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**DETERMINATION OF OPTIMAL MARKET POLICY BY THE APPLICATION OF  
MARKOV CHAIN ANALYSIS**

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**Abstract**

*In this study we applied the first order Markov chain to determine the market share of customers of beer in the current period as a basis for predicting future market shares. The transition probability matrix was estimated which helped us to obtain the scope of brand loyalty and brand switching among four types of beer. From the model obtained was established that the optimum marketing mix among the various types of beer were as follows Guinness (51%), star (26%), Gulder (15%) and Henekin (8%). This will serve as a guide towards attaining optimal policy that maximizes the expected revenue over a long time. Other subsequent periods were predicted using the model.*

*Keywords: Markov Chain, Probability Matrix, Transition Probability Matrix*

**Introduction**

It is pertinent to mention that business outfit is established for the purpose of profit optimization and satisfaction of wants for the yearning population. It has often been necessary that producers and marketers know what qualities, or variables that attract the consumers most, as a way of finding out optimum marketing mix that will lead to profit optimization. In most cases, to increase the sales of any product, we must understand very clearly what buyers think of the company's product, considering the marketing mix packages of the different products, such as product quality, packaging, promotional activities distribution network and price Nworuh and Anyiam (2009). The main objective of this investigation is aimed towards obtaining optimal marketing mix policy which could be used as guiding principle on future allocation purposes for marketing of Beers like Guinness, Star, Gulder, and Henekin.

**Theoretical Framework**

Markov chain theory of the first order was used to analysis the Marketing data collected, from which we obtained information about brands of beer on Market share.

Markov Probability Model: The probability of shifting from one type of beer say brand type  $i$  to another say brand type  $j$  is a conditional probability and can be shown by the transition matrix  $P = [P_{ij}]$ , such that  $\sum_{j=1}^m P_{ij} = 1$ ,  $i$  refers to the number of brands of beer type. For example  $P_{2, 1}$  represents the probability of changing from Star(s) to Guinness (G) in the next period of time. While  $P_{i,i}$  represents the probability of remaining in the same brand of beer. The

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transition probability matrix  $P = [P_{ij}]$  must satisfy the following relations  $\sum_{j=1}^m P_{ij} = 1$ , and  $0 \leq P_{ij} \leq 1$ ,  $\forall i, j \in P$  Cinlar E. (1995).

Transition Probability Matrix Estimation for Brand of Beer Shifting: According to Theaparajin and Bin Mohammed, (2005), estimation of transition probability matrix (TPM) plays an important role in the study of Markov process and analysis. The estimation procedure follows that of a multinomial distribution, that is  $P_{ij} = \frac{n_{ij}}{n_i}$ , where  $n_{ij}$  is the number of times the process moves from state  $i$  to state  $j$  and  $n_i$  is the number of times the process is in state  $i$  Catalina etal (2009).

The transition probability matrix can be shown by a sequence for Markov process with states  $X_1, X_2, X_3, X_4$  representing the probability variables with appropriate mapping and the matrix is shown as

$$P = \begin{pmatrix} P_{11} & P_{21} & P_{13} & P_{14} \\ P_{21} & P_{22} & P_{23} & P_{24} \\ P_{31} & P_{32} & P_{33} & P_{34} \\ P_{41} & P_{42} & P_{43} & P_{44} \end{pmatrix}$$

This matrix  $P$  is called a homogenous transition or stochastic matrix because all the probabilities  $P_{ij}$  are fixed and independent of time. The probabilities  $P_{ji}$  must satisfy the condition for Markov chain (Thyaparajin and Mohammed 2005)  $P = \begin{cases} 1 & \text{for all } i \\ 0 & \text{for all } i \text{ and } j \end{cases}$

**Methodology**

This data was collected the day Nigeria won Code Ivorie in 2013 African Cup of Nations. The objective was to enable us get enough respondents, target area for this study was Aba because of its commercial nature. A total of 500 questionnaires were distributed at 20 different flash points located in Aba where people go for relaxation. A total of 420 questionnaires were completed and returned, the 20 different data collectors.

The questionnaires attempted to find out the different brands of beer each respondent referred for different periods with emphasis on four types of beer namely Guinness, Star, Gulder and Henekin. With respect to favourable price, quality, packaging, promotional activities, distribution network and availability.

The questionnaire also recorded the brand switching of some respondents that is those people that left their brand to other brands as a result of new discoveries. The data collected are compiled as shown below.

Respondents according to their brands and brand switching (gain or losses).

**Table 1: Respondents according to their brands and brand switching (gain or losses)**

Brand	No of customers / brand in period one	Gain from				Losses from			
		A	B	C	D	A	B	C	D
GA (GUINNESS)	150	141	4	7	5	0	2	0	2
SB (STAR)	105	8	78	10	5	1	0	3	2
GC (GULDER)	95	1	0	30	5	2	0	40	5
HD	70	1	6	3	50	2	2	2	10
	420								

SOURCE: Field work (primary data)

**Analysis**

We used the data on table 1, to calculate present and prediction of future equilibrium market share by obtain first the matix probabilities and the transition probability matrix (TPM).

**Table 2: Matrix Probabilities**

$$\begin{pmatrix} \frac{141}{150} & \frac{4}{105} & \frac{7}{95} & \frac{5}{70} \\ \frac{8}{150} & \frac{78}{105} & \frac{10}{95} & \frac{5}{70} \\ \frac{1}{150} & \frac{0}{105} & \frac{30}{95} & \frac{5}{70} \\ \frac{1}{150} & \frac{6}{105} & \frac{3}{95} & \frac{50}{70} \end{pmatrix} + \begin{pmatrix} \frac{0}{150} & \frac{2}{105} & \frac{0}{95} & \frac{2}{70} \\ \frac{1}{150} & \frac{0}{105} & \frac{3}{95} & \frac{2}{70} \\ \frac{3}{150} & \frac{0}{105} & \frac{0}{95} & \frac{5}{70} \\ \frac{2}{150} & \frac{2}{105} & \frac{2}{95} & \frac{2}{70} \end{pmatrix} = \begin{pmatrix} 0.94 & 0.06 & 0.07 & 0.1 \\ 0.06 & 0.74 & 0.14 & 0.1 \\ 0.06 & 0 & 0.74 & 0.14 \\ 0.02 & 0.08 & 0.05 & 0.86 \end{pmatrix}$$

Source: Completed from Table 1

Table 2: Shows the probabilities of brand switching (gains and losses) recorded within the period.

**Table 3: Transition Probability Matrix (TPM)**

	GS	S	GD	H	
	A	B	C	D	
GS A	$  \begin{pmatrix} 0.94 & 0.06 & 0.07 & 0.1 \\ 0.06 & 0.74 & 0.14 & 0.1 \\ 0.06 & 0^{p32} & 0.74 & 0.14 \\ 0.02 & 0.08 & 0.05 & 0.86 \end{pmatrix}  $				$  \begin{pmatrix} P_{11} & P_{12} & P_{13} & P_{14} \\ O_{21} & P_{22} & P_{23} & P_{24} \\ P_{31} & P_{32} & P_{33} & P_{34} \\ P_{41} & P_{42} & P_{43} & P_{44} \end{pmatrix}  $
S B					
GD C					
H D					

Guinness Stout = GS, Star = S, Gulder = GD and Henekin = H

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The transition probability matrix depicts that the probability of brand switching from Gulder to Star ( $P_{32} = 0$ ) cannot be made as indicated by its zero probability. Probability of no brand switching for Guinness Stout ( $P_{11} = 0.94$ ), Star ( $P_{22} = 0.74$ ), Gulder ( $P_{33}=0.74$ ) and Henekin ( $P_{44} = 0.86$ ) were quite high. Which means people tend to stick to their brand of beer? While the probability of switching from one particular beer Guinness Stout to Star ( $P_{12} = 0.06$ ), Gulder ( $P_{13} = 0.07$ ) and to Henekin ( $P_{14}=0.1$ ) were relatively very low, which was that people who take Guinness Stout tends to stick to their brand more than others.

Calculating Probability Future Market Share after Year one

From table 3, we obtained the following homogeneous equations

$$\begin{array}{l}
 0.94 P_{11} \quad +0.06P_{12} \quad +0.07P_{13} \quad +0.1P_{14}= 0 \\
 0.06P_{21}+ \quad 0.74P_{22}+ \quad 0.14P_{23}+ \quad 0.1P_{24} = 0 \\
 0.06P_{31}+ \quad 0.0P_{32} + \quad 0.74P_{33}+ \quad 0.14P_{34}= 0 \\
 0.02P_{41}+ \quad 0.08P_{42}+ \quad 0.05P_{43}+ \quad 0.86P_{44}= 0
 \end{array}$$

Solving the equation by Gaussian elimination method we obtained  $P_{11} = 0.51$ ,  $P_{12} = 0.25$ ,  $P_{13} = 0.15$  and  $P_{14} = 0.08$ , which shows that after one year the equilibrium market share of Guinness stout, Star, Gulder and Heinekin would be 51%, 26%, 15% and 8% respectively. To obtain the equilibrium market share for the second period after period one is

	GS	S	GD	H		Period One	Period Two
GS	$  \begin{pmatrix}  0.94 & 0.06 & 0.07 & 0.1 \\  0.06 & 0.74 & 0.14 & 0.1 \\  0.06 & 0 & 0.74 & 0.14 \\  0.02 & 0.08 & 0.05 & 0.86  \end{pmatrix}  $	X	$  \begin{pmatrix}  0.51 \\  0.26 \\  0.15 \\  0.08  \end{pmatrix}  $	=	$  \begin{pmatrix}  0.514 \\  0.251 \\  0.153 \\  0.107  \end{pmatrix}  $		
S							
GD							
H							

For the Third period equilibrium market share

	GS	S	GD	H		Period Two	Period Three
GS	$  \begin{pmatrix}  0.94 & 0.06 & 0.07 & 0.1 \\  0.06 & 0.74 & 0.14 & 0.1 \\  0.06 & 0 & 0.74 & 0.14 \\  0.02 & 0.08 & 0.05 & 0.86  \end{pmatrix}  $	X	$  \begin{pmatrix}  0.514 \\  0.24 \\  0.153 \\  0.107  \end{pmatrix}  $	=	$  \begin{pmatrix}  0.817 \\  0.249 \\  0.159 \\  0.130  \end{pmatrix}  $		
S							
GD							
H							

The three periods market share for the four brands of beer are predicted as follows

	Guinness	Star	Gulder	Heinkin
Period one	511%	25%	15%	8%
Period two	51%	25%	15%	11%
Period three	52%	25%	16%	13%

Thus the model can be used to predict for the probable market share of the beer at any given point in time for appropriate decision making.

### Conclusion

The study applied Markov chain analysis to establish a model which can be used to forecast future value market share provided that the transition probabilities remain unaltered. In most cases most of the advertisements contribute in luring people to switch from their brand of beer to another or the conviction from friends, this must have been responsible for the slight changes observed in the three market share equilibrium for the three periods indicated that Guinness stout is the most patronized followed by Star Beer, Gulder and Henekin in that order. The major interesting aspect of the work was the simple analysis of the net gains and losses of customers to other beer competitors. This will help the management to attempt to predict the share of the total market a seller will gain or lose in future. It will also help to rate the impact of promotional efforts made by sellers.

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