COMPUTERISATION OF THE PRODUCTION RATE OF NIGERIAN BOTTLING COMPANY PLC

(A Case Study Of Kaduna Depot)
1987 - 1996

By

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CERTIFICATION

I certify that this project was carried out by Harry Uhunamure O. Post Graduate Diploma of the Department of Mathematics and Computer, School of Science and Social Education, Federal University of Technology, Minna, Niger State.

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INSPIRATION

Unto thee oh! Lord do I gaze all day long and Alas! You revealed to me all that I needed to successfully complete this project.

I thank you Lord.

DEDICATION

I dedicate this project to God Almighty for giving me the grace for the successful completion of this program and the provision of materials. Ideas and people who contributed towards the success of this project.

PREFACE

This project is designed to fulfil part of the requirements needed for the award of Post-Graduate Diploma Program in Computer Science.

Chapter one deals with the general introduction of the project work touching the process, the aims and objective of the study, sources of data collection and purpose, historical background of source of data.

Chapter two contains the literature review. It covers econometrics, meaning, types of econometrics. Correlation analysis, metric method of data analysis - statistical linear method of data analysis. Assumptions underlying the general linear model. Estimation of parameters and inference regarding individual coefficient.

Chapter three sheds light on Research Methodology and data presentation. This chapter highlight the method used in the procurement of raw material (data), the method of analysis. It also deals with general model of data analysis and presentation. It also highlights the variables needed for analysis from Nigeria Bottling Company Plc, Kaduna under production department.

Chapter four deals on program design. This chapter is very important as its where the use of computer actually come to play. Here, the different aspects of design is discussed. The program proper for analysis is written in this chapter. And based on results obtained appropriate conclusion is drawn.

In Chapter Five, the results obtained from chapter four is used to make appropriate inference and advice Nigerian Bottling Company (Makers of Cocoa Cola) accordingly.

ACKNOWLEDGEMENT

It is pertinent to recognise and appreciate the efforts of people who contribute one way or the other in the successful completion of the project.

I also want to thank my able supervisorMr Isaha Audu for his unflinching support and assistance in leading, guiding and editing of this project. I thank him for his invaluable patience, endurance, and his intellectual contributions to the success of this project.

My utmost thanks goes to God Almighty, the creator of mankind and all his intellects for giving me the vision of this program, the insight of this projects, the wisdom and enigma in conducting my findings and bringing the project presentation to a successful and reasonable conclusion.

Also, my gratitude also goes to the staff of Nigerian Bottling Kaduna, for their assistance and co-operation in the collection of the raw materials needed for this project.

I give kudos to my parents for their moral, physical, spiritual support and for making me to understand the importance of education. May they live long to reap the fruit of their labour.

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Computerisation of the Production Rate of Nigerian Bottling Company Plc

$$Y = B0 + B_1 X_1 + B_2 X_2 + B_3 X_3 + ei$$

Y	=	Production per year (in 100,000)	-	Dependent Variable
X1	=	Mechanical effects	-	Independent Variable
X2	=	Technical effects	-	Independent Variable
X3	=	Non-Machinery effects	-	Independent Variable
Bn	=	Parameters /constants to be estimated, n = 0, 1, 2, 3		
e2	=	Random error component or disturbance terms		

Where Xn, Vn = 1---3 and Y are - Naira Values

Chapter One

1.0 INTRODUCTION

Statistics is often defined as numerical information called data. It is also the methods of gathering, collating, summarizing, analysing and dissemination of data in order to make appropriate inference.

The primary function of statistics is to provide information. Data collected gives different types of information; the use of these data depends upon the purpose for which its required and manner of its collection.

The use of statistics cannot be overemphasised. In any economy where growth and economic advancement is desired - statistics come to play. It is essential in the planning and development of components of the economic sub-sector such as Education, Health, Finance, Power, Water Resources, Agriculture, Transport, Industries, Housing, Town and Country Planning. Needless to say that worldly acclaimed companies like UAC, UTC, JULUS BERGER, NIGERIA BOTTLING COMPANY (makers of Coca Cola) need to apply the broad knowledge of statistics to attain the present and future economic advancement.

For this reasons and for the purpose of this research, I want to use Nigerian Bottling Company, makers of Coca Cola as a case study. This will be based on production and the factors that affects production of Coca Cola products. These factors are grouped into three categories namely MECHANICAL, TECHNICAL AND SERVICES and NON MACHINERY EFFECTS. These factors are further divided into sub-groups namely.

1. Mechanical Factors: Filler, crowner, washer, uncaser, packer, conveyors, flomix and cooling compressors.
2. Technical and services: Air compressor, boiler, manpower.
3. Non Mechanical effects: No Water, No carbondioxide, foaming crown hooking etc.

At the end of the study we shall see how these factors affects the production of Coca Cola products from the appropriate conclusion drawn.

It must be stated here that statistics is usually ascribed to the computer world because of its technological excellence in providing data as well as its precision in retrieving data on demand. Computer also has relieved the statistician a great deal on the analysis of data from which inference is drawn.

1.1 AIMS AND OBJECTIVES

The aim of study is to enhance a deliberate control and direction of the economy for the purpose of achieving definite target and objective within a specified period of time. The essence is the establishment of the relationship between the means and the ends, with the aim of achieving the later by the efficient use of the former. The 'means' in this case are

(a) To computerise the effects of the factors such as mechanical effects, technical and services effects and non machinery effects which are dependent variable) on production of Coca Cola products (independent variable).

(b) To forecast the value of the independent variable Y (production) for a given sets of X's (dependent).

The 'ends', which is the findings could be catergorised thus

(a) To see whether any of these factors (dependent variables) have any significant effect on production (independent variable).

(b) To present the final findings/model - mathematical equation.

(c) The mathematical model interpreted for consumption and appropriate conclusion and recommendation drawn.

1.2 MATHEMATICAL MODELING

A model is a concept that is used to represent something else (something like the real thing).

A mathematical model is a system model whose parts are mathematical concepts such as constants, variable functions, equations, inequalities etc.

In describing some parts of real world in mathematical term, mathematical model come to play. Mathematical model is as old as antiquity but as recent as today's newspaper. An attempt to describe some parts of the real mathematical models and some bad ones which are better forgotten.

Often times mathematical model have been welcomed with great enthusiasm even when their values were uncertain or negligible other times good mathematical model have been greeted in different ridicule.

Mathematical models have been built in physical, biological and social sciences. The building blocks for these model have been taken from calculus, algebra, geometry and early every other field within mathematics. Mathematical modeling is a rich and diverse activity with many interesting aspects and with various fields of application. It was on the realization of the importance of mathematical modelling that Leonardo Davioce based his argument that "no human investigation can claim to be scientific if it does not pass the test of mathematical proof.

1.3 MODELLING METHODOLOGY

Modeling cannot be done mechanically, nevertheless there are some guidelines on how to go about it. Modeling processes can be divided into three main steps: Formulation, mathematical manipulation and evaluation.

1.3.1 FORMULATION

This aspect of modeling can be divided into three smaller sub-steps including:

(a) **Stating the Question:** The question we start with is often too "vague" or too "big". If it is too vague, we try to make it precise. If it is too big, we subdivide it into manageable parts.

(b) **Identifying Relevant Factors:** Decide which qualities and relationships that are relevant and important to the state question and which cannot be neglected.

(c) **Mathematical Descriptions:** Each important and relevant quality should be properly represented by a suitable mathematical entity such as variable, function, geometric figure etc. Each relationship should be represented by an equation, inequality or other suitable mathematical assumptions.

1.3.2 MATHEMATICAL MANIPULATION

The mathematical formation rarely gives solution directly to our problem, we usually have to do some mathematical interpolations of the objective theorem under the formation, to obtain a reasonable model. This mathematical interpolation may involve calculation, solving equation, proving of theorem etc.

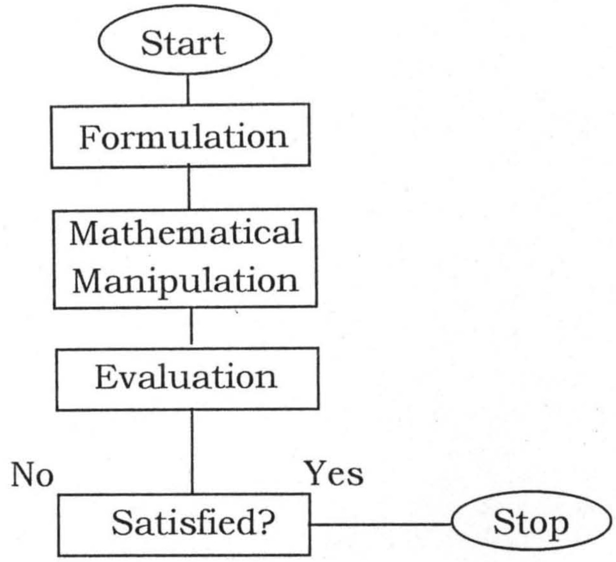
1.3.3. EVALUATION

In deciding whether a model is good or bad, there are many things we should take into consideration. But the most important question concern whether or not the model gives correct solution to our problem. If the resulting solutions of the model are not accurate enough or if the model has other shortcoming, then we should try to identify the source of the shortcoming.

It may be possible that the mistake might have been made in the mathematical manipulation. It may also be possible that the mistakes is from the initial assumption under formation, then what is needed is a new formation of the model.

For example, it may be that some quantities or relationships which are neglected are more important than we might have initially thought it. After a new formation, we will need to do some new mathematical manipulation and a new evaluation of the designed model.

Therefore a mathematical modeling processes can be thought of as a repeated cycle of the three modeling steps as shown in the flow chart below.

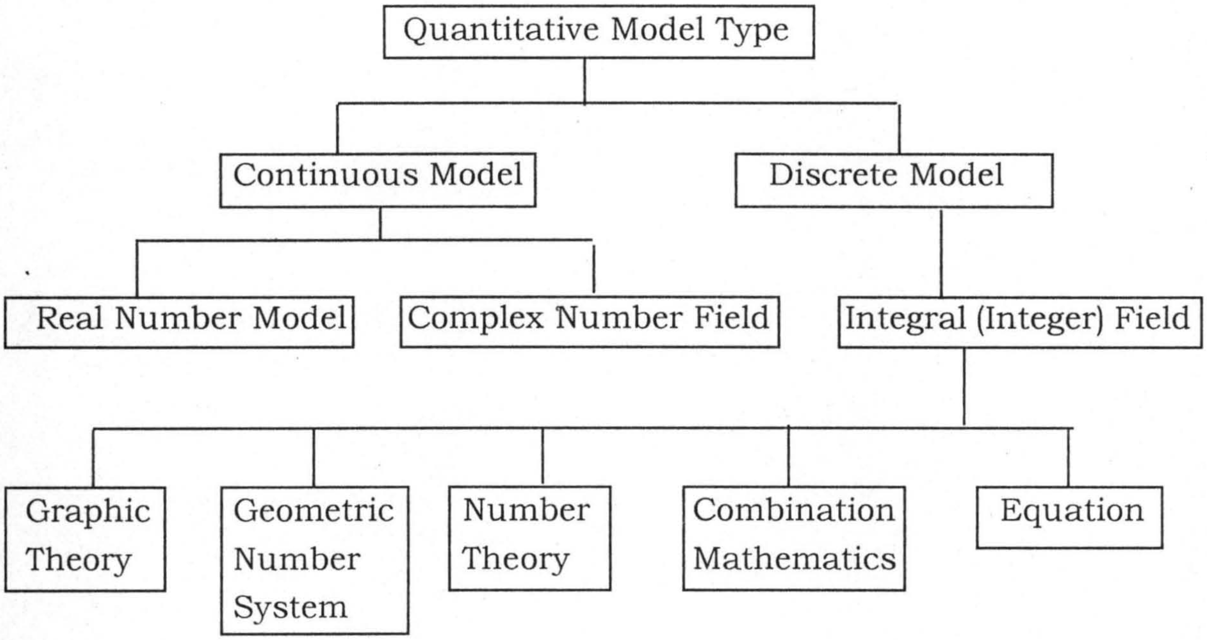


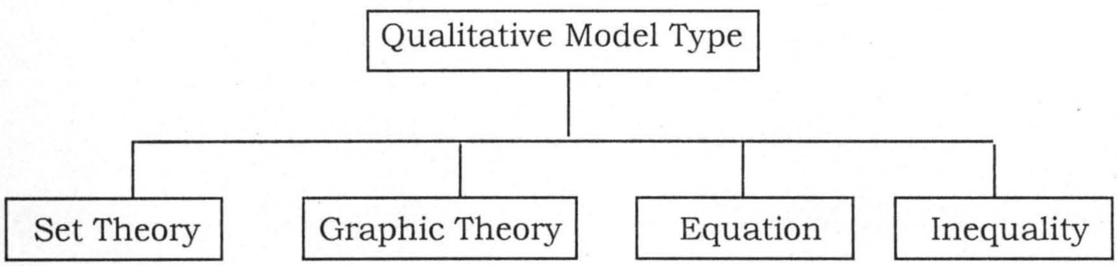
1.4 <u>TYPES OF MATHEMATICAL MODELING</u>

Mathematical model can be categorised thus

(a) **Quantitative type:** As the name typifies - 'Quantity', talking about number system in answer to questions "How much or how many" - countable, numerable.

(b) **Qualitative type:** In order to obtain quality in anything, comparison has to be carried out. Hence, this employs the set theory rather than the number system. It studies the relationship between systems and properties of the system. The charts below summarises the model types and their mathematical tools.





Continuous and discrete models are involved
(a) Equation and Inequalities
(b) Optimization
(c) Probabilities and stochastic Processes

It must be clearly stated that when building a mathematical model the underlying assumptions must be clearly stated and thoroughly followed throughout the modeling processes, regardless the design method or types.

1.5 CLASSIFICATION OF PROBLEM

Problems of mathematical modeling can be classified into four categories.

1.5.1 (I) DETERMINISTIC PROBLEM:

When estimation plays a major role in the analysis of the problem, deterministic problem come to play. A good example of this is the model of economic distribution or population estimation. Also, estimation of production rate is also classified as deterministic, which is the subject matter of this paper work.

1.5.2. (II) STOCHASTIC PROBLEM:

When random effects (chance) plays a major role in the analysis of events, then, we talk stochastic process. Notable example are the problem of queue and services in public places. The outcome in this problem (queue and services) is not fixed since variability of solution has to be allowed.

1.5.3. (III) STABILITY PROBLEM:

A property which remains in variant to changes has a stability characteristics. This cuts across various life situations for example in politics, oscillation and dynamics.

This primarily employs the fixed point theory. If a transformation.

T: $X \Rightarrow X$ such that $\mathcal{X} \in X$

$T\mathcal{X} = X$. Then the solution X is called the fixed point of the function T.

(IV) SURROGATIVE PROBLEM:

The aim of this is to show the interaction of various factors in the absence of any useful way of measurement to obtained numerical solution. For example, the utility function can be defined to serve as a substitute for Matrix.

1.6 SOLVING MATHEMATICAL MODEL PROBLEMS

When solving a mathematical problem, the following need be explored.

(a) **A prior bounds or estimate:** This has to do with finding out the maximum number of solution to a given problem; need to stop solving the problem when there are more and seek a most feasible and desirable one.

(b) **Existence and Uniqueness of Solution**
When the existence of solution differs from (a) above, we need to establish the existence of solution and find out the uniqueness of the solution established.

(c) **Convergence:** There is need to know if iteration converges to the desired solution point when considering iteration.

(d) **Approximation and Error:** Knowing that, iteration will surely stop at a stage, depending on the number of times of iteration and nearness to the exact solution, we will be interested on 'how good' the last iteration is, by reason of its closeness to the exact solution by approximating the error.

APPLICATIONS OF MATHEMATICAL MODELING

Fields of applications of mathematical modeling can be classified into social, physical, Biological and behavioural. Generally, there are other fields whereby mathematical modeling can be applied including production (or manufacturing) progress problem.

CHARACTERISTICS OF A GOOD MODEL

(a) **Accuracy:** When the model (i.e the given solution when tested and evaluated) is near to correct or correct, then the model is said to be accurate.

(b) **Precision:** If the model predictions are definite numbers or definite model of mathematical entitles e.g. formula, geometric figure and equations, then the model is precise.
But if the model's prediction is range of numbers or set of functions or a set of figures, then the model is not precise.

(c) **Descriptive Realism:** A model is descriptively realistic if it is based on assumption(s) which are perfect, simple and correct.

(d) **Robustness:** If the model is relatively immune to errors in the input data then the model is said to be robust.

(e) **Generality:** If the model is used in a variety of life situation, then if is said to have a generality characteristics.

(f) **Fruitfulness:** A model is fruitful if either (i) it is conclusive and useful (ii) it inspires another good model.

SOURCE OF DATA

The data collected for this project is purely a secondary data. The data was collected from the production department of Nigerian Bottling Company Plc. The data is by products of their yearly production report for a decade (1987 - 1996).

HISTORICAL BACKGROUND

Coca-cola is the world leading soft drink, sold in more than 154 countries (as at 1995). A total of 250 million of the soft drink is consumed everyday in all parts of the world from Canada in the north to Argentina and new Zealand in the south, from Alaska to China from Mexico to Nigeria, to mention but a few countries.

Coca-Cola came to Nigeria in 1953 when Nigeria Bottling Company set up its first plant in Lagos. It was to be the beginning of an existing story of growth and development particularly during the past ten years.

Nigeria Bottling Company is today Nigeria's number one bottler of soft drinks selling more than 6 million bottles per day, a figure which is still growing with the continuing expansion of the existence of 21 plants and with the opening of brand. New plants in various parts of the federation. Fanta is undisputedly the number one best seller in the orange segment and sprite the most widely sold lemon. Other products bottled by NBC include Fanta, Giner Ale, Fanta Tonic, Fanta

Chapma, Fanta Soda and Krest Bitter Lemon.

The success of Coca-cola has brought with the development of a number of sister industries all contributing to the growth of the Nigeria economy industries like the delta glass company in Ughelli, which supplies the million of bottles required to keep the large bottling company like NBC in operation. Also, at Ijebu-Ode and Kano are the crown products factories where the metal crowns to seal the bottles, the Benin plastic company which makes the plastic crates for carrying the bottles. In addition, the trunk C (i.e. Apapa and Ikeja plants) are a familiar sight in many parts of the country delivering soft drinks to more than 80,000 dealers in Nigeria.

Nigeria Bottling Company is also the largest manufacturer in the country of carbondioxide, used to carbonate Nigeria's favourite soft drink. NBC employs over 6,000 Nigerians in all field of operation. The manufacturing process of Coca-Cola is based on a carefully measured combination of sugar, water and concentrates. The same standard is maintained throughout the world.

The headquarters of NBC is at Leventies Building Iddo House, Lagos, NBC has various plants in Nigeria where Coca-Cola products are bottled, Sokoto (SSOF) Kano (Challawa), Maiduguri, Abuja, Kaduna, Jos, Ilorin, Ibadan, Asejire, Onitsha, Otta (canning plant), Ikeja 2, Benin, Enugu, Owerri, Aba, Minna, Port Harcourt etc.

Source: Vol 011, November 1995 Edition of Nigerian Bottling Company Publication - THE INSIDE STORY.

Chapter Two

2.0 LITERATURE REVIEW

2.1 ECONOMETRICS

Econometrics is the study of economic problem using mathematical model. It is concerned with empirical determination of mathematical or theoretical laws. Econometrics is a combination of mathematical Economics and statistics.

Economists are typically less interested in describing a single variable like profit than describing how two variable are related. For example, how does assets affect profit. Econometrics deals with the measurement of such casual relationships, either to show how the economy operates or to make prediction about the future.

Thus, an Econometric estimate of how profit depends on assets and vice versa will shed more light on the effectiveness of health (i.e soft drinks consumption). An estimate of the relationship between soft drinks production consumption and revenue patterns will help to compare the importance of each relative to the others. The essential role of econometrics is the specification of various econometrics models in mathematical forms. After which data must be appropriately assembled and relevant from the economic sector that the model purposes to describe.

The use of data to estimates parameters is a necessity and finally carry out a test on the estimate model in an attempt to judge whether it constitutes a sufficiently realistic picture of the economy being studied or not.

Econometrics interest is to use sample data to obtain numerical estimate of the unknown population parameters. It should be noted that no economic data ever give an exact fit to simple relations of this kind since linear or other simple forms are only an approximation to possible complex but unknown forms, since only a small subset of all possible explanatory variable can usually be included in any specifications of a stochastic error (disturbance term) in each relation other than identities and indeed a very useful product of the econometric process.

There are two types of econometrics, namely

(i) **Behavioural Relation:** This is the relation that describes the forces thought to determine the behaviours of various groups of econometrics agent most of the relationship are of the form.

$\text{Log } C + B_0 + B_2 \text{ long } Y + B_2 \text{ Log } P$................. (1)

Where C is the total production of soft drinks from Nigerian Bottling Company.

Y = Total Consumption in a given year

P = The revenue made or collected during the given year.

(ii) **Technical Relations:** It is the one that describes the restriction imposed by the current technology or endowment of the system

Most of the relations are of the form

P = $LCK\ (1 - \alpha)$, where

P = The revenue made by Nigerian Bottling Company in a given year

K = Average per capital stock in the same year

L = Total number of man hours

C and α = Constants

2.2 CORRELATIONS ANALYSIS

Correlation is the degree of relations existing between two or more variable.

2.2.1 SIMPLE CORRELATIONS

The degree of relations existing between two variable is called simple correlation. Lets assume we are comparing two things, how the increase/decrease of one affects the decrease/increase of the other, then simple correlation is used to determined the degree of relationship. The formula is stated thus.

$Y = B_0 + XB_1$ where
Y = Production Level
U = Profit
B_0B_1 = Constant

When analysed we notice that increase in production level (Y), always brings about increase in profit (X). This is the degree of relationship between the two variable X and Y.

2.2.2 MULTIPLE CORRELATION

In multiple correlation, the degree of relations existing between three or more variable is considered multiple correlation is applied in the computation of this project. It is applied when three or more variable are been compared. In this case we are interested in how the dependent variable (Y) is been affected by the independent variable (X_1, X_2, X_3....... X_n). The comparison could be carried out on individual independent variable. That is the degree of relationship existing between Y and X_1, Y and X_2 .... Y and X_n could be computed and appropriate conclusion drawn. The formula for computing multiple correlation is

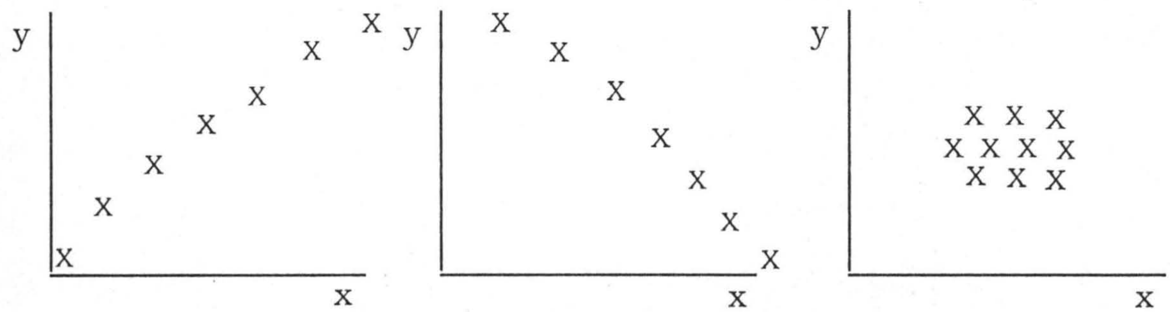
$Y = B_0 + X_1B_1 + X_2B_2 + X_3B_3 + \ldots\ldots\ldots\ldots X_nB_n$ where
Y = Production (Dependent)
X_1 = Mechanical effect
X_2 = Technical effect
X_3 = Non-Machinery effects
X_n = Other effects

Generally correlation may be linear or non-linear. Correlation is linear when all the points plotted on a graph bear straight line and non-linear when the points are scattered or curved. Two variables may be positive correlation Negative correlation or they are uncorrelated (i.e when there is no relationship)

(a) **Positive Correlation:** Two variable are positively correlated when they tend to change together. That is a change in one affect the other positively. It there is an increase in one, there is same in the other.

(b) **Negative correlation:** There is negative correlation when a change in one brings and inverse change of the other, that is when there is an increase in one, there is decrease in the other.

(c) **Uncorrelated:** There is uncorrelated relationship between two variable when there is no relationship between the variables. When stated or represented graphically we have a cluster of points which indicate no relationship see diagrams.



For a precise, quantitative measurement of the degree of correlation between Y and X, a parameter called correlation coefficient is often used and this is denoted by a Greek letter P (ho) which subscript XY e.g P(xy). Its estimated from any relevant subscripts.

Correlation analysis has serious limitation as a measure for the study of economic relations, thus its application does not give room for assumptions about the nature of the relationship between the variable X and Y. The knowledge of the value of the product moment correlation coefficient r, is given by

$$r = \sqrt{\frac{Exy - ExEy}{\{nEx^2 - (Ex)^2\}\{nEy^2 - (Ey)^2\}}}$$

In case where X and Y has exact linear relationship, for example, X = Y hence the variances are said to be equal. Hence we have coveriance, thus COV (xy) = Var (x) - Var (y).

If this situation exists then r = 1, this is a limiting case of perfect positive relationship. Therefore, the correlation coefficient r, may be stated inform of

$$r = \sqrt{\frac{\text{Cov (xy)}}{\text{Var (x) Var (y)}}} \quad \text{where } 1 < r < 1$$

2.3 TESTING THE CORRELATION COEFFICIENT R

The usual null hypothesis tested is given as

Ho: P = O (there is no correlation)

HA: P =) (there is correlation)

When P = O then there is correlation between the variable. To find the value of P, a small sample is drawn from the population from where r is computed as a sample estimate of P. The test statistic is

$$t = \frac{r\sqrt{n-2}}{1-r^2}$$

This makes the final decision as to the acceptance or rejection of absolute value, /t/ which is compared with the table value of student t. Ho is reject if

t cal > tab otherwise we accept Ho

where tcal is t calculated and

tab is the table value of student t.

2.4 SPEARMAN RANK CORRELATION COEFFICIENT

Spearman Rank Correlation Coefficient is applied or comes to play because of the stringent measure on the significance test. Moreso, non-parametric alternative can be applied under much general conditions. This test of the null-hypothesis of no correction is based on the rank-correlation coefficient, which is essentially the coefficient of correlation of the ranks of the X's and the Y's within the two samples. The rank correlations coefficient has the added advantage that it is usually easier to determine than r (product moment correlation coefficient) when there is no calculator.

To calculate the rank correlation coefficient, we first rank the X's among themselves, giving ranks 1 to the large (or smallest) values, rank 2 of the second largest (or smallest) values and so on, Then we do same to Y, ranking the large or smallest in the order of magnitude hence we find the sum of the squares of the differences, d, between the ranks of the X's and Y's i.e $Edi^2 = E(xi\text{-}yi)2$ i = 1-------------n, then we substitute this into the formula (spearman's rank correlation coefficient)

$$R = \frac{I - 6Edi^2}{n(n^2-1)}$$

where di = are the difference between the ranks of the corresponding values of x and y.

n - the number of pair of observations however, there is said to be correlation when the value of R is positive. And the degree of correlation is known or determined by how large the positive value is.

However, if the value of R is negative, it means there is negative correlation, and the degree is expressed on degree negativity.

The advantages of Rank Correlation are (i) it is the only way to find out relations when the table value from t - distribution with t /2 (n-2). If t /2 (n-2) is true, then we reject Ho otherwise we accept it.

(ii) It is easier to compute the product correlations

(iii) It can be used when actual values are given

The disadvantages are as follows:

(i) For a large population, that is when N > 30, the calculation of r becomes tedious, hence product rank correlation coefficient is inefficient when number of items is more than thirty.

(ii) During ranking there are usually some loss of information, hence R is not accurate as when r is calculated using product moment method.

2.5 TEST OF HYPOTHESIS

Testing of hypothesis for a special value of P: If we are to test for equality with a given value of the population correlation coefficient e.g Po, then the hypothesis tested will be.

HO: P = Po

HA: P = Po

We conduct this from a sample information using the quality.

$$Zr = 1/2 \, In \frac{(1 + r)}{(1-r)} \qquad {}^{1}/_{2}In \frac{(1 + r)}{1-r}$$

Where In is a natural logarithm. It can equally be shown that Zr is a random variable following approximately the normal distribution with mean

$$ZPO = 1/2 \, In \frac{(1 + Po)}{(1-Po)}$$ and variance

$$VPO = \frac{1}{n-3}$$ and standard deviation

$$SPO = \sqrt{\frac{1}{n-3}}$$

Testing the null hypothesis that C is equal to some value other than zero, the test statistics is

$$Z_{cal} = \frac{Zr - Zco}{\sqrt{\frac{1}{n-3}}}$$

Hence, the value of Z_{cal} follows approximately the standard normal distribution and it is compared with the approximate value of Z_{Tab} obtained from the table. If calculated Z_{cal} is less than Z_{Tab} from the table, we accept Ho otherwise, we reject Ho.

2.6 REGRESSION ANALYSIS

In order to establish a relations between variables. Regression analysis is used. There are two types of regression analysis.

SIMPLE LINEAR REGRESSION ANALYSIS

Simple linear regression analysis come to play when we are establishing a relationship between two variables. One of the variable is called dependent variable while the other is independent variable. As the word conotes the formula is quite 'simple'

$Y = a_0 + a_0 (x)$ where

Y = Dependent variable

x = Independent variable

a_0, a_0 = Constants

Y is said to be regressed against x. This can be greatly applied in the area of forecasting.

MULTIPLE LINEAR REGRESSION ANALYSIS

In order to establish a relationship between a dependent variable (Y) and several independent variables (x_i, i = 1, r-----n) we use multiple linear regression analysis it is the appropriate technique to use when we are investigating the effects of a variable on several other variables simultaneously.

This multiple regression gives a true picture of reality because it seldom happen in real life economic situation that only one variable will affect another variable. This is the purpose of this study, to establish a relationship between (y), independent variable, and several other factors (x, independent variables) and see how there independent variables affects the rate of production.

Hence, multiple linear regression analysis is often defined as a logical extension of the simple linear regression which utilizes two or more independent variables as a parameter to estimate the values of the dependent variable.

In contrast with the simple linear regression model, the model of multiple linear regression explains the dependent variable Y in relationship to the linear function of K explanatory variable X11, X12, X13 ---- X and a random term U which is normally distributed with zero mean and a unit variance which is independent of U. The multiple linear regression is of a general form.

$Y = B_o + B_1(X_1) + B_2X_2 + B_3X_3 + \text{------} + B_kX_k + U_{i\ \text{where}}$

Y = dependent variable

Xn, n = 1,2 -----k = Independent variable

Bo, B1, B2, P3-----Bk = Unknown populations parameter to be estimated from available data

LEAST SQUARE ESTIMATION OF THE PARAMETERS

Y	X_1	X_2	------------------	X_k
Y_1	X_{11}	X_{12}	------------------	X_{1k}
Y_2	X_{21}	X_{22}	------------------	X_{2k}
Y_3	X_{31}	X_{32}	------------------	X_{3k}
Y_n	X_{ni}	X_{n2}	------------------	X_{nk}

Unbiased estimate of the parameters B_1, B_2, $P_{3,}$ B_k are obtained by least square method. Basically estimate of B_1, B_2 ---- Bk are selected in such a way that the quantity is minimised.

$\sum Ei^2 = \{Y_1 - (B_0 + B_1X_1 + \text{-----} + B_kX_k)\}$ ------ (1)

The quantity expressed as sum of square of error may just be written as $(Y_1 - Y)^2$ ------ (2)

Indicating the fact that the sum of sqaures of the deviations of the observed values of Y from the estimated values of is minimised.

Estimate B_0, B_1, B_2---- Bk of the regression coefficient are obtained by solving the following set of normal equations which we are obtained after the application of the minimization procedure of equation (1)

$EYi = nB_0 + B_1EX_1 + B_2X_2$ ---- B_kEX_{ik}

$EXi\ Yi = B_0 + B_1EX_{ij}X_i + B_2EX_{ij}$ ---- B_kEyX_{ik}

$EXik\ Yi = B_0 + B_1EX_{ik} + B_1EX_{ik}X_{ij} + \text{---} B_2E_{ik}X_{i\,+\,\text{-------}}\, B_k\, X_{ik}y_i$

$X'Y = B = X'y\ (X'X)^{'1}$ where $B =$

$B = X'Y (X'X)^{-1}$

$X'X = nEX_{11} \quad EX_{12} \text{-------} \quad EX_{ik}$

$EX_{11} \; Ex_{11}^{2} \quad EX_{11}X12 \text{------} \quad EX11 \; Xik$

$E \; X_{ik} \; X_{ik} \; X_{ik} \text{------} \; EXik^{2}$

$X'Y - EY_{1}$

$EX_{11}Y_{11}$

$EX_{11}Y_{12}$

$EX_{ik} \; Y_{1}$

It is useful to note that in the general form Y is X (nx1) vector of samples observation X is (nx_k) matrix of the levels of the independent variable. B is a (Kx_1) vector of the regression coefficient and U is (nx_1) vectors of the random errors.

$(X'X)^{-1}$ is the in verse of the matrix X'X which is obtained from the formula

$$A^{-1} = \frac{\text{Adjoint A}}{IAI}$$

All that is needed in other to obtained the inverse are:-

1. Evaluate the determinant of the matrix
2. Obtain the matrix of co-factors from the original matrix
3. Obtain the adjoint of the matrix which is simply the transpose of the matrix of co-factors

ASSUMPTIONS UNDERLYING THE GENERAL MODEL

(i) E(u) = O

(ii) E (u'u) = O^{-2} i.e (u) error term are incorrected

(iii) All the independent variables are fixed and the data are typical of the process, good and valid.,

(iv) There is no exact linear relationship between any of the explanatory variable.

EVALUATING THE MULTIPLE REGRESSION EQUATION

Once the regression equation has been evaluated to determin whether it adequately describe the relationship between the variables and estimation purposes.

However, in doing this, we must look at the properties of the coefficient before carrying out hypothesis test on them.

THE BEST LINEAR UNBIASED ESTIMATOR OF B

The unbiasedness of the statistical properties of the least square estimator B may be investigated as follows:

Mean and variable of B is

$$\hat{B} = (X'X)^{-1} X'Y$$

$$E(\hat{B}) = E(X'X^{-1} X'Y$$

$$= E\{(X'X)^{-1} XB + U\}$$

$$= E[(X'X)^{-1}X'XB + (X'X)^{-1} X'U)]$$

$$= E[B+ (X'X)^{-1} X^{1} (E(u)]$$

But $E(u) = 0$

i.e $E(\hat{B}) = B$

Thus B is an unbiased estimator of B. covariance of B is given as

$$Cov (B) = E(X'X^{-1} X'U (X'X)^{-1} XiU$$

$$= E(X'X)^{-1} XU (X'X)^{-1} X'U$$

$$= (X'X)^{-1} E(U.U)$$

$$= (X'X)^{-1} O^{-2}$$

Since $E(U.U) = O^{-2}$

i.e $Cov (B) = (X'X)^{-1} \; 0^{-2}$

HYPOTHESIS TESTING IN MULTIPLE LINEAR REGRESSION

In multiple regression, the hypothesis usually tested involves the model parameters or regression coefficient, this requires the additional assumptions that:-

1. A random variable Yi (i.e production per year) is statistically

independent possessing a normal distribution with mean E(Yi) = BO + EB1X1 + ----- and variance O^{-2}

2. The error term Ui are independently normally distributed random variable with mean $E(Ui)^2 = O^{-2}$

E(ui) 2 = O-2

To determine whether the overall regression is significant, we consider the following hypothesis

HO: B1 = B2------ Bk

HA: B1 = (for at least one i)

If Ho is rejected, it implies that at least one variable contribute to the determination of Y.

The sum of squares total (SST) is partitioned with some of squares due to regression and error sum of squares, that is

SST = SSR + SSE

where

$$SST = \sum_{i=1}^{n} Yi2 - \frac{(\sum Y)^2}{n}$$

$$SSR = \sum_{i=1}^{n} Bj \quad Siy$$

SSE = SST - SSR

The degree of freedom for SST = n-1 for SSR, we have K as the number of independent variable and for error we have n-k-1

Therefore, the analysis of variance (ANOVA) is summarised in the table below.

ANOVA

Sources of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F-Ratio
Regression	SSR	K	SVR = MSR K	MSR MSE
Error	SSE	n-k-1	n-k-1	MSE
Total	SST	n-1		

To test the hypothesis that all the regression coefficient equal to zero, we compute

F - Ratio = MSR

MSE

We reject the null hypothesis HO if F ratio is greater than F (k, n - k - 1) i.e

F ratio > F (k, n - k - 1) at a given level of significance, we accept if otherwise.

COEFFICIENT OF DETERMINATION

When the explanation variables are more than one we talk of multiple correlation. The square of the correlation is called coefficient of multiple determination and it is denoted by R^2.

The coefficient of determination of R_3 and predicting Y is to consider how much the errors of prediction of Y were reduced by using the information provided by X's.

The partitioning sum of square, the total sum of square can be given as:-

$$TSS = Ey^2 - \frac{E(Y_1)^2}{n} = Y_1 Y - nY^2$$

such that

$SSE = Eei^2 = NEe\ (e - ei) = ee$

Hence the regression SSR is

$SSR = TSS = SSEY^1Y - e\ e - E\ Y_{12}$

$$= Y_1Y - (Y_1Y - BX_1Y) - \frac{EY^2}{n}$$

$$= Y_1Y - (Y_1Y - BX_1Y) - \frac{E(Yi)^2}{n}$$

$SSR = BX1Y - ny^2$

Hence the coefficient of determination R^2 is written as

$$R^2 = SSR = \frac{BX1Y - NY^2}{SST\ YIY - NY^2}$$

$$= \frac{SST - SSE}{SST} = 1 - \frac{SSE}{SST}$$

$$R^2 = \frac{SSR}{SST}$$

When R^2 is multiplied by 100%, this gives the proportion of SST that explains the fitted model.

The value of R^2 lies between 0 and 1. The higher the R^2, the greater the percentage of the variation explained by the regression plane, that is the better the goodness of fit of the regression plane to the sample observation. The closer the R^2 to zero the worse the fit.

Chapter Three

RESEARCH METHODOLOGY

The method to be adopted in the data analysis of this project is the use of correlation and multiple linear regression analysis. This will increase the strength of relationship between production, mechanical effects, technological and services effects and non machinery effects for a period of ten years. The general model is

$Y = B_0 + B_1X_1 + B_2X_2 + B_3X_3 + U_1$ where

B_0 is the constant

X_1 is she mechanical effects

X_2 is the technical and services effects

X_3 is the non machinery effects.

The above factors measures the rate of changes for each of the independent variables. The U_1 stands for the error term or the disturbance terms which is independent and randomly distributed with mean and variance.

METHOD OF DATA COLLECTION

The method of data collection adopted in this project is the documentary method or secondary data. This means the extraction of published data for the purpose of further statistical investigation and analysis. Data is the raw material with which important duty of statistical system can be performed depending on the kinds of objective.

Data collection could be through controlled experiment, census and surveys or even by summarizing routine report of day to day operation of an organisation. Raw data used in this project where collected from the production department of the Nigerian Bottling Company Plc, Kaduna and it is used as a secondary data in this project work.

The data collected for analysis in this project corrected on:-

(i) Total Production of soft drinks

(ii) Total Mechanical Effects

(ii) Technical and Services effects

(iv) Non Machinery Effects

The data covered the period of 10 years (1987 - 1996)

VARIABLE REPRESENTATION AND DEFINITIONS

All the data used in this project are supplied from the production department of Nigerian Bottling Company Plc, Kaduna State.

The data are presented in a tabular form with column one showing the period 1987 - 1996. Column two shows the production for each year (Y), column three shows the mechanical effect for each year (X_1), column four shows the technical and services effects per year (X_2) and column five shows non-machinery effects for each year (X_3).

Chapter Four

4.0 PROGRAMME DESIGN

This part is made up of the programme design methodology adopted in developing the computer program for the mathematical model of populations Estimation from its mathematical algorithm.

A program is a sequence or list of instructions written in a specified computer language. It could be in BASIC, PASCAL COBOL, FORTRAN etc. A program can also be defined as an algorithm specifically expressed in a particular high level language capable of executing by a computer machine.

Design methodology is a well defined approach used in setting the program, sets of instructions to execute a particular procedural task.

Program design methodology is the approach for designing program sets of instruction for execution of a procedural task. There are 2 major types of program design approaches for any given programming language:

(a) **Top-down Design Approach:** This is a design approach which the program sets of instructions are developed starting from the most complex stage and sequentially follow the trend down to the simplest stage.

(b) **Bottom-up Design Approach:** This design approach is directly the opposite of Top-Down Design Approach. It is the development of program sets of instructions starting from the simplest to the most complex stage.

The design approach used in developing both the algorithm of the program itself is Top-Down Design Approach. The design approach is applied because of its numerous advantages over the Bottom-Up Design Approach. Some of these advantages are here stated.

(i) Program Errors are easily traced in Top-Down Design

(ii) Since program Errors are easily detectable, debugging of such errors are also easily done.

(iii) To-Down approach allows for easy development and quick understanding of the program.

(iv) Program developed using Top-Down technique are always shorter, clearer and neater than program developed using bottom-up design technique.

(v) In Top-Down technique, proper structuring of program sets of instructions are always feasible.

4.1 PROGRAMMING LANGUAGE

Programming is a way of communicating with the computer. A computer is a electronic machine which has the ability to accept input and process the input and generate output.

A programming language is a tool which is used in communicating with the computer. These are sets of instruction, which must be in a specified syntax that computer can understand and execute. This is called Computer Programming language. Programming language therefore can be defined as finite sets of instructions in a specified syntax that can be interpreted and executed by a computer to accomplish a given procedural task.

Any computer programming language must have some characteristics in common. These characteristics include.

(i) **Finiteness:** It must be finite sets of instructions

(ii) **Precision:** The program sets of instruction must be precise and void of ambiguity and assumption

(iii) **Specification:** The syntax to be used must be well specified.

(iv) **Output:** Any programming language must be capable of generating a result after execution, it must be void of endless repeatation

(v) **Termination:** The execution of the programme must be capable of termination in case of instructions that have repeated execution.

(vi) **Flexibility:** A good programming language must be amenable to changes when required

4.2 TYPES OF PROGRAMMING LANGUAGE

Machine Language:

Programs are written in operation codes and machine address. The operation code implies that the instruction given is in binary digits which implies series of zeros and one (0 and 1) e.g 00011 could represent addition 00010 subtraction etc. This differs from one machine to another. Machine codes are so cumbersome that they cannot be easily remembered anyhow, one major benefit of writing in machine language is that it has a speed of execution, for the fact that it is written in the language of computer without any translator.

Because of the cumbersome nature, time consuming and ambiguity of machine language another way of communicating with the computer was deviced or developed. These are called LOW LEVEL PROGRAMMING LANGUAGE and HIGH LEVEL PROGRAMMING LANGUAGE.

LOW LEVEL PROGRAMME LANGUAGE:

These are the programme language that computer can execute their sets of instructions directly without the use of a translator, this include machine language and assembly language.

HIGH LEVEL LANGUAGE:

These are sets of instruction that computer can only interpret and execute with the aid of either interpreter or compiler. They include languages like. BASIC, COBOL, PASCAL, FORTAN, DBASE, CLIPPER etc. Any of the high level language are standardised and can be employed in developing a particular programme to accomplish a procedural task.

4.3 ALGORITHM

Ordinary algorithm can be regarded as any special method of solving a certain kind of problem, even complex types.

Algorithm can be defined as a finite set of instructions each of which has a clear meaning and can be carried out in a fixed order the a finite amount of effort and time in order to accomplish a particular task. An algorithm is composed of finite steps each of which may require more operations. In a null shell Algorithm is a step by step procedure of breaking down complex problems into simple problem for proper understanding and simplicity.

4.4 PROPERTIES OF ALGORITHM

All Algorithms have two things in common

(i) A set of permissible operations that can be performed on given information or data (e.g summation subtraction etc.)

(ii) The given information on which operation should be performed (e.g the given constant a, b and c of a quadratic equation, $ax^2+bx+c = 0$) called the input data.

To be a valid algorithm therefore, a sequence of instructions must be capable of at least three properties.

(i) Each instruction must used some basic sets of operation available in computer such as addition, multiplication, exponenciation etc.

(ii) Produces a result in a specified number of sets and in a finite time. That is to say an algorithm should not loop indefinitely. For this reason there are control structures which serves as a building block for any algorithm. They include the following.

(a) **Sequencing:** This is the list of instructions in the order at which they are to be performed.

(b) **Selection Constrant:** This is the conditional branching of the algorithm

(c) **Iteration:** It is the repetition of a certain operation within the programme several times.

4.5 TOOLS OF ALGORITHM

In order to design and algorithm, some essential tools are needed, they include

(i) Truth Table
(ii) Psudocode
(iii) Nassi-Schendermen Chart
(iv) Flow Chart

Any of these tools can be used to design a particular algorithm. But it must be clearly understood that among the four tools, only the flow chat is standardised and move widely used, with less advantages and of the widest scope of application.

Though, in the study of programming and algorithm, Pseodocode is widely used too but not standardised as flow chart and can be present the way a user likes best.

Years	Production Per Years (Y_1)	Mechanical Effects (X_1)	Technical & Services Effect (X_2)	Non Machinery Effects (X_3)
1987	1,148,243	710,210	515,804	536,647
1988	1,061,353	607,602	519,350	541,677
1989	1,176,082	658,121	510,185	556,867
1990	1,169,859	687,954	506,818	529,868
1991	1,092,082	687,169	510,516	536,317
1992	971,309	615,000	514,169	516,318
1993	693,130	549,723	501,832	506,700
1994	931,958	625,300	510,682	523,747
1995	907,660	519,861	537,451	512,147
1996	921,896	632,439	539,207	613,035

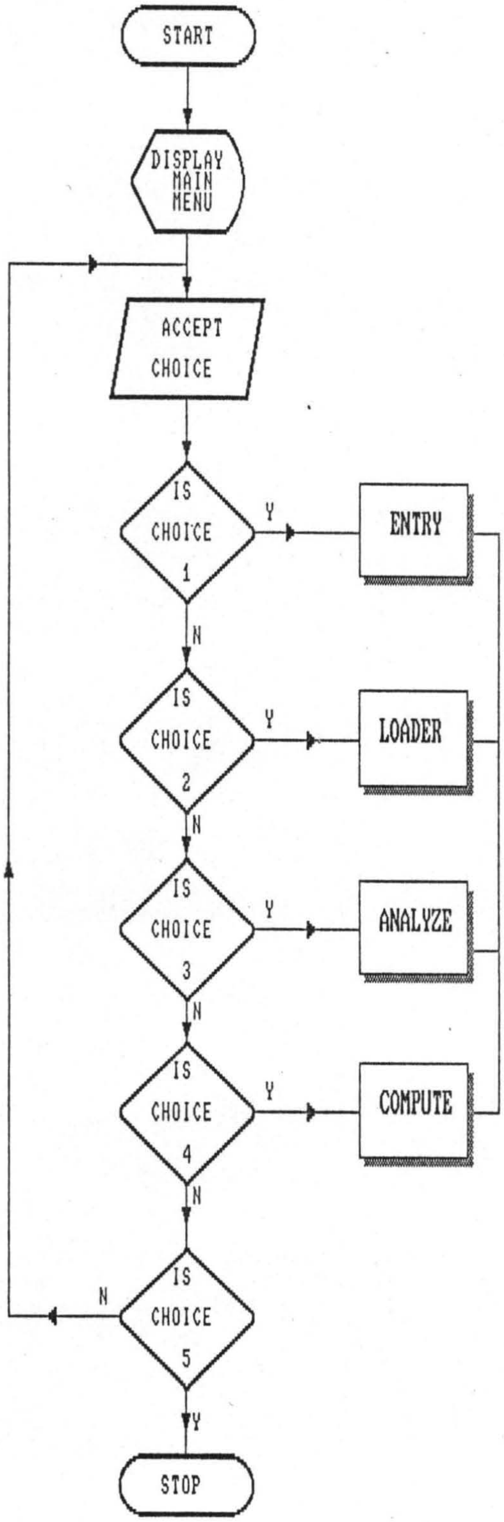
Source: Production Department Nigerian Bottling Company Plc, Kaduna

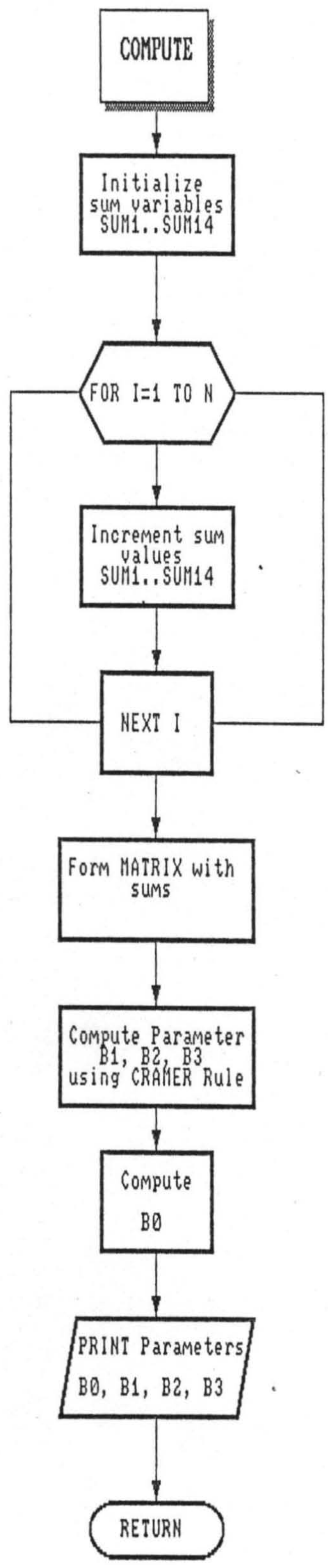
ANALYSIS OF DATA

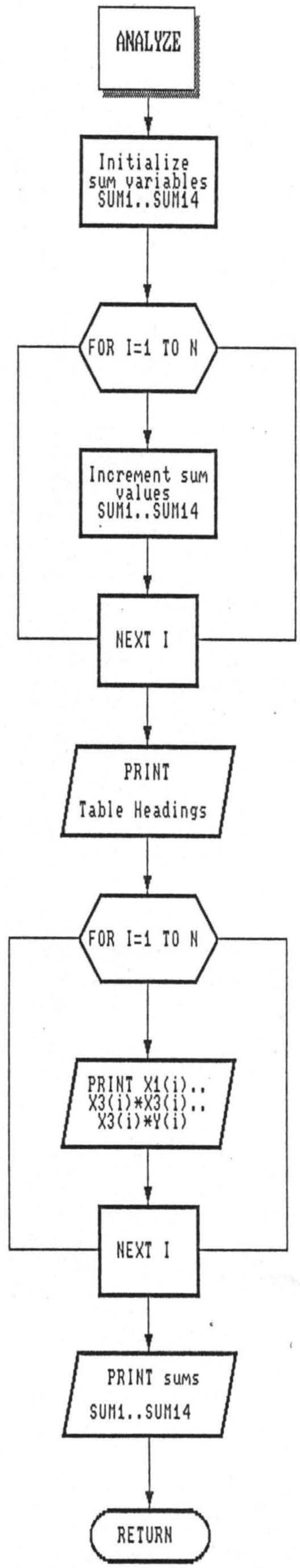
YEAR	X1	X2	X3	Y	YX1	YX2	YX3	X1X2	X1X3	X2X3	Y^2	X1^2	X2^2	X3^2
1987	7.10	5.16	5.37	11.48	81.51	59.24	61.65	36.64	38.13	27.71	131.79	50.41	26.63	28.84
1988	6.08	5.19	5.42	10.61	64.51	55.07	57.51	31.56	32.95	28.13	112.57	36.97	26.94	29.38
1989	6.58	5.10	5.57	11.76	77.38	59.98	65.50	33.56	36.65	28.41	138.30	43.30	26.01	31.02
1990	6.88	5.07	5.30	11.70	80.50	59.32	62.01	34.88	36.46	26.87	136.89	47.33	25.70	28.09
1991	6.87	5.11	5.36	10.92	75.02	55.80	58.53	35.11	36.82	27.39	119.25	47.20	26.11	28.73
1992	6.15	5.14	5.16	9.71	59.72	49.91	50.10	31.61	31.73	26.52	94.28	37.82	26.42	26.63
1993	5.50	5.02	5.07	6.93	38.11	34.79	35.14	27.61	27.89	25.45	48.02	30.25	25.20	25.70
1994	6.25	5.11	5.24	9.32	58.25	47.63	48.84	31.94	32.75	26.78	86.86	39.06	26.11	27.46
1995	5.20	5.37	5.12	9.08	47.22	48.76	46.49	27.92	26.62	27.49	82.45	27.04	28.84	26.21
1996	6.32	5.39	6.13	9.22	58.27	49.70	56.52	34.06	38.74	33.04	85.01	39.94	29.05	37.58
	62.93	51.66	53.74	100.73	640.48	520.18	542.28	324.88	338.75	277.79	1035.42	399.32	267.01	289.64

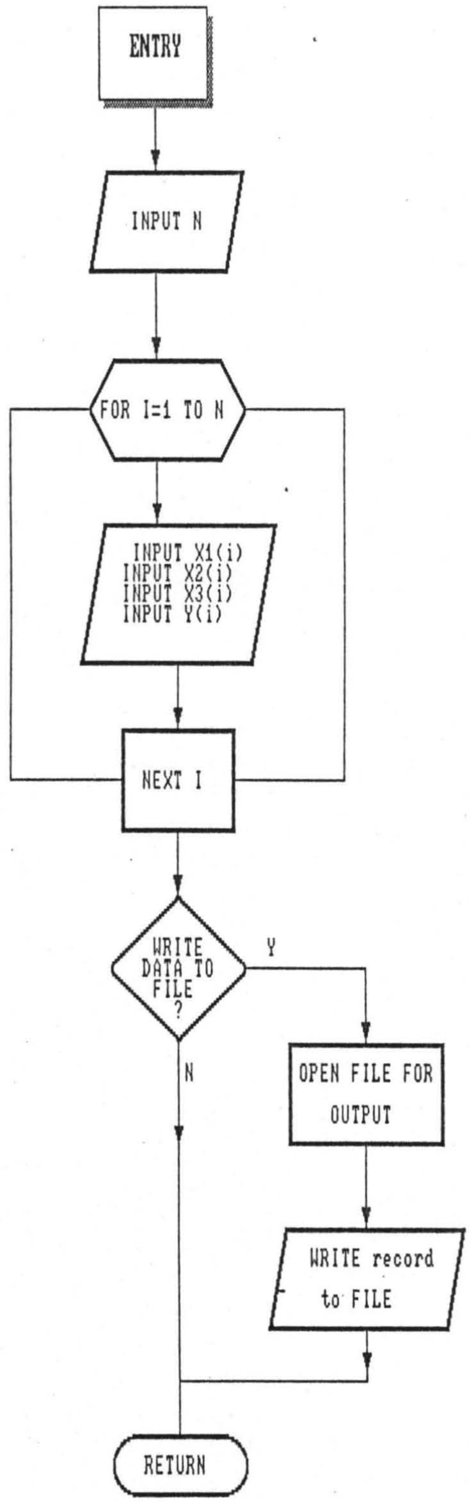
*Note: All values are in HUNDREDS OF THOUSANDS

MAIN PROGRAM FLOWCHART




COMPUTE
Initialize sum variables SUM1..SUM14
FOR I=1 TO N
Increment sum values SUM1..SUM14
NEXT I
Form MATRIX with sums
Compute Parameter B1, B2, B3 using CRAMER Rule
Compute B0
PRINT Parameters B0, B1, B2, B3
RETURN


ANALYZE
Initialize sum variables SUM1..SUM14
FOR I=1 TO N
Increment sum values SUM1..SUM14
NEXT I
PRINT Table Headings
FOR I=1 TO N
PRINT X1(i).. X3(i)*X3(i).. X3(i)*Y(i)
NEXT I
PRINT sums SUM1..SUM14
RETURN


ENTRY
INPUT N
FOR I=1 TO N
INPUT X1(i)
INPUT X2(i)
INPUT X3(i)
INPUT Y(i)
NEXT I
WRITE DATA TO FILE ?
Y
N
OPEN FILE FOR OUTPUT
WRITE record to FILE
RETURN


LOADER
OPEN FILE
FOR INPUT
READ record
fron FILE
PRINT loaded
data on screen
RETURN

4.5.2 APPEND RECORD MODULE

```
'****************************************************
'*** NAME   : HARRY UHUNAMURE
'*** NUMBER: PGD/MCS/97/307
'****************************************************
DECLARE SUB det (matx!, a!)
DIM X1(50), X2(50), X3(50), YX(50), mat(50, 50), Y(50)
DIM SHARED matx(50, 50)
'--------------Introduction Screen Design
SCREEN 9
FOR i = 0 TO 100 STEP 20
LINE (0 + i, 0 + i)-(639 - i, 329 - i), (i / 5) + 1, BF
NEXT i
LOCATE 8, 18: PRINT "E C O N O M E T R I C   A N A L Y S I S   O N"
LOCATE 11, 25: PRINT "P R O D U C T I O N   R O L E"
ANS$ = INPUT$(1)

SCREEN 2
SCREEN 0
COLOR 14, 1
ANS = 0
DO WHILE ANS <> 5
CLS
LOCATE 4, 30: PRINT "********************"
LOCATE 5, 30: PRINT "* M A I N   M E N U *"
LOCATE 6, 30: PRINT "********************"
LOCATE 8, 30: PRINT "1. ENTER VALUES FROM KEYBOARD"
LOCATE 10, 30: PRINT "2. LOAD VALUES FROM FILE "
LOCATE 12, 30: PRINT "3. DATA ANALYSIS"
LOCATE 14, 30: PRINT "4. COMPUTE PARAMETERS"
LOCATE 16, 30: PRINT "5. QUIT"
LOCATE 19, 30: PRINT "ENTER CHOICE (1-5):"
   ANS = VAL(INPUT$(1))
   DO WHILE ANS < 1 OR ANS > 5
      ANS = VAL(INPUT$(1))
   LOOP
   GOSUB MAINPRG
LOOP
END

MAINPRG:                              '-----Main Program
SELECT CASE ANS
    CASE 1
       GOSUB ENTRY
    CASE 2
       GOSUB LOADER
    CASE 3
       GOSUB ANALYZE
    CASE 4
       GOSUB COMPUTE
END SELECT
RETURN


ENTRY:
CLS
INPUT "ENTER NUMBER OF DATA VALUES: "; N
FOR i = 1 TO N
  INPUT "ENTER YEAR"; YEAR(i)
  PRINT "ENTER VALUE OF X1("; i; ")": INPUT X1(i)
  PRINT "ENTER VALUE OF X2("; i; ")": INPUT X2(i)
  PRINT "ENTER VALUE OF X3("; i; ")": INPUT X3(i)
```

```
PRINT #2, TAB(45); "ANALYSIS OF DATA"
PRINT #2, TAB(45); "****************"
PRINT #2,
PRINT #2, "****************************************************";
PRINT #2, "****************************************************"
PRINT #2, "* YEAR     X1      X2      X3      Y      YX1      YX2      YX3";
PRINT #2, "   X1X2   X1X3   X2X3     Y^2   X1^2   X2^2   X3^2 *"
PRINT #2, "****************************************************";
PRINT #2, "****************************************************"
FOR i = 1 TO N
  PRINT #2, "*"; YEAR(i);
  PRINT #2, USING "####.##"; X1(i); X2(i); X3(i); Y(i); Y(i) * X1(i);
  PRINT #2, USING "####.##"; Y(i) * X2(i); Y(i) * X3(i); X1(i) * X2(i);
  PRINT #2, USING "####.##"; X1(i) * X3(i); X2(i) * X3(i);
  PRINT #2, USING "####.##"; Y(i) ^ 2; X1(i) ^ 2; X2(i) ^ 2; X3(i) ^ 2;
  PRINT #2, " *"
NEXT i
PRINT #2, "****************************************************";
PRINT #2, "****************************************************"
PRINT #2, TAB(7); "*"; USING "####.##"; sum1; sum2; sum3; sum4; SUM5;
PRINT #2, USING "####.##"; SUM6; SUM7; SUM8; SUM9; SUM10;
PRINT #2, USING "####.##"; SUM11; SUM12; SUM13; SUM14;
PRINT #2, " *"
PRINT #2, TAB(7); "*********************************************";
PRINT #2, "****************************************************"
PRINT #2,
PRINT #2, "*Note: All values are in HUNDREDS OF THOUSANDS"
PRINT "PLEASE CHECK OUTPUT FILE [OUT1.OUT] FOR OUTPUT"
ANS$ = INPUT$(1)
CLOSE #2
RETURN

COMPUTE:
CLS
sum1 = 0: sum2 = 0: sum3 = 0: sum4 = 0: SUM5 = 0
SUM6 = 0: SUM7 = 0: SUM8 = 0: SUM9 = 0: SUM10 = 0
SUM11 = 0: SUM12 = 0: SUM13 = 0: SUM14 = 0
FOR i = 1 TO N
  sum1 = sum1 + X1(i)
  sum2 = sum2 + X2(i)
  sum3 = sum3 + X3(i)
  sum4 = sum4 + Y(i)
  SUM5 = SUM5 + (Y(i) * X1(i))
  SUM6 = SUM6 + (Y(i) * X2(i))
  SUM7 = SUM7 + (Y(i) * X3(i))
  SUM8 = SUM8 + (X1(i) * X2(i))
  SUM9 = SUM9 + (X1(i) * X3(i))
  SUM10 = SUM10 + (X2(i) * X3(i))
  SUM11 = SUM11 + (Y(i) ^ 2)
  SUM12 = SUM12 + (X1(i) ^ 2)
  SUM13 = SUM13 + (X2(i) ^ 2)
  SUM14 = SUM14 + (X3(i) ^ 2)
NEXT i
mat(1, 1) = SUM12
mat(1, 2) = SUM8
mat(1, 3) = SUM9
mat(2, 1) = SUM8
mat(2, 2) = SUM13
mat(2, 3) = SUM10
mat(3, 1) = SUM9
```

```
YX(3) = SUM7

PRINT "ORIGINAL MATRIX OF VALUES"
PRINT
FOR i = 1 TO 3
FOR j = 1 TO 3
  PRINT USING "####.##"; mat(i, j);
  matx(i, j) = mat(i, j)
NEXT j
PRINT
NEXT i
det matx, detmain

PRINT : PRINT
PRINT "ROW 1 SUBSTITUTION MATRIX"
PRINT
FOR i = 1 TO 3
FOR j = 1 TO 3
  matx(i, j) = mat(i, j)
  matx(i, 1) = YX(i)
  PRINT USING "####.##"; matx(i, j);
NEXT j
PRINT
NEXT i
det matx, deta

PRINT : PRINT
PRINT "ROW 2 SUBSTITUTION MATRIX"
PRINT
FOR i = 1 TO 3
FOR j = 1 TO 3
  matx(i, j) = mat(i, j)
  matx(i, 2) = YX(i)
  PRINT USING "####.##"; matx(i, j);
NEXT j
PRINT
NEXT i
det matx, detb

PRINT : PRINT
PRINT "ROW 3 SUBSTITUTION MATRIX"
PRINT
FOR i = 1 TO 3
FOR j = 1 TO 3
  matx(i, j) = mat(i, j)
  matx(i, 3) = YX(i)
  PRINT USING "####.##"; matx(i, j);
NEXT j
PRINT
NEXT i
det matx, detc
PRINT : PRINT
b1 = deta / detmain
b2 = detb / detmain
b3 = detc / detmain
PRINT
PRINT "PARAMETERS B1, B2, B3"
PRINT "B1 = "; b1
PRINT "B2 = "; b2
PRINT "B3 = "; b3
bo = sum4 - (b1 * sum1) - (b2 * sum2) - (b3 * sum3) \
```

```
a$ = UCASE$(INPUT$(1))
   DO WHILE UCASE$(a$) <> "Y" AND UCASE$(a$) <> "N"
      a$ = INPUT$(1)
   LOOP
IF a$ = "Y" THEN
   OPEN "ECO.DAT" FOR OUTPUT AS #1
   WRITE #1, N
   FOR i = 1 TO N
        WRITE #1, YEAR(i)
        WRITE #1, X1(i)
        WRITE #1, X2(i)
        WRITE #1, X3(i)
        WRITE #1, Y(i)
   NEXT i
   CLOSE #1
END IF
RETURN

LOADER:
CLS
   OPEN "ECO.DAT" FOR INPUT AS #1
   INPUT #1, N
   FOR i = 1 TO N
        INPUT #1, YEAR(i)
        INPUT #1, X1(i)
        INPUT #1, X2(i)
        INPUT #1, X3(i)
        INPUT #1, Y(i)
   NEXT i
   CLOSE #1
PRINT "DATA HAS BEEN SUCCESSFULLY LOADED FROM FILE"
PRINT
PRINT "NUMBER OF DATA = "; N
PRINT
PRINT " YEAR      X1      X2      X3      Y"
FOR i = 1 TO N
    PRINT YEAR(i); USING "####.##"; X1(i); X2(i); X3(i); Y(i)
NEXT i
PRINT
PRINT "PRESS ANY KEY TO CONTINUE": a$ = INPUT$(1)
RETURN

ANALYZE:
OPEN "OUT1.OUT" FOR OUTPUT AS #2
CLS
sum1 = 0: sum2 = 0: sum3 = 0: sum4 = 0: SUM5 = 0
SUM6 = 0: SUM7 = 0: SUM8 = 0: SUM9 = 0: SUM10 = 0
SUM11 = 0: SUM12 = 0: SUM13 = 0: SUM14 = 0
FOR i = 1 TO N
  sum1 = sum1 + X1(i)
  sum2 = sum2 + X2(i)
  sum3 = sum3 + X3(i)
  sum4 = sum4 + Y(i)
  SUM5 = SUM5 + (Y(i) * X1(i))
  SUM6 = SUM6 + (Y(i) * X2(i))
  SUM7 = SUM7 + (Y(i) * X3(i))
  SUM8 = SUM8 + (X1(i) * X2(i))
  SUM9 = SUM9 + (X1(i) * X3(i))
  SUM10 = SUM10 + (X2(i) * X3(i))
  SUM11 = SUM11 + (Y(i) ^ 2)
  SUM12 = SUM12 + (X1(i) ^ 2)
```

ORIGINAL MATRIX OF VALUES

399.32	324.88	338.75
324.88	267.01	277.79
338.75	277.79	289.64

ROW 1 SUBSTITUTION MATRIX

640.48	324.88	338.75
520.18	267.01	277.79
542.28	277.79	289.64

ROW 2 SUBSTITUTION MATRIX

399.32	640.48	338.75
324.88	520.18	277.79
338.75	542.28	289.64

ROW 3 SUBSTITUTION MATRIX

399.32	324.88	640.48
324.88	267.01	520.18
338.75	277.79	542.28

PARAMETERS B1, B2, B3
B1 = 1.99889
B2 = .1792936
B3 = -.6375424
Bo = •6.093319~~E-02~~

NOTE: TO OBTAIN THE ABOVE MATRIX, THIS FORMULA WAS APP

$$\begin{bmatrix} \sum X_1X_1 & \sum X_1X_2 & \sum X_1X_3 \\ \sum X_2X_1 & \sum X_2X_2 & \sum X_2X_3 \\ \sum X_3X_1 & \sum X_3X_2 & \sum X_3X_3 \end{bmatrix}$$

Chapter Five

From the above analysis of computation we have

$B_0 =$ 1.99889

$B_1 =$ 0.1792936

$B_2 =$ 0.6375424

$B_3 =$ 6.093319

Hence the regression is

$Y = 6.09 + 1.99ZX_1 + 0.179X_2 - 0.638X_3$

We can see that there is a positive relationship between the production of coca cola products mechanical effects are positive (X_1) in relation to production. Also, we find that the technical effects are positive in relationship to the production. But the non-machinery effects are negative showing weak correlation

Here, we find that mechanical factors greatly affects the productions of coca cola products in that the parameter of the factors is positive. These mechanical factors includes machines that are used in the whole processes of production of coca cola products, these include the washing machine, the conveyors (carrying the bottles from washer to filler, then to the crown etc.), the crown fitter. Also we see that technical effect, have positive relationship to production of coca cola products. It refers to skill of the labour force. Undoubtedly skilled labour force will surely deliver better results than unskilled labour force. In other to have a good yield of production, skilled labour (Graduates) should be employed to head the sub-units of the company, such as quality control sections, electrical section, production section, sales, account sections etc.

The non-machinery factors, affects production level but not as much as mechanical and technical effects. Non-machinery factors include the mixing of the concentrates to produce the required taste, quantity, colour, hygiene etd. These are fundamentally important, as well but we find out from our analysis that there is a weak correlation (because of the negative sign). A general analysis of these three factors will produce a very strong relationship showing that the three factors affects the production of coca cola products.

5.2 RECOMMENDATION

For a manufacturing company like Nigerian Bottling Company Plc, Apapa Branch to grow successfully, it has to ensure proper control on mechanical factors, technical and non-machinery factors so as to enhance maximum output.

Talking about mechanical effects we refer to machines used in production, vehicles for conveying the products to customers, generators, every mechanical gadgets involved in production. For technical effects, we mean skilled manpower harnessing other human resources (unskilled) to bring out the desired excellence in the campaign. Though, by our analysis non-machinery effects proves not too significant factor in the production of coke produce, however, it should not be taken with levity. The importance of having the right proportion of sugar, concentrates and other ingredients cannot be overemphasised for this is the stage that determined whether there will be sales or not this aspects links the company to the customers. For, if the ingredients are not in the right proportion, there won't be good sales and eventually the aim of maximising profits will not be met.

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