Consumer Choice of Drinks in Acompetitive Market: Game Theory Approach

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Abstract: *This research applies the concept of game theory under optimizationtechniques to determine the behavioural factor that affects the choice of soft drinks of residence of Port Harcourt city , Nigeria using its different market strategies. It summarised how best to use marketing strategies to analyse the desirabilityand sales of beverage known as soft drink, using responses from the distributed questionnaires to the residence of PortHarcourt, Nigeria.A case study of Coca-Cola Group of Companies and Seven-up bottling Company were examined and analysed. The payoff matrix was calculated from the harvested data from the distributed questionnaire in eight major populated areasin port Harcourt (University of Port Harcourt, Rivers State University of Science and Technology, ElechiAmadiPolytechnique, Rivers State polytechnic Bori, Fedral College of Education and Technical, Omoku, Mile one market, Mile2 market and Oil mill market, and its environs in Rivers State.) as shown in appendix. The gameresulted to aTwo-person zero sum game which utilised the concept of theminimax-maximin principle, and was analysed using Tora 2013. The result shows that residents of PortHarcourt prefer Coca cola to seven up due to promo, and also Seven up company incurred less loss due to its drink flavour.*

Keyword: *Optimization, marketing strategies,Two-person zero sum game, pay off matrix, questionnaire, minimax principle*

I. Introduction

Therehave been different setback and obstacles that one has to address in order to figure out theirlevel of survival since the evolution of man on earth; contending with other species or their kind for land, territory, food.

Today, the rate of competition among organization of different kind is high that the companies are often faced with decision to make in order to increase theirsales that are of great competition with other product in the market. This implies that if companies want to succeed in their targets, they need to continuously check the behaviour attitude of consumers and their priorities due to the fact that consumers are the kings in the business world. Today soft drink has become a vital daily usage which is unavoidable by many user.

Game theory is the study of mathematical models of conflict and co-operation between intelligent rational decisions makers in which each players strategy depends on what the other players does. It is applied in competitive situations and is concerned with interdependent decision in which the options being evaluated are functions of the player's choice.

Gametheory was initially introduced by Von Neumann and Morgenstern (1944) and modified by Nash in1950 where he demonstrated that for every finite games, there exist an equilibrium point at which all players choose strategy that they consider best for them given their opponents' choices.Every game requires players and a game must consist of at least two players. When the game consists of two players only is called a TWO-PERSON GAME, whereas the one that consists of more than two players is called N-PERSON GAME.

Several authors have worked on both game theory and its applications from 1950s till date.

However, Game theory can be applied in the business world such as in a soft drink industry, where two companies (Coca-Cola group of companies, and Seven up,) contend for dominance in the market over the years. These brands have been striving to totally chase the other out of the market or control a large portion of the market. The companies wants to win over existing customers and do not lose them to their competitors. In view of this, over time, different strategies have been employed by the competitors which include advertisement, promo, brand development and branding, as well as cost,and taste. These strategies will determine the company which will dominates in the market.

However, the research wants to apply the concept of the two-person zero-sum game theory to determine what strategy will be of benefit to the individual companies in order to win in the market.

In section two, brief explanation of two person zero sum game will be provided, followed by the history of the two beverage companies in section three.Data collection, analyses and computational result will be presented in section four and five respectively.Section six and seven includes summary of result and conclusion respectively.

II. Two Person Zero Sum Game

Game which requires only two players is called Two-Person Game. In a Two-Person game, when one player wins, it implies a direct and equal loss to the other player. This is called Zero -Sum Game.This involves list of possible course of actions that can be taken by a player called STRATEGIES which are chosen by a player in order to either minimizes his loss or maximizes his gain. The particular combination of strategies that best does this to both party is referred to as optimal strategy. As a result of picking a particular strategy, a player derives a degree of satisfaction called PAYOFF.

Therefore a player will obtain maximum payoff if he selects his optimal strategy. Game theory provides a data structure called PAYOFF MATRIX which is used to calculate the VALUE OF THE GAME. i.e the value that represents the maximum payoff for each player. It can also be the expected outcome when two players choose their optimal strategies. In a pure strategy game, the saddle point is the value of the game while a mixed strategy game, the value of the game is solved by choosing from strategies with fixed probabilities. The value of the game satisfy the following:Maximum value $\leq v \leq$ minimum value, where v is the value of the game.

Generally, assumptions of this type of game are;
- Each players has available to him a finite number of possible strategies
- Players act rationally and intelligently
- One player attempt to maximize gain and the other attempt to minimize loss
- Both players make their decision individually , prior to the play, without direct communication between them.
- The payoff is fixed and determined in advance.

III. Data Base And Historical Background Of The Companies

Literature recorded that Coca-Cola was initially discoveredby John P. in 1886 ; an American scientist during his quest for a quick relief of headaches and tiredness. It was a combination of carbonated water and tested on a selected number of persons who accepted to be used.He sold the company to an Atlanta man known and addressed as Griggs Candler in 1891. Candler became the first company's president who brought the vision to the business and the brand. He changed Coca-Cola from an invention into a business.

In 1895, He built syrup plant in Chicago, Dallas and Los Angeles.Coca-Colacame to Nigeria In 1951, and in that same year, the Nigerian bottling company (NBC) was incorporated to bottle and sell the carbonated non-alcoholic beverage. Normal production started in 1953 at Lagos State and in the same year, the first bottling plant was opened in Apapa, Lagos State. Today, the company has different products in many countries and thousands of plants and factories across the world.

Seven-up was invented in 1920 by Charles Grigg. In 1929, he came up with the formula for a lemon-lime sod now known as Seven-up (7up). The name of the company was changed from Howdy Corporated to the Seven-up Company in 1940.

In 1960, the country experienced the birth of seven up in Yora, Lagos State. Today, the company has grown into a class beverage with factories all over the world.

3.1 Data Collection/ Presentation

This research employed primary data. This was obtained through distributions of questionnaires as shown in appendix A to residence of Port Harcourt. A simple random sampling technique called the table of random number was employed to determine eight major populated areas to be covered which gave, University of Port Harcourt, Rivers StateUniversity of Science and Technology, ElechiAmadiPolytechnique, Rivers State polytechnic Bori, FedralCollege of Education and Technical, Omoku, Mile one market, Mile2 market and Oil mill market, and its environs in Rivers State. A total of twenty five thousand (25,000)questionnaires were distributed out of which only ten thousand five hundred and ninety two (10,592) respondentscomplied as presented in tables below.

The two major beverage companies in Nigeria, Coca-cola Group of Companies (which produces sprite, coke and Fanta) and Seven-up Bottling Company (which produces pepsi, mirinda and seven-up) are the players and the factors considered in the questionnaire are:
i.   Advertisement (ADV)
ii. Promos (PRO)
iii. Packaging (PAC)
iv. Sugar level (S/L)
v.   Flavour (FL)
vi. Prize (P)
vii. Taste(T)

Data collated by the researcher were fully utilized to ensure that the purpose of the statistical input is not biased.

The table3.1 below shows the number of respondents that prefers a particular drink to the other considering different factors. Also factors that affect movement of customers from one brand to the other, the rate of movement from one brand to another, and as well as customers who stayed loyal to their brand based on certain factors are also tabulated.

Table 3.1: Table of Factors against Movement

BRAND	FACTORS	COCA	SEVEN UP	RETAINED CUSTOMERS
Coca	Advert	-	356	158
	Promo	-	210	163
	Pack	-	192	147
	Sugar	-	326	167
	Flavor	-	415	142
	Prize	-	399	140
	Taste	-	400	112
Seven Up	Advert	820	-	100
	Promo	918	-	109
	Pack	752	-	122
	Sugar Level	608	--	141
	Flavour	667	-	132
	Prize	723	-	140
	Taste	605	-	

Source*: own research (generated from questionnaire from the field)*

Based on the above result, the payoff matrix of two competitors say A and B at a time for any given pair of strategies will be determined. This is done by comparing the payoff for one competitor A using a particular strategy against the other B, using his own strategy.

Mathematically, let A be gaining competitor(Coca-Cola) be represented by rows on the payoff matrix with strategies (α_i: i=1,2,…n) having payoffs (a, b, c, d, e,f, g) and B be a losing competitor(seven up company) represented by columns on the payoff matrix with strategies (β_1: i= 1,2, …n) having payoffs (h, i, j, k, l,m,n). Let r_i: i=1,2,…7 be the number of customers retained by A (COCA COLA) company due to factors α_i, and v_i; i=1,2,…7 be the number of customers retained by b (Seven up) company due to factors β_i respectively, then the Table of Factors against Movement becomes

Table 3.2: Table of Factors against Movement

BRAND	FACTORS	COCA	SEVEN UP	RETAINED CUSTOMERS
Coca	Advert		356 =h	158 =r
	Promo		210 =i	163=r2
	Pack		192=j	147 = 3
	Sugar		326 = k	167 =r 4
	Flavor		415 =L	142 =r5
	Prize		399= M	140 =r7
	Taste		400 =n	112 =V1
Seven Up	Advert	820 = a		100 = V2
	Promo	918 = b		109 = v3
	Pack	752 =c		122 = V4
	Sugar Level	608 = d		141 =V5
	Flavour	667= e		132 =V6
	Prize	723= f		140 =V7
	Taste	605= g		

Source*: own research (generated from questionnaire from the field)*

And the resulting 7*7 value of the payoff table will be calculated thus ;

Table 3.3: Payoff tablecalculation

$a_{11} = \alpha_1 - \beta_1$,=(a+r1)-(h+V1)=(820+158) –(356+112)	$a_{12} = \alpha_1 - \beta_2$ =(a+r1) – (i+v2)=(=210+158) -(210 +100)	$a_{13} = \alpha_1 - \beta_3$, =(a+r1)-(j+V3) =(820+158-)- (192+109)	a14 = $\alpha_1 - \beta_4$, =(a+r1)- (k+v4) =(820+158)- (326+122)	a15= $\alpha_1 - \beta_5$, =(a+r1)- (L+v5 =(978)- (415+141)	$a_{16} = \alpha_1 - \beta_6$, =(a+r1)- (m+v6)- (399+132)	$a_{17} = \alpha_1 - \beta_7$, =(a+r1)- (n+v7)=(978)- (540)=
$a_{21} = \alpha_2 - \beta_1$ =(b+r2)-(h+v1)	$a_{22} = \alpha_2 - \beta_2$ =(b+r2)-(i+v2) =(918+163)	$a_{23} = \alpha_2 - \beta_3$ =(b+r2)- (j+v3)=(918+16	$a_{24} = \alpha_2 - \beta_4$ =(b+r2)- (k+v4)	$a_{25} = \alpha_2 - \beta_5$ =(b+r2)-	$a_{26} = \alpha_2 - \beta_6$ =(b+r2)- (m+v6)-	$a_{27} = \alpha_2 - \beta_7$ =(b+r2)- (n+v7)

=(918+163)-(356+112)	-(210+100)	3)-(192+109)	=(918+163)-(326+122)	(M+v6)=(1081)-(415+141)	=(1081)-(399+132)	=(r2)-n+v7)=(1081)-(540)
$a_{31} = \alpha_3 - \beta_1,$ =(C+r3)-(h+v1) =(752+147)-(356+112)	$a_{32} = \alpha_3 - \beta_2$ =(c+r3) –(i+v2) =(752+147) -(210+100)	$a_{33} = \alpha_3 - \beta_3$ =(c+r3)-(j+v3)=(752+147)-(192+109)	$a_{34} = \alpha_3 - \beta_4$=(c+r3)-(k+v4) =(752+147)-(326+122)	$a_{35}= \alpha_3 - \beta_5$=(c+r3)-l+v5)=(899)-(415+141)	$a_{36} = \alpha_3 - \beta_6$=(c+r3)-(m+v6) =(899)-(399+132)	$a_{37} = \alpha_3 - \beta_7$ =(c+r3)-(n+v7) =(899)-(540)
$a_{41} = \alpha_4 - \beta_1$ =(d+r4)-(h+v1) =(608+167)-(356+112)	$a_{42} = \alpha_4 - \beta_2$ =(d+r4)-(i+V2) =(608+167) -(210+100)	$a_{43} = \alpha_4 - \beta_3$ =(d+r4)(j+v3) =(608+167)-(192+109)	$a_{44} = \alpha_4 - \beta_4$=(d+r4)-(k+v4) =(608+167)-(326+122)	$a_{45}= \alpha_4 - \beta_5$=(d+r4)-(l+v5) =(775)-(415+141)	$a_{46}= \alpha_4 - \beta_6$=(d+r4)-(m+v6)-(775)-(399+132)	$a_{47} = \alpha_4 - \beta_7$ =(d+r4)-(n+v7) =(775)-(540)
$a_{51} = \alpha_5 - \beta_1$ =(e+r5) (h+v1) =(667+142)-(356+112)	$a_{52} = \alpha_5 - \beta_2$ =(f+r6)-(i+v2) =(667+142) -(210+100)	$a_{53} = \alpha_5 - \beta_3$ =(f+r5)-(j+v3) =(667+142)(192+109)	$a_{54} = \alpha_5 - \beta_4$ =(e+r5)-(k+v4) =(667+142)-(326+122)	$a_{55} = \alpha_5 - \beta_5$ =(e+r5)-(l+V5) =(809)-(415+141)	$a_{56} = \alpha_5 - \beta_6$ =(e+r5)-(M+v6) =(809)-(399+132)	$a_{57} = \alpha_5 - \beta_7$ =(e+r5)-(n+v7) =(809)-(540)
$a_{61} = \alpha_6 - \beta_1$ =(f+r6)-(h+v1) =(723 +152)-(356+112)	$a_{62} = \alpha_6 - \beta_2$ =(g+r7)-(i+v2)=(723152)-(2010+100)	$a_{63} = \alpha_6 - \beta_3$ =(f+r6)-(j+v3) =(723+152)-(192+109)	$a_{64} = \alpha_6 - \beta_4$ =(f=r6-)-(k+v4) =(723+152)-(326+122)	$a_{65}=\alpha_6-\beta_5$ =(f=r6)-(l+v5) =(875)-(415+141)	$a_{66} =\alpha_6- \beta_6$ =(f+r6)-(M+V6)=(875)-(399+132)	$a_{67} = \alpha_6 - \beta_7$ =(f+r6)-(n+v7)=(875)-(540)
$a_{71} = \alpha_7 - \beta_1$ =(g+r7) – (h+v1) =(605+140)-356+112)	$a_{72} = \alpha_7 - \beta_2$ =(g+r3) –(i+v2) =(605+140)-(210+100)	$a_{73} = \alpha_7 - \beta_3$ =(g+r7)-(j+v3) =(605+140)-(192)+109)	$a_{74} = \alpha_7 - \beta_4$=(g+r7)-(k+v4) =(605+140)-(326+122)	$a_{75} = \alpha_7 - \beta_5$ =(g+r7)-(l+v5)- =(745)-(415+141)	$a_{76} = \alpha_7 - \beta_6$ =(g=r7)-(M+v6) =(745)-399)-(132)	$a_{77} = \alpha_5 - \beta_7$ =(g+r7)-(n+v7) =(745)-(540)

Source*: own research (calculated fromtable 3.2)*
The above yields the values in the pay off matrix below;

Table 3.4: The pay off matrix of Coca-Cola versus Seven-Up

					SEVEN UP			
C O C A- C O L A		Advert	Promo	Packaging	Suger level	flavour	price	Taste
	Advert	510	668	677	530	422	447	438
	Promo	613	771	780	633	525	550	541
	Packaging	431	589	598	451	343	368	359
	Suger level	307	465	474	327	219	244	235
	flavour	341	499	508	361	253	278	369
	price	407	565	574	427	319	344	335
	Taste	277	435	444	297	189	214	205

Source*: own research (generated from table 3.3)*

IV. Theory And Methods
Apply the rule of game as shown below to table 3.4:
RULES FOR GAME THEORY
- A two person zero sum game in strategic(or normal form) α *and* β consist of two strategy set
- A play of the game consists of player A choosing a strategy $\alpha_i \in \alpha$ and player B simultaneously choosing a strategy $\beta_j \in \beta$. Player A is then awarded A(α_i, β_j) in winning and player A awarded –A(α_i, β_j)
- Look for a pure strategy or saddle point(minmax=maximin=game). It is the point of equilibrium
- If v =0 then the game is said to be fair
- If v >0 then the game is favourable to player along row a
- If v<0 it is favourable to the player along the column

If there is no saddle point (it is not pure but mixed) then we apply the rule of dominance which state
- Delete the columns that is less than or equal to any other column
- Delete the row that is less than or equal to the next
- Then solve by mathematical method

Then, inputing the above values intora gives table 4.1 below

Table 4.1: INPUT TABLE

And the output is;

Table 4.2 Out Put Result Table

V. Results

Minimax- maximin principle together with Tora 2006 were used to analyze the data in the cost matrix on table 3.4 and 4.1, the result obtained shows thatthe table has a saddle point at (Promo, flavour) at the minimax value = 525 = maximin value. Hence the value of the game is 525. This shows that the game is favorable to Coca-Cola (coke).

It implies that the resident of PortHarcourt City prefers coke than Sevenup in terms of promo. That is to say that Coca-Cola has an advantage of promo over seven-up as it brings gain to them irrespective of Seven-Up's course of action, while the factor 'flavour' brings less loss to Seven-Up.

The result of this research shows that the competition between the beverage companies is a pure strategy game.

VI. Summary And Conclusion

It was observed from the data collected, that the companies' factors greatly affect the market flow of the two soft drinks companies. This influences the decision of the customers as to what brand to choose and if already drinking a brand, to remain with the brand or to move to the other brand.

From the analysis, it is noticed that Coca-Cola Company's promo brings them more customers and/or make their existing customers to remain with the brand; thus enhancing companies profit. This is due to the fact that more customers buy more of coca cola product when compared with that of seven up. However, because of the flavour of Seven-Up, the probability of them losing their customer is obvious.

VII.   Recommendations

It is observed that the strength of Coca-Cola is their promo. But this does not necessarily mean that it is the only available strategy; hence, Coca-Cola while retaining their promos strategy, should also improve on their flavour in other to be in total control. Also, Seven-Up, while capitalizing on their flavour, should improve on advertisement and promos.

In general, it has been shown from this research that one strategy is not enough to keep any firm in business; hence, other factors that cause the movement of customers should be considered and improved upon to a satisfactory level.

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[11]   APPENDIX A
[12]   Dear respondent, I am Orumie, U.C of Department of mathematic and statistics, UNIPORT. I am carrying out a research on the CONSUMER CHOICE OF DRINK "COCA-COLA AND SEVEN-UP COMPANY"
[13]   Please your information on the questions below are highly required, and will be kept confidential. I shall appreciate your cooperation.
[14]   INSTRUCTION:Please read the following questions carefully and tick the answer which you feel is appropriate.

Instruction

Please tick as appropriate and just indicate a number where needed.

Section A

1.   Sex:
 Male   Female

2.   Age:
           16 – 20 years   21 – 25 years
           26 – 30 years   31 – 35 years
           36 – 40 years   41 – 45 years
           46 – 50 years   51 - above

3.   Category:
Staff
Student

business
civil servant
self employed

Section B

1. Which brand do you think has done better in terms of:

Coca-cola ☐   Seven-up ☐

2. Would you like to change to a better brand?

Yes ☐   ☐

3. a) If yes, why?
- Advertisement ☐
- Promo ☐
- Packaging ☐
- Sugar level ☐
- Flavour ☐
- Prize ☐
- Taste ☐

b) If no, why?
- Advertisement ☐
- Promo ☐
- Packaging ☐
- Sugar level ☐
- Flavour ☐
- Prize ☐
- Taste ☐

4. When both are available, which do you prefer:

       Coca-Cola ☐   Seven - up ☐

5. A) If Coca – Cola, which do you prefer:

Coke

Fanta ☐

Sprite

B) If seven – up, which do you prefer:

Seven up

Pepsi ☐

Mirinda

6. How long have you been taking your preferred brand?

       0 – 5 years ☐   6 – 10 years ☐

       11 – 15 years   16 – 20 years

21 – 25 years   26 and above