<td>S₆</td>
<td>Transient</td>
<td>Chinaware wholesalers buying from the competitor.</td>
</tr>
</tbody>
</table>

Postponing the discussion of difficulties associated with data acquisition until section 6, let us present the completed transition matrix \( P \):

\[
P = \begin{bmatrix}
1 & 0 & 0 & 0 & 0 & 0 \\
0 & 1 & 0 & 0 & 0 & 0 \\
.50 & .10 & .25 & .15 & 0 & 0 \\
.20 & .10 & .20 & .50 & 0 & 0 \\
.60 & .40 & 0 & 0 & 0 & 0 \\
.10 & .90 & 0 & 0 & 0 & 0
\end{bmatrix}
\]

In Equation 1, \( P_{ij} = .10 \) represents the probability a glassware wholesaler indicating high interest will buy the competitor's brand. The rest of the matrix represents similar probabilities of going from one state to the other. These probabilities, \( P_{ij} \), were determined on the basis of market research conducted by the marketing staff, thereby reducing the likelihood that the salesmen will over- or under-estimate the respective probabilities. Ehrenberg [1] stresses the distinction between calling the \( P_{ij} \) probabilities versus proportions. Accordingly,
the $P_{ij}$ in Equation 2 should more correctly be termed proportions and not probabilities since $S_{32} = .10$ really means that the group as a whole has 10% chance of going from $S_2$ to $S_2$, whereas treating the $P_{ij}$ as a probability means that every member of the group individually has the same probability of transition. For our purposes it is not necessary to insist on calling the $P_{ij}$ probabilities because we are really interested in the behaviour and potential of groups rather than the individual wholesalers. The more important consideration is $P_{ij}$ in Equation 1 represents proportions at a point in time and cannot be assumed to remain constant over the long run. However, this is not a major concern in treating the chinaware wholesalers since they cannot readily switch back and forth over a period of at least one year, which is assumption four. In the case of glassware wholesalers the transition probabilities $S_{31}$, $S_{32}$ and $S_{41}$, $S_{42}$ may change between time periods. In that event, the transition matrix may be kept current by including the more recent estimate on the basis of experience, research and stated intent to purchase.

Transforming Equation 1 into the canonical form expressed by Equation 2 facilitates future computations. For a matrix with $r$ absorbing and $s$ transient states, the canonical form is:

$$P = \begin{bmatrix}
I & O \\
R & Q
\end{bmatrix}$$

(2)

where $I$ is an $(r \times r)$ identity matrix, $O$ is an $(r \times s)$ zero matrix, $R$ is $(s \times r)$, and $Q$ is $(s \times s)$. In this problem the corresponding sub-matrices are:

$$I = \begin{bmatrix}
1 & 0 \\
0 & 1
\end{bmatrix}$$

$$O = \begin{bmatrix}
0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0
\end{bmatrix}$$

$$R = \begin{bmatrix}
.50 & .10 \\
.20 & .10 \\
.60 & .40 \\
.10 & .90
\end{bmatrix}$$

$$Q = \begin{bmatrix}
.25 & .15 & 0 & 0 \\
.20 & .50 & 0 & 0 \\
0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0
\end{bmatrix}$$

(3)
Following Kemeny & Snell [2], one can obtain some very interesting results that will be helpful in evaluating the potential of different customer groups. Let us define the fundamental matrix of the absorbing Markov chain as:

\[ N = (I - Q)^{-1} \]  

From 4,

\[
(I - Q) = \begin{bmatrix}
.75 & -.15 & 0 & 0 \\
-.20 & .50 & 0 & 0 \\
0 & 0 & 1 & 0 \\
0 & 0 & 0 & 1
\end{bmatrix}
\]

and the inverse, which is \( N \), is given by

\[
N = (I - Q)^{-1} = \begin{bmatrix}
1.45 & .43 & 0 & 0 & S_3 \\
.58 & 2.18 & 0 & 0 & S_4 \\
0 & 0 & 1 & 0 & S_5 \\
0 & 0 & 0 & 1 & S_6
\end{bmatrix}
\]

The elements \( n_{ij} \) of matrix \( N \) represent the average number of times a group of customers will be in a transient state \( S_i \) before being absorbed. For instance, glassware wholesalers, \( S_4 \), who have indicated medium interest in stocking chinaware, will be in state \( S_3 \) which is high interest in chinaware, an average of .58 times and remain in state \( S_4 \) on the average 2.18 times before being absorbed. In line with our assumptions, it is seen that customers who are in states \( S_5 \) and \( S_6 \) will be absorbed at the end of the first three-week period.

The expected total number of periods that must elapse before absorbing a group of customers is \( T = NU \)  

where \( U \) is a unit column vector. The vector \( T \), giving the average number of times each customer group stays in a non-absorbing state before finally being absorbed, is found by summing the rows of matrix \( N \). Thus
wholesalers who have been in the chinaware business will either buy from Crystal or from the competitor by the end of the first period. Similarly, customers who are in state $S_1$ will require on the average approximately 1.884 periods before they are absorbed. In interpreting results of Equation 8, it is most important to recognise that vector $T$ gives the average number periods before absorption and the distribution around the mean can be evaluated by computing the variance associated with the means (see Appendix A).

The model has not differentiated between the two absorbing states so far. Fortunately, it is possible to continue the above analysis and make a distinction between the two absorbing states. Clearly, this is one of those cases where the analyst is very much interested in obtaining as much useful information as possible in order to discriminate between states $S_1$ and $S_2$. Let us define the matrix

$$B = NR$$

which indicates the probabilities $b_{ij}$ that a group of customers who are in the transient state $S_i$ will be absorbed in the absorbing state $S_j$. Using Equations 3 and 6, we obtain

$$B = \begin{bmatrix} 1.45 & .43 & 0 & 0 \\ .58 & 2.18 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} .5 & .1 \\ .2 & .1 \\ .6 & .4 \\ .1 & .9 \end{bmatrix} = \begin{bmatrix} .81 & .19 \\ .73 & .27 \\ .6 & .4 \\ .1 & .9 \end{bmatrix}$$
It follows from Equation 10 that 81% of the customers in state $S_2$ will eventually become customers of the recently acquired chinaware subsidiary. Note that $S_{32}$ which is 19% should be interpreted as the proportion of glassware wholesalers who may ultimately purchase chinaware from the competitor or do not stock the product at all. As far as Crystal is concerned, in the case of glassware wholesalers, $S_2$ is an absorbing state denoting a lost customer. The way the matrix is set up, it is not possible to determine whether the customer is lost to the competitor or is not in the market any longer. Nor is this information essential for the purposes of this study. However, the problem may easily be treated with the addition of another absorbing state.

Assuming the cost of contacting each customer (c) is constant, the expected cost of moving customers from any one of the transient states to one of the absorbing states is given by the vector

$$C = cT$$

where $c$ is a constant, $5$, and $T$ is the vector of Equation 7. The cost of making a sales call, $5$, sounds unusually low due to the price structure in Turkey where an average salesman earns approximately $200$ a month. It is expected that the cost of making a sales call in New Zealand may be around $50$. Therefore,

$$C = 5 \begin{bmatrix} 1.884 \\ 2.754 \\ 1 \\ 1 \end{bmatrix} = \begin{bmatrix} 9.42 \\ 13.77 \\ 5 \\ 5 \end{bmatrix}$$

Following the reasoning used for the values of $T$ in Equation 8, it is expected that, for instance, $9.42$ and $13.77$ are needed to absorb the typical customer classified in states $S_3$ and $S_4$ respectively.

The expected sales associated with the typical prospect in each group may be found by multiplying the probability of making a sale with the revenue that may be generated if a sale is made. Using the absorption probabilities for state $S_1$ from Equation 11, the following table is constructed:
### TABLE 1

<table>
<thead>
<tr>
<th>CUSTOMER TYPE</th>
<th>PROBABILITY OF PURCHASING</th>
<th>ESTIMATED AVERAGE REVENUE</th>
<th>EXPECTED GROSS REVENUE PER CUSTOMER</th>
</tr>
</thead>
<tbody>
<tr>
<td>S₃</td>
<td>.81</td>
<td>$6,000</td>
<td>4,860</td>
</tr>
<tr>
<td>S₄</td>
<td>.73</td>
<td>$2,500</td>
<td>1,825</td>
</tr>
<tr>
<td>S₅</td>
<td>.60</td>
<td>$10,000</td>
<td>6,000</td>
</tr>
<tr>
<td>S₆</td>
<td>.10</td>
<td>$8,000</td>
<td>800</td>
</tr>
</tbody>
</table>

This information may be used to estimate the expected sales per three-week period by including the probable number of prospects in each one of the states S₃, S₄, S₅ and S₆, as follows:

### TABLE 2

<table>
<thead>
<tr>
<th>CUSTOMER TYPE</th>
<th>EXPECTED GROSS REVENUE PER CUSTOMER</th>
<th>NUMBER OF PROSPECTS</th>
<th>EXPECTED GROSS REVENUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>S₃</td>
<td>$4,860</td>
<td>20</td>
<td>$97,200</td>
</tr>
<tr>
<td>S₄</td>
<td>$1,825</td>
<td>40</td>
<td>$73,000</td>
</tr>
<tr>
<td>S₅</td>
<td>$6,000</td>
<td>13</td>
<td>$78,000</td>
</tr>
<tr>
<td>S₆</td>
<td>$800</td>
<td>7</td>
<td>$5,600</td>
</tr>
</tbody>
</table>

TOTAL: $253,800

On the basis of expected gross revenues, Table 2 indicates that top priority should be given to the group of customers in state S₃ with an expected gross revenue of $97,200, followed by those in states S₅ and S₆. The prospects in state S₆ receive the lowest priority. These
results provide an economic guideline for determining the importance of different target markets.

In general, expected values of customers by states are given by the vector

\[ V = R - C \]  \hspace{1cm} (13)

where \( R \) and \( C \) are obtainable from Equation 13 and Tables 1 and 2.

In this particular case, since the cost of making a sales call is very small compared with the expected revenue, the value of information obtained from Equation 13 is not critical. However, in other situations where the expected revenue per customer is comparable with the associated sales costs, Equation 13 may yield important clues for ranking the customers.

3. ANALYSIS OF THE RESULTS

The primary purpose of the model and the results obtained in the previous section is to aid in determining the attractiveness of different target markets. Matrix \( N \), Equation 6, suggests that china wholesalers will take less time on the average to make up their minds and to place orders swiftly. The typical glassware wholesaler who has indicated high interest in chinaware, \( S_3 \), will spend an average of 1.45 time periods or approximately 4.5 weeks before making a decision. Matrix \( T \), Equation 8, further shows that it will take the same customer 2.4 periods, or almost 6 weeks, before he decides finally to order chinaware. Even then his chances of ordering are 81% as indicated by Matrix \( B \) of Equation 10. Likewise, customers in state \( S_4 \) who have indicated a low degree of interest in stocking chinaware need on the average more than 7 weeks to decide and have 73% probability of purchasing Crystal's chinaware. On the other hand, all the chinaware wholesalers seem ready to order by the end of the first three-week period and 60% of the subsidiary's old customers are likely to continue dealing with Crystal. The standard deviations associated with Matrix \( T \), as shown in Appendix A, are 1.56 and 1.96 periods for \( S_3 \) and \( S_4 \) respectively, and indicate further that attracting some of the prospects in states \( S_3 \) and \( S_4 \) may take longer than the average times indicated above. In contrast, the standard deviations of \( S_5 \) and \( S_6 \) are zero, meaning there will not be further delays in attracting the chinaware wholesalers.
The results exhibited in Tables 1 and 2 show that the average revenue, $10,000 and $8,000, as compared with the glassware wholesalers, $6,000 and $2,500. However, because of the larger number of glassware prospects, 20 in $S_3$ and 40 in $S_4$, the expected gross revenue for the group showing high interest, $S_3$, exceeds that of $S_4$. Furthermore, it is important to note that the combined expected gross revenue of the glassware wholesalers exceeds that of the chinaware wholesalers by $87,000 or by almost 100%.

In summary, the model indicates porcelain wholesalers will become customers much faster but will represent a very static market. Glassware wholesalers will require substantially more time to become customers but represent a larger market in terms of the expected gross revenue. Additionally, the chances of converting to $S_3$ or $S_4$ those glassware wholesalers who have not indicated at least a medium interest is larger than attracting new chinaware wholesalers because the number of new chinaware wholesalers has been stable around 20 in the past decade. On the other hand, there are around 100 glassware wholesalers who have the potential of moving into $S_3$ or $S_4$ in the future. This suggests that the growth potential of the number of prospects for $S_3$ and $S_4$, and consequently the expected gross revenue of the segment including the glassware wholesalers, is larger than the chinaware segments. Lastly, the probability of absorbing glassware wholesalers in State $S_5$ is larger, 81% and 73%, as compared with the probability of attracting chinaware wholesalers, 60% and 10%.

4. RECOMMENDED COURSE OF ACTION

As a result of the above analysis, the marketing department proposed the following priority ordering of the targets: the first target segment is $S_3$, followed by $S_5$ and $S_4$. Since state $S_6$ ranks last, allocating resources in order to move wholesalers from $S_3$ to $S_1$ was recommended over dealing with those in state $S_6$.

The marketing department supported this view for the following reasons. Firstly, Crystal had the resources to withstand lower revenues during the initial periods while glassware wholesalers were being absorbed into state $S_3$. Secondly, the total expected revenue from the glassware wholesalers was much larger than the expected revenue of the chinaware wholesalers in $S_5$ and the probabilities of being absorbed into $S_1$ of the former, 81 and 73%, were larger than the probability of going from $S_5$ to $S_1$ which
was 60%. Thirdly, if minimum purchase requirements, terms of sale and the other marketing tactics were prepared along the lines the china wholesalers requested, it would be almost impossible for the glassware wholesalers to enter the market. Lastly, limiting transactions to a group of 10 to 15 chinaware wholesalers was unwise and everything should be done to increase the number of wholesalers in order to reduce undue reliance on a small group. By offering terms to attract the glassware wholesalers there was no doubt some prospects would go from $S_5$ to $S_2$. However, it was out of the question that all of the wholesalers in state $S_5$ would be lost to state $S_2$ because the competitor could not accommodate their demands. Crystal's subsidiary, on the other hand, had the idle capacity to increase output by about 40% without much difficulty. The recommendation of the marketing department to actively seek the business of the glassware wholesalers and at the same time attract as many of the 13 previous customers as possible was not favoured. The sales department's proposal to use the prospects in $S_5$ as the core market and augment it with as many prospects as possible from states $S_3$ and $S_4$ was adopted.

5. SIX MONTHS LATER

During the next six months sales were substantially behind forecasted targets and the fluctuation of orders from one month to the next was alarming.

Consequently, top management reviewed the situation and decided to alter its marketing strategy by adopting, basically, the recommendations of the marketing department. Within six months after the necessary changes had been made, Crystal was doing business with approximately 80 wholesalers, of which 70 were former glassware wholesalers. Sales were following a much smoother and increasing trend as compared to the previous six-month period.

6. DIFFICULTIES ENCOUNTERED

The first set of problems, which will be called technical, have to do with problem definition, data collection and parameterization. The second type of problem is concerned with the implementation or utilization of the model's recommendations. Based on experiences with the model presented in this article, utilization problems outweighed the technical problems by far. There seem to be two reasons for this behaviour. Firstly, the model employed to analyse the situation was not technically
sophisticated. Secondly, top management requested separate recommendations from the sales and marketing departments but made it very clear that the final sales responsibility rested with the sales department. The fact that they had already committed themselves in terms of recommending a given segment, coupled with the assertion that they would be held responsible, made it harder for the sales people to change their position later on.

The problem of determining the number of states was discussed at length and there were arguments in favour of having three absorbing states and six transition states. The additional absorbing state was proposed to differentiate between purchasing from the competitors and not purchasing chinaware at all. For purposes of this analysis, it was felt that treating all those prospects who did not become Crystal's customers in state $S_0$ was sufficient. For similar reasons the idea of including a transient state for new chinaware wholesalers and another one for glassware wholesalers who showed little or no interest would have increased data collection and computation demands more than its benefit warranted. The major problem under this heading was the assigning of probabilities to the transition matrix $P$. Requests for subjective inputs from the sales people resulted in mixed reactions ranging from inability to guess to refusal to comment. Subsequently the marketing research staff surveyed the market and the proportions obtained as a result of the market survey were shown to the sales people. The figures used in matrix $P$ represent the consensus reached as a result of discussions between the sales and marketing research people. It would have been much more difficult to obtain the preceding figures had the wholesalers not been concentrated in several major cities.

7. OBSTACLES TO UTILIZATION

Although the marketing staff tried as much as possible to get the sales people involved with the building of the model, the procedure and the resulting recommendations were often referred to as "the marketing department's" and very infrequently as "our" recommendation. However, the participation of the sales executives was better than expected in (1) discussing the transition probabilities, (2) identifying the relevant states, and (3) analyzing the results of different equations. Since the users were not active initiators but were constantly responding to the needs and the requests of the model-builders, the usual benefits of the
evolutionary model-building approach [3] cannot be claimed. Consequently, the sales department would acknowledge knowledge of and participation in the model but would not join in supporting the results or recommending them.

One crucial point that intrigued and concerned the sales people was the difference between the $R_{ij}$ of Equation 3 and $B_{ij}$ of Equation 10. Everyone was comfortable with the fact that corresponding probabilities for states $S_5$ and $S_6$ remained the same in both equations. However, changes in $R_{11}$, $R_{12}$, $R_{21}$ and $R_{22}$ as compared with $B_{11}$, $B_{12}$, and $B_{22}$ were disturbing. Some members of the group understood the mechanics of the process and the difference in the meaning of the two sets of probabilities but expressed disbelief in the magnitudes of especially $B_{11}$ and $B_{21}$. Others stated that they respected these results but there were "all sorts of other factors" which the model did not take into account. They, then, indicated and insisted on directing efforts at the chinaware wholesalers on the basis of "years of experience" and "to strengthen the future growth potential of the company". The latter reason was interpreted to mean concentrating on the chinaware wholesalers and turning to the glassware wholesalers later on after having established a strong foothold in the market. It is interesting to note that throughout these discussions the model-builders' proposal to reconsider the probabilities ($P_{ij}$) of Equation 1 never received support since everybody "felt comfortable" with the figures and considered them realistic. The ensuing events during the next six months prompted a change in the target market strategy due to the threatening behaviour of the chinaware wholesalers. Within a period of another six months there was general agreement that treating the glassware wholesalers as a major segment of the market was already paying off.

As a result of this experience, the marketing department established a better understanding of its role among the executives of the holding as well as the sales department. That is, the marketing department should not be looked upon as an advisory group but should be given the authority to formulate marketing plans. Secondly, enthusiasm to employ quantitative techniques was boosted among the younger and better-educated members of the marketing staff. Thirdly, the sales people appreciated the potential benefits of working closely with the marketing department since the recommendations of the latter usually benefited them in the form of increased sales or profits. Lastly, it was seen that the proper way to solicit proposals or recommendations from the
marketing company was by forcing them to submit a document which stated that company's position rather than that of the individual departments.

8. CONCLUSION

Markov chains may be used successfully to determine economic decision rules or priorities in evaluating alternative target markets. Technically it is necessary to make sure the problem can be structured in such a way that the Markov property is upheld. Once this hurdle is successfully overcome the general transition matrix may be constructed by assigning probabilities or proportions to different states. The problem of lack of hard data may be circumvented by using subjective estimates of the managers. These subjective estimates may be verified by conducting market surveys or by using more sophisticated sampling techniques. In those instances where the stages are numerous and the model is expected to be used over a long period of time, the entire process may be computerized. Integration of the model into the marketing information system increases interest and interaction. Whether the model is built to run on the computer or manually, it seems to encourage the managers in asking "what if" types of questions. This helps in stating and evaluating more alternatives by bringing together the expertise, hunches and the knowledge of various individuals with different backgrounds. Consequently, better decisions may be made in planning and controlling the target market decisions.

REFERENCES


The vector of variances of the time before absorption (T) is given by the formula

\[
\text{Vector of Var. of } T = (2N - I)T - T_{sq}
\]

where \( T \) and \( N \) are obtained from Equation 9, \( I \) is a \((4 \times 4)\) identity matrix and \( T_{sq} \) is the square of matrix \( T \) which is

\[
T_{sq} = \begin{bmatrix}
1.884^2 \\
2.754 \\
1 \\
1
\end{bmatrix} = \begin{bmatrix}
3.550 \\
7.585 \\
1 \\
1
\end{bmatrix}
\]

Using the above formula,

\[
(2N-I) = \begin{bmatrix}
1.45 & .43 & 0 & 0 \\
.58 & 2.18 & 0 & 0 \\
0 & 0 & 1 & 0 \\
0 & 0 & 0 & 1
\end{bmatrix}
\]

and

\[
(2N-I)T = \begin{bmatrix}
1.90 & .86 & 0 & 0 \\
1.16 & 3.36 & 0 & 0 \\
0 & 0 & 1 & 0 \\
0 & 0 & 0 & 1
\end{bmatrix}
\]

Therefore,

\[
\text{Vector of Var. of } T = \begin{bmatrix}
5.948 \\
11.439 \\
1 \\
1
\end{bmatrix} - \begin{bmatrix}
3.55 \\
7.585 \\
1 \\
1
\end{bmatrix} = \begin{bmatrix}
2.398 \\
3.854 \\
0 \\
0
\end{bmatrix}
\]