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Research/Review

Analysis of Bottled Water Brand Market Share Using the Markov Chain Method in the Faculty of Mathematics and Natural Sciences, Udayana University

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Abstract: This study analyzes bottled water consumer traits and the market share of various brands over five years at the University of Udayana using the Markov chain method. Primary data from questionnaires show most consumers are female informatics students in dorms, consuming over 2 liters daily, mostly purchasing from stores. Decisions consider quality and brand, influenced by TV ads over peer recommendations. Market share in period 1: Aqua led with 52%, followed by Le Minerale (28%), Club (13%), Cleo (7%), and others (0%). In period 2, Aqua maintained 52%, Le Minerale rose to 36%, while Club and Cleo declined to 2% and 3%. Period 3 saw Aqua at 49%, Le Minerale at 33%, and Club/Cleo at 2% and 1%. In period 4, Aqua led with 45%, Le Minerale at 31%, and Club/Cleo/others at 2%, 1%, and 7%. Finally, in period 5, Aqua remained at 41%, Le Minerale fell to 28%, while others decreased to 6%, and Club/Cleo remained at 2% and 1%.

Keywords: Bottled Water Consumers; Buying Decision; Market Share; Markov Chain; Markov Chain Method.

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1. Introduction

Along with the increase in population, the need for healthy drinking water continues to rise. Companies engaged in the bottled water business have also grown and expanded their networks, creating an increasingly competitive market (Az-zahra et al., 2019).

This condition requires each company to work hard and innovate creatively in creating and developing products, sizes, and packaging that differ according to consumer needs, so that their products are favored, trusted by consumers, and able to compete in the market.

Table 1. Top Brand Index of Bottled Water.

Bottled Water Brands	Year				
	2019	2020	2021	2022	2023
Cleo	4.70	3.70	3.70	4.20	4.20
Le Minerale	5.00	6.10	4.60	12.50	14.20
Club	5.10	6.60	5.80	3.80	3.50

Ades	6.00	7.80	7.50	6.40	5.30
Aqua	61.00	61.50	62.50	57.20	55.10

The table of top brand indexes of bottled water above shows that these five brands are the top bottled water brands in Indonesia from 2019 to 2023. Aqua ranks first, surpassing Le Minerale, Cleo, Club, and Ades. However, each year there are increases and decreases for each product. These data indicate competition in product marketing.

One method capable of predicting market share is the Markov chain method, which can analyze market share in the future within dynamic variables. The Markov chain method has been widely used in marketing research, as in the study by Dura (2006), which explained the use of Markov in marketing forecasting. Thota and Wright (2006) discussed customer satisfaction using Markov. In addition, research by Trinh (2018) analyzed market share using the Markov chain method.

Another definition states that Markov chain analysis is a technique related to the probability of future conditions by analyzing the current probability (Heizer & Render, 2006).

With the phenomenon of changing market share and the availability of the Markov chain analysis method, this study was conducted to analyze market share among several bottled water brands using the Markov chain method within the campus environment of the University of Udayana, as well as to analyze market share for the next five years and determine the long-term market share equilibrium of each bottled water brandenvironment, as well as analyzing the market share for the next five years and determining the long-term market share balance of each brand of bottled water.

3. Literature Review

Markov Chain

A stochastic process with discrete time where {X_t, t = 0, 1, …} for any period t = 0, 1, 2, … and for all conditions or states is called a Markov chain. The formula used in calculating the Markov chain is as follows:

$$\boldsymbol{P\{X_{t+1} = j | X_0 = i_0, \ldots, X_{t-1} = i_{t-1}, X_t = i\}} \\ \boldsymbol{= P\{X_{t+1} = j | X_t = i\}}$$

Explanation:

$X_0 = i_0, \ldots, X_{(t-1)} = i_{(t-1)} \rightarrow$ past states

$X_t = i \rightarrow$ current state

$X_{(t+1)} = j \rightarrow$ future state

There are several conditions that must be met before the Markov chain can be applied to a case, as follows:

1) In a system, the total probability of one-step transition must equal 1.
2) The transition probability is constant and does not change over time, meaning that each state in transition for $t \geq 0$ has the same probability.
3) The transition probability does not depend on previous states but depends only on the current state.

Transition Probability

If a Markov chain has the probability of $X_{(t+1)}$ being in state j given that X_t is in state i, it is called a one-step transition probability. The value of transition probability is usually expressed as:

$$\boldsymbol{P = [P_{ij}] = \begin{bmatrix} P_{00} & P_{01} & P_{02} & \cdots \\ P_{10} & P_{11} & P_{12} & \cdots \\ \vdots & \vdots & \vdots & \vdots \\ P_{i0} & P_{i1} & P_{i2} & \cdots \end{bmatrix}}$$

The following conditions must be satisfied by the value of:$\mathbf{P_{ij}}$

$\mathbf{P_{ij} \geq 0}$, for all $\mathbf{i, j \in \{0, 1, 2, \dots\}}$

$\mathbf{\sum_{j=0}^{\infty} P_{ij} = 1}$, for all$\mathbf{i \in \{0, 1, 2, \dots\}}$

Chanman-Kolmogrova equation

The Chapman–Kolmogorov equation is used to calculate the n-step transition probability, where the calculation is as follows.

$$\mathbf{P_{ij}^{(n)} = \sum_{k=0}^{\infty} P_{ik}\, P_{kj}^{(n-1)}}$$

Explanation :

$\mathbf{P_{ij}^{(n)}}$= n-step transition probability

$\mathbf{P_{ik}}$ transition probability from state i to state k.

$\mathbf{P_{kj}^{(n-1)}}$= transition probability from state k to state j for (n−1) steps, where n $= \mathbf{1, 2, 3,}$.

Steady State

Steady state is a condition in which a system is said to be constant, stable, or balanced over time. This indicates that the Markov process will move toward a steady-state condition over several periods until it reaches a stable point or when the results obtained no longer change.

3. Materials and Method

This research was conducted within the campus environment of the Faculty of Mathematics and Natural Sciences, University of Udayana, located in Bukit Jimbaran, Bali. Data collection was carried out for one week. The data used in this study are primary data obtained from questionnaires.

This research analyzes consumer shifts among bottled water brands, future market share projections, and market equilibrium for each brand. The research stages began with observing existing conditions, collecting data, and identifying potential obstacles. This was followed by a literature study to support the research and formulating research problems regarding the market share of each bottled water brand within the University of Udayana environment. The study focuses on the brands Aqua, Le Minerale, Ades, Club, and Cleo. Samples were selected using the purposive sampling method from consumers of these bottled water brands within the Udayana campus area, Bali. Questionnaires were distributed to more than 100 respondents with the same criteria. The Markov chain method was used to analyze consumer transitions among brands, market share projections, and equilibrium conditions.

The analysis steps included questions related to the current brand usage and respondents' future brand-switching plans, the creation of a brand transition table, the development of a Transition Probability Matrix, and the calculation of market share by multiplying the transition probability matrix with the market share. Equilibrium is achieved when no competitors influence the transition probability matrix.

4. Results and Discussion

Consumer Characteristics of Bottled Water Products.

Table 1. Characteristics of Respondents Based on Gender, Study Program, and Residence.

Respondent Characteristics		Number of People	Percentage
Type	Man	36	29%
Sex	Woman	90	71%
Program	Biology	14	11%
Studies	Pharmacy	18	14%

	Physics	11	9%
	Informatics	43	34%
	Chemistry	15	12%
	Mathematics	25	20%
Residence	Not in the dormitory/boarding house	59	47%
	In the dormitory/boarding house	67	53%

The data obtained show that bottled water is mostly consumed by female respondents (71%), students from the Informatics study program (34%), and those living in dormitories or boarding houses (53%).

Table 2. Characteristics of Respondents Based on Average Consumption.

Average Consumption	Number of People	Percentage
< 2 Liters	23	18%
> 2 Liters	70	56%
2 Liters	33	26%
Total	126	100%

On average, most respondents consume more than 2 liters of bottled water daily (56%).

Table 3. Characteristics of Respondents Based on Purchase Location.

Location	Number of People	Percentage
Anywhere	1	1%
Indomaret or Alfamart	1	1%
Canteen	14	11%
Mini Market	1	1%
Street Vendor	4	3%
Supermarket	38	30%
Store/Shop	67	53%
Total	126	100%

The ease of finding bottled water products also affects purchasing decisions. The results show that the products are most frequently purchased from stores or small shops (53%), which is also due to the large number of such stores selling bottled water from various brands.

Table 4. Characteristics of Respondents Based on Purchasing Decisions.

Decision	Number of People	Percentage (%)
Plan ahead	28	22%
Never Plan	34	27%
Depends oncurrent situation	59	47%
Buy impulsively when available	5	4%
Total	127	100%

Most respondents make their purchase decisions depending on the current situation (47%). This indicates that a person's situation or condition strongly affects their decision to purchase bottled water.

Table 5. Characteristics of Respondents Based on Main Considerations.

Main Consideration	Percentage (%)
Price	51.6%
Quality	68.3%
Brand	63.5%
Promotion	29.4%
Availability	38.9%

In purchasing bottled water, most respondents primarily consider quality (68.3%), followed by brand (63.5%). This shows that quality and brand are the main considerations in purchasing bottled water.

Table 6. Characteristics of Respondents Based on Product Information Sources.

Information Source	Number of People	Percentage (%)
Television advertisements	62	49%
Stores/Supermarkets	37	29%
Relations (friends, family, etc.)	14	11%
Promotional materials (billboards, posters, etc.)	13	10%
Newspaper advertisements (magazines/newspapers)	0	0%
Total	126	100%

Product information sources certainly have an effect on the purchasing process. The data indicate that the highest percentage of respondents obtained product information from television advertisements (49%). According to studies by Khasanah (n.d.) and Qolbi (2014), advertising media is one of the variables that has the effect on consumer attitude formation. This shows that advertising media has the effect in shaping consumer shopping behavior.

Table 7. Characteristics of Respondents Based on Influencing Factors.

Influenced By Friends	Number of People	Percentage
Yes	27	21.4%
No	99	78.6%

Most respondents purchase bottled water brands without being influenced by friends or peers (78.6%). This situation shows consumer awareness of the importance of meeting their water needs.

Table 8. Brand Switching Patterns of Bottled Water Products (Number of People).

	Bottled Water Brands	Moving to Brand					Previous Respondents
		Aqua	Le Minerale	Club	Cleo	Other	
From Brand	Aqua	19	37	0	1	8	65
	Le Minerale	30	2	2	0	1	35
	Club	12	4	0	1	0	17
	Cleo	5	2	0	2	0	9
	Other	0	0	0	0	0	0
Current respondents		66	45	2	4	9	126

Table 9. Total Gains and Losses for Each Bottled Water Brand.

Brand	Previous Respondents	Gained	Lost	Current respondents
Aqua	65	47	46	66
Le Minerale	35	43	33	45
Club	17	2	17	2
Cleo	9	2	7	4
Other	0	9	0	9

Transition Probability Matrix

Based on the table above, the transition probabilities from one brand to another can be calculated. The probability that bottled water customers of the Aqua brand remain loyal to Aqua in the next period is.

$$\frac{\mathbf{19}}{\mathbf{65}} = \mathbf{0,29}$$

Written as:

$\mathbf{P_{11}} =$ the probability that initial (early October) Aqua customers consume Aqua at the beginning of November$= \mathbf{0,29}$

This can be written in the form of a one-step transition probability matrix or one-step stochastic matrix,

$$\mathbf{P} = \begin{bmatrix} \mathbf{0,29} & \mathbf{0,57} & \mathbf{0} & \mathbf{0,01} & \mathbf{0,12} \\ \mathbf{0,86} & \mathbf{0,06} & \mathbf{0,06} & \mathbf{0} & \mathbf{0,03} \\ \mathbf{0,70} & \mathbf{0,23} & \mathbf{0} & \mathbf{0,06} & \mathbf{0} \\ \mathbf{0,56} & \mathbf{0,22} & \mathbf{0} & \mathbf{0,22} & \mathbf{0} \\ \mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{0} \end{bmatrix}$$

Market Share Analysis

The market share of bottled water can be calculated by dividing the number of respondents for each brand by the total number of respondents in the previous period. The following are the market shares for period 1 and period 2 obtained from the previous and current respondents.

Table 10. Market Share Analysis.

Brand	Respondents from the Previous Period	Market Share Period 1	Current Period Respondents	Market Share Period 2
Aqua	65	$\frac{65}{126} \times 100\% = 52\%$	66	$\frac{66}{126} \times 100\% = 52\%$
Le Minerale	35	$\frac{35}{126} \times 100\% = 28\%$	45	$\frac{45}{126} \times 100\% = 36\%$
Club	17	$\frac{17}{126} \times 100\% = 13\%$	2	$\frac{2}{126} \times 100\% = 2\%$
Cleo	9	$\frac{17}{126} \times 100\% = 7\%$	4	$\frac{4}{126} \times 100\% = 3\%$

Other	0	$\frac{0}{126} \times 100\% = 0\%$	9	$\frac{9}{126} \times 100\% = 7\%$
Total	126	100%	126	100%

Market share in period 1 based on the results above, was topped by Aqua brand bottled water at 52% and followed by Le Minerale at 28%, then Club 13%, Cleo 7% and other brands had no market share percentage or 0%. Furthermore, for market share in period 2 (currently), it is still outperformed by the Aqua brand at 52% and followed by Le Minerale which has experienced an increase of up to 36%, then Club which has experienced a decrease in market share of up to 2%, Cleo has also experienced a decrease of up to 3%, and for other brands there has been an increase of up to 7%.

For brands with a large market share, such as Aqua and Le Minerale, several factors contribute to consumers choosing these brands, including good quality and easy access to product information through television advertisements.

The market share for future periods can be calculated using the formula: $\boldsymbol{x^n = x^0 p^n}$ by multiplying the state vector with its transition probability matrix (P). It is assumed that the transition probability matrix is constant and the calculation results are as follows:

$$= [0,51587 \quad 0,27778 \quad 0,13492 \quad 0,07143 \quad 0] \begin{bmatrix} 0,29 & 0,57 & 0 & 0,01 & \\ 0,86 & 0,06 & 0,06 & 0 & \\ 0,70 & 0,23 & 0 & 0,06 & \\ 0,56 & 0,22 & 0 & 0,22 & \\ 0 & 0 & 0 & 0 & \end{bmatrix}$$

$$= [0,5229379 \quad 0,3574589 \quad 0,0166668 \quad 0,0289685 \quad 0,0702378]$$

The market share in period 2, based on the results above, is still dominated by Aqua at 52%; Le Minerale increased to 36%; Club and Cleo decreased to 2% and 3% respectively; whereas other brands increased to 7%.

Table 11. Predicted Market Share of Bottled Water Consumption (%).

Brand	Period 1	Period 2	Period 3	Period 4	Period 5
Aqua	0.51587	0.5229379	0.486955765	0.44685439263	0.4107830033297
Le Minerale	0.27778	0.3574589	0.329728571	0.30505397367	0.2795248655497
Club	0.13492	0.0166668	0.021447534	0.01978371426	0.0183032384202
Cleo	0.07143	0.0289685	0.012602457	0.00892895023	0.0076199358325
Other	0	0.0702378	0.073476315	0.06832654893	0.0627741463257

Period 3

$$[0,486955765 \quad 0,329728571 \quad 0,021447534 \quad 0,012602457 \quad 0,073476315]$$

$$\begin{bmatrix} 0,29 & 0,57 & 0 & 0,01 & 0,12 \\ 0,86 & 0,06 & 0,06 & 0 & 0,03 \\ 0,70 & 0,23 & 0 & 0,06 & 0 \\ 0,56 & 0,22 & 0 & 0,22 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

$$= [0,44685439263 \quad 0,30505397367 \quad 0,01978371426 \quad 0,00892895023 \quad 0,06832654893]$$

$$= [45\% \quad 31\% \quad 2\% \quad 1\% \quad 7\%]$$

The market share in period 3, based on the results above, remains dominated by Aqua at 49%, although it decreased from the previous period. Similarly, Le Minerale and Cleo decreased to 33% and 1%, respectively, while Club and other brands remained unchanged at 2% and 7%.

Period 4

$$[0,486955765 \quad 0,329728571 \quad 0,021447534 \quad 0,012602457 \quad 0,073476315]$$

$$\begin{bmatrix} 0,29 & 0,57 & 0 & 0,01 & 0,12 \\ 0,86 & 0,06 & 0,06 & 0 & 0,03 \\ 0,70 & 0,23 & 0 & 0,06 & 0 \\ 0,56 & 0,22 & 0 & 0,22 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

$$= [0,44685439263 \quad 0,30505397367 \quad 0,01978371426 \quad 0,00892895023 \quad 0,06832654893]$$

$$= [45\% \quad 31\% \quad 2\% \quad 1\% \quad 7\%]$$

The market share in period 4, based on the results above, remains dominated by Aqua at 45%, although it continues to decline from the previous period. Le Minerale also decreased to 31%, while Club, Cleo, and other brands remained unchanged at 2%, 1%, and 7%, respectively.

Period 5

$$[0,44685439263 \quad 0,30505397367 \quad 0,01978371426 \quad 0,00892895023 \quad 0,06832654893]$$

$$\begin{bmatrix} 0,29 & 0,57 & 0 & 0,01 & 0,12 \\ 0,86 & 0,06 & 0,06 & 0 & 0,03 \\ 0,70 & 0,23 & 0 & 0,06 & 0 \\ 0,56 & 0,22 & 0 & 0,22 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

$$= [0,4107830033297 \quad 0,2795248655497 \quad 0,0183032384202 \quad 0,0076199358325 \quad 0,0627741463257]$$

$$= [41\% \quad 28\% \quad 2\% \quad 1\% \quad 6\%]$$

The market share in period 5, based on the results above, remains dominated by Aqua at 41%, even though it continues to decline from the previous period. Similarly, Le Minerale and other brands decreased to 28% and 6%, while Club and Cleo remained unchanged at 2% and 1%, respectively.

Table 12. The Market Share In Period 5.

Brand	Period 1	Period 2	Period 3	Period 4	Period 5
Aqua	52%	52%	49%	45%	41%
Le Minerale	28%	36%	33%	31%	28%
Club	13%	2%	2%	2%	2%
Cleo	7%	3%	1%	1%	1%
Other	0	7%	7%	7%	6%

The prediction results above show that Aqua's market share continues to decline over the following periods, yet it remains the most preferred bottled water brand. Similarly, Le Minerale experiences a decline but reaches a constant state by period 5, similar to its market share in period 1. Club's market share decreased from 13% in period 1 to 2% in period 5,

while Cleo dropped from 7% to 1%. Meanwhile, other bottled water brands increased from 0% in period 1 to 6% in period 5.

5. Conclusion

The characteristics of bottled water respondents are dominated by female students, totaling 90, and the Informatics study program dominates with 43 students. Most respondents, as many as 67 students, live in dormitories or boarding houses. On average, students consume more than 2 liters of water daily. Most respondents purchase bottled water products from stores or small shops. The majority of respondents buy bottled water products based on decisions depending on the current situation. Respondents purchase bottled water products considering brand and quality. Respondents mostly obtain information sources about bottled water products from television advertisements. Furthermore, bottled water product purchases are mostly not influenced by friends.

The market share of bottled water products shows that Aqua continues to lead. In period 1, Aqua (52%), Le Minerale (28%), Club (13%), Cleo (7%), and other brands (0). In period 2, a constant market share was observed for Aqua (52%), an increase for Le Minerale to (36%), a decrease for Club (2%), Cleo (3%), and other brands increased to (7%). In period 3, a decrease occurred for Yakult (49%), Le Minerale (33%), Cleo (1%), while the market share remained constant for Club (2%) and other brands (7%). In period 4, only a decline occurred for Yakult (45%) and Le Minerale (31%). In period 5, a decrease occurred for Yakult (41%), Le Minerale (28%), and other brands (6%)

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