

**COMPUTER SOLUTION TO PRODUCTION MODELING  
IN A MANUFACTURING COMPANY  
(A CASE STUDY OF NIGERIAN BOTTLING COMPANY, Ilorin)**

**BY**

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## **ABSTRACT**

The need to plan production is of utmost importance to the management of any manufacturing outfit. Efforts geared at computerizing analysis that can aid such planning are hence worthwhile. This project is one such effort.

This work is a successful attempt at computerizing time series analysis and forecasting of production data. The software, developed in Qbasic, can analyze any monthly time series data and produce forecasts and hence, not restricted to production data alone. The software exploits the highly interactive nature of Qbasic language and is user-friendly.

DEDICATION

To my daughter, Fatimat Ajibola

## **ACKNOWLEDGEMENT**

I must first of all thank Allah for his mercies.

Great thanks to my project supervisor, Prof. K.R. Adeboye for his invaluable contribution to this project work.

I must also acknowledge the efforts of all lecturers in the Department of Maths & Computer Science, Federal University of Technology, Minna for imparting the knowledge.

I equally acknowledge my husband, Mr Bolarinwa, I.A of the Department of Maths, Statistics and Computer studies, The Federal Polytechnic, Bida for his support.

## CERTIFICATION

We, the undersigned certify that this project was carried out by Odede, B. T. of the Department of Mathematics & Computer Science, Federal University of Technology, Minna, Nigeria.

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## CHAPTER ONE

### GENERAL INTRODUCTION

#### 1.1 Introduction

In any profit oriented outfit, the need to meet customers' taste and demand at the appropriate time is uppermost in the minds of managers.

Gone were those days when planning was based on the rule of thumb. These days, planning process is essentially based on carefully analyzed data. Results of such analysis are usually in numerical terms and as such can be numerically and precisely interpreted. It is not just enough to say that the price of an item rises every January, but of interest in addition to this is by how much or by what percentage?

This will definitely create room for comparison with prices of other goods and hence places the investor in a better position as regards which items to invest on. In a similar manner, it is equally not enough to say that the demand for coca-cola increases during the dry season. Although, this is informative to the management of the company, it will be in the company's best interest if such can be put in numerical term so that such knowledge of the expected demand will help in future production planning.

To evolve such quantitative description, an attempt must be made at describing the movements of the series from time to



process, one can now project into the future. This is forecasting.

Since planning is critical to the success of any organization, it must be based on figures that are reliable. Reliable in the sense that the raw data must be reliable and the method of analysis must be correct so that results produced can be worth planning with. The reliability of such produced results will in turn depend on whether factors that influenced the pattern of the collected figures will behave alike within the period covered by the planning process.

It is worth mentioning that drastic changes in government policies can have drastic effects on planning as projected results may end up not being realized. There is always little or nothing managements of private organizations can do about this. Options available to such managements are not within the scope of this work.

This has been mentioned to forestall a situation whereby the software will be condemned on the basis that projected figures are much different from realized figures. All things being equal, the software will produce good and reliable results.

Although, production data generated by Nigeria Bottling Company will be used in test running the software, this does not mean that its use is restricted to Nigeria Bottling Company alone. In fact it is not even restricted to production data alone, rather it can be utilized by any one wishing to

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**A project submitted to the Department of Mathematics and  
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Post-Graduate Diploma in Computer Science**

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have a better understanding of his monthly time series data with the ultimate aim of forecasting future values. Thus the software should be of interest to any organization that generates monthly data.

### **1.2 Scope and Limitations**

The data collected covered a period of seven years, i.e (1990-1996) and the software can be used by any one wether individual or corporate willing to perform time series analysis on monthly data.

The software can not perform analysis on quarterly data except for minor adjustments are made. The software is only restricted to time series analysis on monthly basis and cannot be used on data collected on basis of longer time periods like quarters, six monthly, yearly etc.

### **1.3 Aims and Objectives**

The main aim of this work is to develop a software that can be used to carry out time series analysis. That is the software should be able to decompose a time series into its various components.

The main objectives of the work are :

- i) Fitting the annual trend equation to the monthly data collected.
- ii) Conversion of fitted annual equation to monthly equation so that monthly trend projections can be made.

- iii) Estimation of the seasonal component via computation of the seasonal index.
- iv) Production of forecasts on the basis of trend and seasons estimates.

## CHAPTER TWO

### METHODOLOGY

#### 2.1 Components of Time Series

A time series is a set of quantitative data collected sequentially in time i.e observations obtained at regular periods over a period of time. Such time period could be daily, weekly, monthly, yearly, etc. So students' enrolments at the Federal University of Technology, Minna over say eight years constitute a time series. Other examples include annual non-oil exports by Nigeria over years, monthly sales of beer by a brewing company etc. One thing that these three examples have in common is that they are time dependent i.e they are all described with respect to time and hence the name time series.

All time series are expected to assume varying figures from time to time. Some factors are obviously responsible for the fluctuations. These factors are referred to as components of time series. Precisely, a time series is regarded as the result of the interaction of these components. These components are namely trend, seasonal, cyclical and random or irregular components.

**Trend Component** : This is the overall or persistent long-term, upward or downward pattern of movements. Such movements could be due to technological changes, changes in population, values, etc. Its duration is several years.

**Seasonal Component :** These are fairly regular periodic fluctuations which occur within each 12-month period, year after year. Causes include weather conditions, social customs, religious customs, etc. Its duration is usually within twelve months.

**Cyclical Component :** These are repeating up and down swings or movements through four phases i.e from peak (prosperity) to contraction (recession) to depression to expansion or recovery. Its duration is usually two to ten years with differing intensity for a complete cycle.

**Irregular Component :** These are erratic or residual fluctuations which exist in a time series after taking into account the three other components. They do not occur with any statistical regularity. Its occurrence is due to unforeseen events like fire outbreak, war, strike, earthquake, etc.

## **2.2 Time Series Analysis**

Time series analysis is the isolation of the components of the series so that the effect of each component can be measured. The analysis is based on one fundamental assumption that factors which affected the series under study during the period covered by the series will continue to behave in more or less the same manner in the future. So, if a forecast is being made, the analysis is assuming that the policies particularly as they affect the series remain fairly stable.

Time series analysis has two perspectives. The first is

stationary time series analysis which utilizes Auto Regressive Integrated Moving Average (ARIMA) models for explaining the behaviour of time series. The second is the traditional approach which views the time series as either addition of its components (additive) or product of its components (multiplicative model).

In this work, the multiplicative model will be entertained. Usually when analyzing monthly data, attention is only paid to trend and seasonal effects for the purpose of explaining the behaviour of the series and forecasting.

In analyzing the trend, linear behaviour is always assumed for the series. The linear equation is given as

$$T = a + bX + e$$

where

T is the dependent variable i.e the trend component of time series variable

X is the independent variable and it is the time variable

a is the intercept and it shows part of trend that is time independent.

b is the slope and it is the change in T per unit change in X

e is the error term

The parameters a and b of the linear model are estimated by least square estimation and the results are

$$b = \frac{n \sum xy - \sum x \sum y}{\sum x^2 - (\sum x)^2}$$

$$a = \frac{\sum Y}{n} - \frac{b \sum X}{n}$$

But if the coding is done such that

$$\sum X = 0$$

then,

$$b = \frac{\sum XY}{\sum X^2}$$

$$a = \frac{\sum Y}{n}$$

Since the software to be developed will code such that  $\sum x = 0$ , the latter versions of the estimates will be used.

The approach to be adopted in the trend fitting is to first sum figures for each year to get T, code the time variable accordingly and regress T on X to arrive at annual trend equation which is then converted to monthly equation accordingly.



If a and b are respectively the intercept and slope of the annual equation, then

i) for odd number of years, the monthly equation is

$$T = \frac{a}{12} + \frac{bX}{144}$$

ii) for even number of years, the monthly equation is

$$T = \frac{a}{12} + \frac{bX}{72}$$

Since we are interested in monthly forecast, one of these equations is used depending on whether the number of years is odd or even to estimate the trend. This trend estimate is subsequently combined with estimate of seasonal components to produce forecasts. The software will code the time variable accordingly, estimate the annual equation and convert it to monthly equation by making appropriate choice out of the two stated monthly equations.

The seasonal component is estimated by "seasonal index". It is the seasonal index that measures the fluctuation of series from month to month throughout a typical year. Seasonal index is defined as a set of numbers showing relative values of a variable during the months of the year. Twelve values expressed in percentages, each representing a month, constitute the seasonal index. Each figure is usually interpreted relative to monthly average.

For example, an index of 120 % for the month of April

indicates that the series values for April are typically 20 % higher than monthly average while 90 % means 10 % less than monthly average. Although, the Ratio- to-Moving Average method is the most tedious in terms of ease of calculation, it has been acclaimed the best and hence is to be used for estimating seasonal components. The steps involved are :

- i) compute 12-month moving total for the series
- ii) compute 2-month moving total of results from step (ii)
- iii) compute 12-month centred moving average by dividing results from step(ii) by 24
- iv) express original figure for each month as a percentage of the corresponding centred moving average
- v) find the average percentages for corresponding months of different years using the mean
- vi) express each mean from step (v) as a percentage of their own mean. The results constitute the required seasonal index.

Forecasting will be carried out by combining the monthly trend estimate and the corresponding index.

$$\text{Forecast} = \text{Trend} \times \text{Seasonal index}$$

Given the year and month for which forecast is desired, the software will produce forecast for 12 consecutive months starting from the month earlier indicated.

### 2.3 Time Series Models

Two models which fall within the class of traditional time series models are the additive model and the multiplicative model.

The additive model is given as

$$Y = T + S + C + I$$

and the multiplicative model is

$$Y = T * S * C * I$$

where:

**Y** is the time series variable

**T** is the trend component

**S** is the seasonal component

**C** is the cyclical component

**I** is the irregular component

## CHAPTER THREE

### LITERATURE REVIEW

#### 3.1 General Review of Time Series Works

Time series works can be fundamentally divided into traditional time series modelling works (involving the multiplicative and additive models) and the Box-Jenkins approach (involving Autoregressive-Integrated -Moving Average (ARIMA) models).

Mark L. Berenson and David M. Levine (1986) treats elaborately, the traditional time series modelling with special emphasis on the multiplicative model. They discussed meaningfully the methods of fitting trend including the moving average method, ordinary least squares approach, exponential smoothing and Holt-Winters approach to forecasting. Both the exponential smoothing and the Holt-Winters approaches are particular situations of the Box-Jenkins models. Instead of weighing all items equally as is done with moving average approach, exponential smoothing ensures that the weights assigned the values decrease with age so that the most recently observed value receives the highest weight, the previously observed value receives the next highest weight and so on, with the initially observed value receiving the lowest weight.

To smooth a series at any time period  $t$ , we require the following formula

$$\epsilon_t = Wy_t + (1-W)\epsilon_{t-1}$$

where

$\epsilon_t$  = value of the exponentially smoothed series being computed

$\epsilon_{t-1}$  = value of the exponentially smoothed series already computed

$y_t$  = observed value of the time series in period  $t$

$W$  = subjectively assigned weight or smoothing coefficient.

Note that  $W + (1-W) = 1$ . Thus  $W$  is a measure of relative emphasis placed on the current value of  $y$  and what is left i.e.  $(1-W)$  is a measure of relative emphasis placed on the exponentially weighted average of all previous values. i.e. the lower  $W$ , the less relevant are past values of  $y$ ; and the higher  $W$ , the more relevant are past  $y$  values.

In relation to smoothing ability, a series of 1 term moving averages is related to an exponentially smoothed series having weight  $W$  as follows

$$W = \frac{2}{1+2}$$

Mark, L. Berenson and David, M. Levine (1986) and Richard, L. Mills (1977).

Thus smoothing a series by a moving average of order 1 is analogous to exponentially smoothing the series with smoothing constant  $W=2/(l+1)$ . A moving average of order 3 is analogous to smoothing constant of 0.5.

The following table gives some values of order of moving average,  $l$  and equivalent smoothing constant,  $W$

1	3	4	5	6	7	8	9	1
W	.50	.40	.33	.29	.25	.22	.20	.1

It is suggested that  $W$  be kept at a small value (closer to 0) if the aim is to eliminate unwanted cyclical and irregular variations. If the aim is forecasting,  $W$  is kept closer to 1.

Analysis of the seasonal effect is accomplished by computation of seasonal index. The Ratio-to-moving average method has enjoyed the greatest use owing to its superiority over others.

Murray, R. Speigel (1981) and Mark, L. Berenson and David, M. Levine (1986) applied the method on monthly data on the basis of the multiplicative model.

Box and Jenkins (1876) discusses extensively what is now

generally referred to as Box-Jenkins approach to time series analysis. The approach is entirely different from traditional approach. The approach is built on the premise that many a time, values of frequently observed series at particular points in time are highly correlated with the values which precede and succeed them. The approach takes advantage of the potential autocorrelation feature inherent in the series.

This approach is described in steps below

- i) postulate general class of models
- ii) identify model to be tentatively entertained
- iii) estimate parameters in the tentatively entertained model
- iv) perform diagnostic checking
- v) if model is adequate ,go to step (vi) else, go to step (iii)
- vi) use model for forecasting and control.

The general class can be represented in the form of the ARIMA model given as:

$$\phi(B) {}_p\nabla^d Z_t = \theta(B) {}_q a_t \quad \dots\dots (i)$$

where :

$$\phi(B) = (1 - \phi_1 B - \phi_2 B^2 \dots\dots\dots - \phi_p B^p)$$

$$\theta(B) = (1 - \theta_1 B - \theta_2 B^2 - \dots - \theta_q B^q)$$

$a_t$  is a white noise process

B is an operator defined by

$$B^j Z_t = Z_{t-j}$$

and

$$\nabla = (1 - B)$$

d is the order of differencing required for stationarity.

p and q are the number of autoregressive and moving average parameters respectively.

If in (i),  $p=0$  and  $q=0$ , we have a purely moving average process given by

$$\nabla^d Z_t = \theta(B) a_t \quad \dots \dots \dots (ii)$$

If  $q=0$  and  $d=0$ , we have a purely autoregressive process given by

$$\nabla^d Z_t \phi(B) = a_t \quad \dots \dots \dots (iii)$$

If  $d > 0$  in (i), result is integrated moving average process

$$Z_t = \theta(B) a_t$$



If  $d > 0$  in (iii), result is integrated autoregressive process

$$\phi(B) Z_t = a_t$$

ARIMA model is written in short form as ARIMA  $(p,d,q)$  where  $p,d$  and  $q$  remain as previously defined.

E.g for  $p=0, d=1, q=1$  the resulting ARIMA model is  $(0,1,1)$  process written as

$$\nabla Z_t = a_t - \theta_1 a_{t-1}$$

$$(1-B) Z_t = a_t - \theta_1 a_{t-1}$$

$$Z_t - Z_{t-1} = a_t - \theta_1 a_{t-1}$$

where  $|\theta_1| < 1$

for  $p=0, d=2, q=2$ , the resulting model is ARIMA  $(0,2,2)$  process written

$$\nabla^2 Z_t = a_t - \theta_1 a_{t-1} - \theta_2 a_{t-2}$$

$$(1-B)^2 Z_t = a_t (1 - \theta_1 B - \theta_2 B^2)$$

where  $\theta_1 + \theta_2 < 1$

$$\theta_1 + \theta_2 < 1$$

$$-1 < \theta_1 < 1$$

for  $p=1$ ,  $d=1$ ,  $q=1$ , we have ARIMA(1,1,1) process

$$(1-B) \nabla Z_t = (1-\theta_1 B) a_t$$

$$\text{where } -1 < \theta_1 < 1, -1 < \phi_1 < 1$$

Box and Jenkins (1976) applied this approach on two hourly readings of 197 observations of a chemical process concentration and arrived at ARIMA (0,1,1) process with parameter 0.7. i.e

$$\nabla Z_t = (1-.7B) a_t$$

Application of the method on IBM stock of 369 observations resulted in ARIMA (0,1,1) process with parameter -0.1. i.e

$$\nabla Z_t = (1+.1B) a_t$$

Same analysis on 226 observations of a chemical process temperature resulted in ARIMA (1,1,0) process with parameter 0.8. i.e

$$(1 - 0.8B) \nabla Z_t = a_t$$

In recognition of the fact that monthly and quarterly data are often characterized by seasonal influences, Box and Jenkins incorporated seasonal factor into their ARIMA model.

The seasonal ARIMA model is given as

$$\phi(B)_p \Phi(B^s)_P \nabla^d (\nabla^D)_s Z_t = \theta(B)_q \Theta(B^s)_Q a_t$$

This model is said to be of order

$$(p, d, q) \times (P, D, Q)_s$$

where :

p is the number of non-seasonal autoregressive parameters

P is the number of seasonal autoregressive parameters

s is seasonality and equals 12 for monthly data and 4 for quarterly data

q is the number of non-seasonal moving average parameters

Q is the number of seasonal moving average parameters

$Z_t$  is the time series

$a_t$  is a white noise process

Box and Jenkins (1976) fitted ARIMA seasonal model to airline data and obtained seasonal model

$$(0,1,1) \times (0,1,1)_{12}$$

with parameters

$$\theta = 0.4, \quad \Phi = 0.6$$

The model is written as

$$\nabla_{12} Z_t = (1 - .4B)(1 - .6B) a_t$$

$$i.e. \quad Z_t - Z_{t-1} - Z_{t-12} + Z_{t-13} = a_t - .4a_{t-1} - .6a_{t-12} + .24a_{t-13}$$

### **3.2 Review of Computer solutions to Time Series Works**

In recent years, the statistics profession has witnessed the development of a number of statistical software for use on various brands of microcomputers. Whereas in 1982 there were perhaps fewer than twenty microcomputer based statistical packages, by mid-1985, several hundreds packages were available, Mark and David (1986). Today, the number is outrageous.

Statistical packages are well defined integrated set of programs for performing various statistical analysis based on user's specifications using statistical technique, C.K. Ayo

(1994).

Examples of statistical packages include

- i) Statistical packages for social sciences (SPSS).
- ii) Statistical analysis system (SAS).
- iii) MYSTAT
- iv) MINITAB
- v) EXEC\*U\*STAT

These packages can handle the two distinct approaches to time series analysis in addition to numerous statistical analysis they can carry out. For example, SPSS has the ability to compute the autocorrelation function (ACF), the partial autocorrelation function (PACF), estimate parameters of ARIMA model and forecast. It can also carry out the traditional time series analysis by computing the trend and the seasonal index and hence forecast as desired.

Apart from these statistical packages like Lotus 1-2-3, Excel, Super-Calc can perform the trend analysis aspect of time series analysis if one supplies the appropriate tome codes. In fact the packages can handle fitting of autoregressive model (a class of ARIMA models) owing to their ability in multiple regression analysis.

In the absence of statistical packages, these spreadsheets can be used to analyze time series to some extent by creating formulas and using some of the predefined functions like MAX, MIN, SUM, AVG, etc

### 3.3 Relevance of Computer Application

Involvement of computer in area of application readily comes to mind when accuracy and speed are of much concern. These two concepts, accuracy and speed are mostly desired in statistical analysis generally. Researchers often have cause to analyze large volume of data. Handling such large volume of data manually has some drawbacks among which may be inaccuracy of results and rather slow processing speed and hence wasting of time.

Some of the computations are so involving that it will take the analyst a rather long time to complete the analysis. In time series, ARIMA modelling for example requires the computation of autocorrelation function, partial autocorrelation function, estimation of parameters and forecasting which involve very tedious calculations that no meaningful research work can be carried out in this area manually and accurate results obtained in good time. For instance, estimation of moving average parameters involves solving a system of equations which are non-linear in the parameters. This poses a problem if such is to be manually treated. Such situation obviously requires the intervention of computer. With available statistical packages, these otherwise complicated procedures have been reduced to very simple procedures.

In the traditional approach to time series, computation of seasonal index particularly, by the ratio-to-moving

average method can be cumbersome most especially for data on monthly basis collected for several years. Any mix-up in its computation will definitely affect the result. But with the existing statistical packages, the procedure has been simplified.

These days, researchers rarely encounter analysis problems as existing packages require just data definition and specification of the desired operation. These statistical packages remain very relevant owing to their contribution to speed of processing and accuracy. Their user friendliness makes them even more relevant.

## CHAPTER FOUR

### SYSTEM DESIGN

System design is the general and detailed specification of a computer based solution. Of crucial importance in system design is correct specification of the inputs to the system so that the garbage-in-garbage-out (GIGO) syndrome does not set in.

#### 4.1 Input Description

The program consists of seven segments and hence inputs to the program shall be discussed on segment basis.

**Segment 1:** This segment prompts user to input "y" if he is a first time user of the software or "n" if not.

**Segment 2:** Prompts user for the number of years and "years" covered by data to be analyzed.

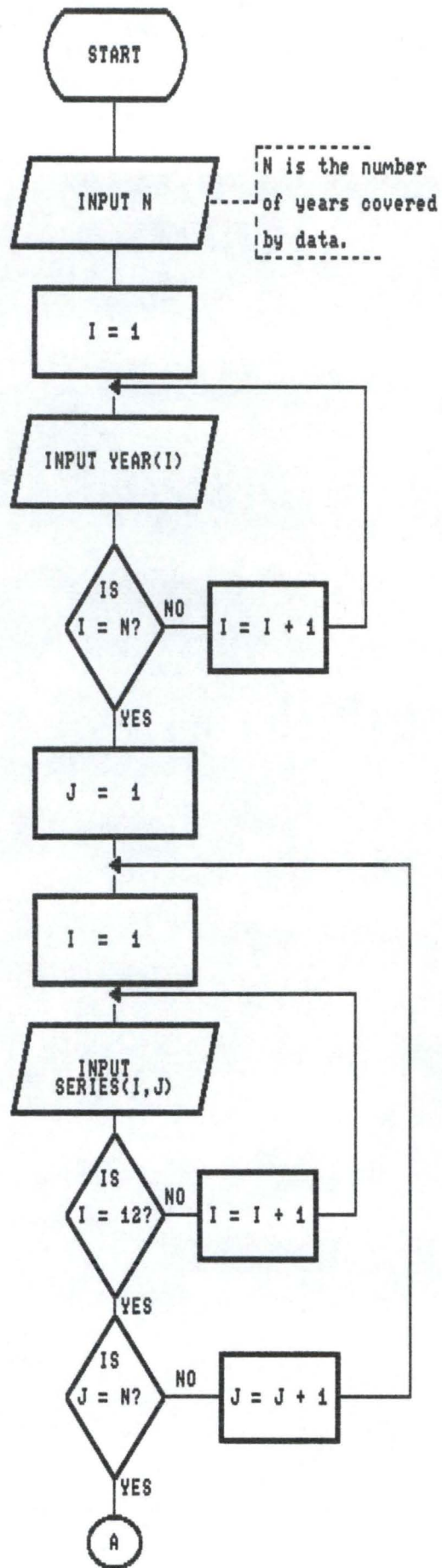
**Segment 3:** Prompts user for time series data.

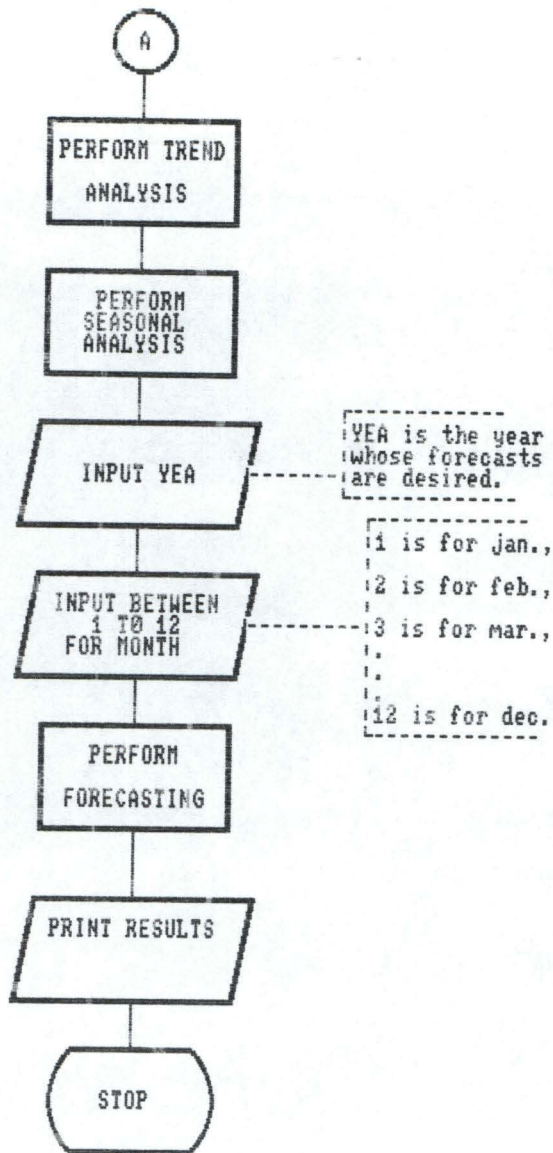
#### 4.2 Algorithm

An algorithm is defined as finite number of steps required for solving procedural problems. Flowchart will be used in presenting the algorithm for this work.



# FLOWCHART





### 4.3 Program Description

Since the program is divided into segments, the description shall be on segment basis.

**Segment 1:** This marks the beginning of the program. It prompts the user to enter "y" if a first time user or "n" otherwise. If "y" is entered, some useful information about the software is displayed. If "n" is entered, the information is not displayed. If any other character besides "y" and "n" is entered, control is transferred back to the statement that prompts user to enter "y" or "n".

**Segment 2:** Prompts user for number of years covered by time series data . The program determines whether the number of years (n) is even or odd by checking whether  $(n/2-.5)$  is equal to integer part of  $n/2$ . If  $(n/2-.5)$  is not equal to  $n/2$ , then n is even else n is odd. This is necessary because choice of certain formulae in trend analysis depends on whether n is even or odd. It also prompts user to enter the n years e.g 1992, 1992, 1993, etc covered by data.

**Segment 3:** Prompts user to enter time series data. Data for whole year are accepted before the data for the following year. It displays each year and month for which data is required. The years displayed are years entered in segment 2.

**Segment 4:** Computers sum and mean of data for each of n years, assigns codes to the independent variable X accordingly, computes the intercept and slope of the annual equation to monthly equation by computing the intercept and slope of

corresponding monthly equation. It makes a choice of the conversion formula to employ on the basis of whether the number of years is even or odd.

**Segment 5:** Computes 12-month moving total of original data, 2-month moving total of 12-month moving total, divides results obtained by 24 to obtain 12-month centred moving averages. Each set of original data is expressed as a percentage of corresponding 12-month moving average. Results are averaged over corresponding months of different years and adjusted to give seasonal index.

**Segment 6:** Prompts user to enter year to forecast. It also requests user to enter any value from 1 to 12 January to December for first of months to forecast. Forecasts for 12 months first of which is month indicated are automatically are automatically computed.

**Segment 7:** Prints the original data, results of trend analysis, seasonal analysis, and forecasts

## CHAPTER FIVE

### SYSTEM IMPLEMENTATION

By system implementation, we mean placing the system into operation. On placing the system into operation, expected output and interpretation of results obtained are discussed below.

#### 5.1 Output Expected

The program is expected to produce the following on execution.

- i) Time series data entered
- ii) Details of trend analysis
- iii) Intercept and slope of fitted annual trend equation
- iv) Intercept and slope of monthly trend equation
- v) Details of seasonal analysis
- vi) Seasonal index
- vii) Forecasts

#### 5.2 Interpretation of Results

The software has carried out three basic operations on the time series data. The three operations are trend analysis, seasonal analysis and forecasting.

The result of trend analysis reveals the following :

$$Y = 2200435 - 174581.5X$$

origin : 1993

X unit : 1 year

This equation suggests an annual decrease of about 174582 crates in production of coca-cola products.

The monthly trend equation is

$$Y = 183369.5 - 1212.372X$$

origin : July 1st 1993

X unit : 1 month

This equation suggests a monthly decrease of about 1212 crates in production of coca-cola products at Ilorin plant.

Results of the seasonal analysis reveal the following :

Production in January is 9.8% greater than monthly average

Production in February is 1.1% lower than monthly average

Production in March is 31.9% greater than monthly average

Production in April is 8.8% greater than monthly average

Production in May is 11.9% greater than monthly average

Production in June is 4.0% less than monthly average

Production in July is 16.2% less than monthly average

Production in August is 18.9% less than monthly average

Production in September is 28.3% less than monthly average

Production in October is 22.0% less than monthly average

Production in November is 5.2% greater than monthly average

Production in December is 12.8% greater than monthly average

The forecasts are for January 1999-December 1999 and are only estimates based on the assumption that the production of coca-cola products will follow more or less the same pattern it followed during the period of 1990-1996. If this basic assumption is seriously violated, forecasts may be rendered useless.

### **5.3 Conclusion and Recommendations**

In conclusion, the analysis carried out so far suggests that the coca-cola production at Ilorin plant has been decreasing at the rate of about 174582 crates annually. Such figure translates to monthly decrease of 1212 crates.

The seasonal analysis suggests that the production January, March, April, May, November and December are greater than monthly average while productions for the other months are less. The forecasts for 1999 suggest lower production than recorded in previous years.

It is recommended to the management of coca-cola to adopt more aggressive marketing strategy to arrest the downward trend in sales. It is recommended to interested researcher to go into software development for time series collected on annual basis.

Lastly, the software is recommended for use by anyone wishing to carry out time series analysis on time series data covering any number of years provided that such data are on monthly basis.

## REFERENCES

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"bus.txt" FOR OUTPUT AS #1

COMPUTERIZED APPROACH TO PRODUCTION MODELLING IN A MANUFACTURING COMPANY  
BY Odede, B.T. (Reg. No PGD/MCS/97/430)

Segment 1: This segment gives some useful information to the first time user

T "Are you a first time user of this software?(y/n)", ch\$

PRINT #1, : PRINT #1,

IF ch\$ = "y" THEN 1 ELSE 2

INT #1, "Information about the software"

NT #1, "-----"

T #1, "The software carries out time-series analysis on monthly data"

T #1, "based on the multiplicative model"

T #1, "The software prompts you for the following :"

T #1, "\* number of years covered by your data"

T #1, "\* years covered by your data e.g 1995,1996,1997"

T #1, "\* year & first of months (in terms of any integer value"

T #1, " between 1-12 for jan-dec) whose forecasts are desired."

T #1, " Note that 1 is for jan;2 for feb;3 for mar etc."

T #1, " It automatically outputs forecasts for 12 consecutive months"

T #1, " starting from the first month earlier indicated"

GOTO 2

REM Segment 1: This segment accepts preliminary data, dimensions some  
variables and assigns months

UT "enter number of years covered by data", n

n < 3 THEN

PRINT "number of years should not be less than 3"

PRINT

GOTO 2

IF

year(n)

i = 1 TO n

INPUT "enter years covered by data e.g 1994,1995 etc", year(i)

i

DMA1(n \* 12), specific(n \* 12), per(12), cmean(12), avmean(12)

index(12), amont\$(12), forecast(12), trend(12), avr(n)

t\$(1) = "jan": amont\$(2) = "feb": amont\$(3) = "mar"

t\$(4) = "apr": amont\$(5) = "may": amont\$(6) = "jun"

t\$(7) = "jul": amont\$(8) = "aug": amont\$(9) = "sep"

t\$(10) = "oct": amont\$(11) = "nov": amont\$(12) = "dec"

Segment 2: accepts data

i = 1 TO n

R j = 1 TO 12

READ SERIES(i, j)

XT j

i

Segment 3: This segment computes row totals and means

i = 1 TO n

sum(i) = 0

i

= 1 TO n

j = 1 TO 12

sum(i) = rsum(i) + SERIES(i, j)

T j

i

Segment 4: This segment performs trend analysis

i = 1 TO n

tot(i) = 0

i

i = 1 TO n

FOR j = 1 TO 12

tot(i) = tot(i) + SERIES(i, j)

avrg(i) = tot(i) / 12

NEXT j

i

IF avrg(i) = "e" THEN

avrg(i) = (n - 1) \* (-1)

FOR i = 2 TO n

avrg(i) = avrg(i - 1) + 2

EXT i

ELSE

avrg(i) = (n - 1) \* (-1) / 2

FOR i = 2 TO n

avrg(i) = avrg(i - 1) + 1

EXT i

IF

avrg = 0: total = 0: sumxx = 0

i = 1 TO n

avrg(i) = avrg(i) \* tot(i)

sumxy = sumxy + avrg(i)

total = total + tot(i)

sumxx = sumxx + avrg(i) ^ 2

i

avrg = total / n: byear = sumxy / sumxx

IF avrg = "e" THEN

bmonth = byear / 12: bmonth = byear / 72

ELSE

bmonth = byear / 12: bmonth = byear / 144

IF

Segment 5: This segment performs seasonal analysis

computation of 12-month m.t

i = 1 TO f

mtot(i) = 0

i

FOR k = 1 TO f

FOR j = 1 TO 12

c = 1: c = j + k - 1

IF c > 12 THEN

c = c - 12: i = i + 1

IF c > 12 GOTO 40

END IF

mtot(k) = mtot(k) + SERIES(i, c)

NEXT j

k

computation of 2-month m.t of 2-month m.t

i = 1 TO f - 1

mtot(i) = mtot(i) + mtot(i + 1)

movtot(i) = mtot(i) / 24

i

converting of series into i-dim tr

i = 1 TO n

FOR j = 1 TO 12

IF i > 1 THEN

k = (i - 1) \* 12 + j

ELSE

k = j

```

trendx = (yea - origin) * 12 + (mont - 7)
trend(1) = (amonth + bmonth * .5) + (bmonth * trendx)
forecast(1) = trend(1) * index(mont) / 100
END IF
Segment 6: This segment print #1, s the output
T #1, TAB(30); "OUTPUT"
T #1, TAB(30); "*****"
T #1, : PRINT #1,
T #1, TAB(26); "ORIGINAL VALUES"
T #1, TAB(26); "-----"
f = 1 TO 2
= 11
R i = a TO b
PRINT #1, TAB(k); amont$(i);
k = k + 10
KT i
FOR i = 1 TO n
k = 10
PRINT #1, TAB(2); year(i);
FOR j = a TO b
PRINT #1, TAB(k); SERIES(i, j);
k = k + 10
NEXT j
KT i
= a + 6: b = b + 6: PRINT #1, : PRINT #1,
f
NT #1, : PRINT #1, : PRINT #1,
NT #1, TAB(25); "TABLE OF TREND ANALYSIS"
NT #1, TAB(25); "-----"
NT #1,
NT #1, TAB(13); "X"; TAB(29); "Y"; TAB(43); "XY"; TAB(58); "XX"
i = 1 TO n
PRINT #1, TAB(12); x(i); TAB(28); tot(i); TAB(42); xy(i); TAB(57); x(i) ^ 2
T i
NT #1, TAB(11); "total"; TAB(28); total; TAB(42); sumxy; TAB(57); sumxx
NT #1, : PRINT #1,
NT #1, "For the annual equation"
NT #1, "Intercept ="; ayear
NT #1, "Slope ="; byear
NT #1, : PRINT #1,
NT #1, "For the monthly equation"
NT #1, "Intercept ="; amonth
NT #1, "Slope ="; bmonth
NT #1, : PRINT #1,
NT #1, TAB(25); "CENTRED MOVING AVERAGE TABLE"
NT #1, TAB(25); "-----"
NT #1, TAB(3); "YEAR"; TAB(11); "MONTH"; TAB(23); "DATA"; TAB(32); "12-MTH
NT #1, TAB(47); "2 - MTH M.T OF C4"; TAB(66); "12 - MTH CMA"
NT #1,
j = 1 TO n
= 1
{ i = 1 TO 12
} = f + (j - 1) * 12
PRINT #1, TAB(2); year(j); TAB(12); amont$(i); TAB(23); TR(D);
PRINT #1, TAB(32); MTOT1(D); TAB(49); MOVTOT1(D); TAB(66); CMA1(D)
= f + 1
T i
J
T #1, : PRINT #1,

```

```

END IF
TR(k) = SERIES(i, j)
XT j
i
nsfers mtot into mtot1
i = 1 TO f
OT1(i + 6) = mtot(i)
i
nsfers contents of movtot into movtot1
i = 1 TO f - 1
VTOT1(i + 6) = movtot(i)
A1(i + 6) = CMA(i)
i
ides original values by cma
i = 1 TO f - 1
pecific(i + 6) = TR(i + 6) * 100 / CMA1(i + 6)
i
new1 :dim c(n,12)

IM cm(n, 12)
OR i = 1 TO n
  FOR j = 1 TO 12
    cm(i, j) = specific(12 * (i - 1) + j)
  NEXT j
EXT i
s values for corresponding months of different years
i = 1 TO 12
r(i) = 0
i
i = 1 TO n
OR j = 1 TO 12
  per(j) = per(j) + cm(i, j)
  cmean(j) = per(j) / (n - 1)
NEXT j
T i
ustment of seasonal index
ean = 0
i = 1 TO 12
otmean = totmean + cmean(i)
T i
ean = totmean / 12
i = 1 TO 12
ndex(i) = cmean(i) * 100 / avmean
T i
Segment 6: This segment performs forecasting
  INPUT "enter yr for which forecast is desired", yea
  INPUT "enter btw 1 to 12 for jan-dec for 1st month to forecast", mont
mont < 1 OR mont > 12 THEN 50
INT #1,
IF typ# = "e" THEN
  FOR i = 1 TO n
    IF x(i) = 1 THEN origin = year(i)
  NEXT i
  trendx = (yea - origin) * 12 + (mont - 1)
  trend(1) = (amonth + bmonth * .5) + (bmonth * trendx)
  forecast(1) = trend(1) * index(mont) / 100
  ELSE
FOR i = 1 TO n
  IF x(i) = 0 THEN origin = year(i)
NEXT i

```

```

#1, TAB(28); "TABLE OF PERCENTAGES"
#1, TAB(28); "-----"
l: b = 6
f = 1 TO 2
k = 11
OR i = a TO b
  PRINT #1, TAB(k); amont$(i);
  k = k + 10
NEXT i
R i = 1 TO n
  k = 10
PRINT #1, TAB(2); year(i);
FOR j = a TO b
  PRINT #1, TAB(k); cm(i, j);
  k = k + 10
NEXT j
XT i
= a + 6: b = b + 6: PRINT #1, : PRINT #1,
T f
T #1, : PRINT #1, TAB(33); "SEASONAL INDEX"
T #1, TAB(33); "-----"
T #1, TAB(32); "MONTH"; TAB(44); "INDEX"
T #1, TAB(32); "-----"; TAB(44); "-----"
i = 1 TO 12
INT #1, TAB(32); amont$(i); TAB(42); index(i)
i
T #1, : PRINT #1,
PRINT #1, TAB(21); " FORECASTS FOR 12 CONSECUTIVE MONTHS"
PRINT #1, TAB(21); "-----"
PRINT #1, TAB(23); yea; TAB(38); amont$(mont); TAB(53); forecast(1)
FOR i = 2 TO 12
  mont = mont + 1
  IF mont > 12 THEN
    mont = mont - 12
    yea = yea + 1
  END IF
  trend(i) = trend(i - 1) + bmonth
  forecast(i) = trend(i) * index(mont) / 100
  PRINT #1, TAB(23); yea; TAB(38); amont$(mont); TAB(53); forecast(i)
NEXT i

```

OUTPUT  
\*\*\*\*\*

ORIGINAL VALUES

	jan	feb	mar	apr	may	jun
1990	245201	262334	293333	223145	244335	223123
1991	236330	251312	272211	243146	213116	201116
1992	208172	207113	198174	182243	178625	162116
1993	205488	228010	269995	237441	170162	202325
1994	199965	120111	199320	180615	185554	157101
1995	158407	131631	216783	206377	202525	145165
1996	171236	139876	240765	119786	211887	142234

	jul	aug	sep	oct	nov	dec
1990	209876	200987	176543	211234	243213	254349
1991	182213	173211	163111	183123	213114	231322
1992	173251	171121	163311	182149	200133	213341
1993	155645	133417	166459	212133	204871	220320
1994	97214	70402	129420	132444	206481	174849
1995	128820	155429	21315	68833	94326	140385
1996	105666	143879	187654	129876	139871	149826

TABLE OF TREND ANALYSIS

X	Y	XY	XX
-3	2787673	-8363019	9
-2	2563325	-5126650	4
-1	2239749	-2239749	1
0	2406266	0	0
1	1853476	1853476	1
2	1669996	3339992	4
3	1882556	5647668	9
total	1.540304E+07	-4888282	28

For the annual equation  
Intercept = 2200435  
Slope = -174581.5

For the monthly equation  
Intercept = 183369.5  
Slope = -1212.372

## CENTRED MOVING AVERAGE TABLE

YEAR	MONTH	DATA	12-MTH M.T	2 - MTH M.T OF C4	12 - MTH CMA
1990	jan	245201	0	0	0
1990	feb	262334	0	0	0
1990	mar	293333	0	0	0
1990	apr	223145	0	0	0
1990	may	244335	0	0	0
1990	jun	223123	0	0	0
1990	jul	209876	2787673	5566475	231936.5
1990	aug	200987	2778802	5546582	231107.6
1990	sep	176543	2767780	5514438	229768.3
1990	oct	211234	2746658	5513317	229721.5
1990	nov	243213	2766659	5502099	229254.1
1990	dec	254349	2735440	5448873	227036.4
1991	jan	236330	2713433	5399203	224966.8
1991	feb	251312	2685770	5343764	222656.8
1991	mar	272211	2657994	5302556	220939.8
1991	apr	243146	2644562	5261013	219208.9
1991	may	213116	2616451	5202803	216783.5
1991	jun	201116	2586352	5149677	214569.9
1991	jul	182213	2563325	5098492	212437.2
1991	aug	173211	2535167	5026135	209422.3
1991	sep	163111	2490968	4907899	204495.8
1991	oct	183123	2416931	4772959	198873.3
1991	nov	213114	2356028	4677565	194898.5
1991	dec	231322	2321537	4604074	191836.4
1992	jan	208172	2282537	4556112	189838
1992	feb	207113	2273575	4545060	189377.5
1992	mar	198174	2271485	4543170	189298.8
1992	apr	182243	2271685	4542396	189266.5
1992	may	178625	2270711	4528441	188685
1992	jun	162116	2257730	4497479	187395
1992	jul	173251	2239749	4476814	186533.9
1992	aug	171121	2237065	4495027	187292.8
1992	sep	163311	2257962	4587745	191156
1992	oct	182149	2329783	4714764	196448.5
1992	nov	200133	2384981	4761499	198395.8
1992	dec	213341	2376518	4793245	199718.5
1993	jan	205488	2416727	4815848	200660.3
1993	feb	228010	2399121	4760538	198355.8
1993	mar	269995	2361417	4725982	196915.9
1993	apr	237441	2364565	4759114	198296.4
1993	may	170162	2394549	4793836	199743.2
1993	jun	202325	2399287	4805553	200231.4
1993	jul	155645	2406266	4807009	200292
1993	aug	133417	2400743	4693587	195566.1
1993	sep	166459	2292844	4515013	188125.5
1993	oct	212133	2222169	4387512	182813
1993	nov	204871	2165343	4346078	181086.6
1993	dec	220320	2180735	4316246	179843.6
1994	jan	199965	2135511	4212591	175524.6
1994	feb	120111	2077080	4091145	170464.4
1994	mar	199320	2014065	3991091	166295.5
1994	apr	180615	1977026	3874363	161431.8
1994	may	185554	1897337	3796284	158178.5
1994	jun	157101	1898947	3752423	156351
1994	jul	97214	1853476	3665394	152724.8
1994	aug	70402	1811918	3635356	151473.2
1994	sep	129420	1823438	3664339	152680.8

1994	oct	132444	1840901	3707564	154481.8
1994	nov	206481	1866663	3750297	156262.4
1994	dec	174849	1883634	3755332	156472.2
1995	jan	158407	1871698	3775002	157291.8
1995	feb	131631	1903304	3891635	162151.5
1995	mar	216783	1988331	3868557	161189.9
1995	apr	206377	1880226	3696841	154035
1995	may	202525	1816615	3521075	146711.5
1995	jun	145165	1704460	3374456	140602.3
1995	jul	128820	1669996	3352821	139700.9
1995	aug	155429	1682825	3373895	140579
1995	sep	21315	1691070	3406122	141921.8
1995	oct	68833	1715052	3343513	139313
1995	nov	94326	1628461	3266284	136095.2
1995	dec	140385	1637823	3272715	136363.1
1996	jan	171236	1634892	3246630	135276.3
1996	feb	139876	1611738	3211926	133830.3
1996	mar	240765	1600188	3366715	140279.8
1996	apr	119786	1766527	3594097	149754
1996	may	211887	1827570	3700685	154195.2
1996	jun	142234	1873115	3755671	156486.3
1996	jul	105666	1882556	0	0
1996	aug	143879	0	0	0
1996	sep	187654	0	0	0
1996	oct	129876	0	0	0
1996	nov	139871	0	0	0
1996	dec	149826	0	0	0

TABLE OF PERCENTAGES

	jan	feb	mar	apr	may	jun
1990	0	0	0	0	0	0
1991	105.0511	112.8697	123.2059	110.9198	98.30824	93.72984
1992	109.6577	109.3652	104.6885	96.28909	94.66834	86.51034
1993	102.4059	114.95	137.1118	119.7404	85.1904	101.0456
1994	113.9242	70.46106	119.859	111.8832	117.3067	100.4797
1995	100.709	81.17781	134.4892	133.9805	138.0431	103.2451
1996	126.5825	104.5175	171.632	79.98849	137.4148	90.8923
	jul	aug	sep	oct	nov	dec
1990	90.48858	86.96686	76.83524	91.95219	106.0888	112.0301
1991	85.77265	82.70896	79.76252	92.08024	109.3461	120.5829
1992	92.87908	91.3655	85.43334	92.72099	100.8756	106.8208
1993	77.70903	68.22092	88.48293	116.0382	113.1343	122.5065
1994	63.65308	46.4782	84.76508	85.73435	132.1374	111.7445
1995	92.2113	110.5635	15.01884	49.40887	69.30885	102.9494
1996	0	0	0	0	0	0



## SEASONAL INDEX

MONTH	INDEX
jan	109.7664
feb	98.93047
mar	131.8848
apr	108.8445
may	111.8675
jun	96.0229
jul	83.81974
aug	81.08366
sep	71.74553
oct	88.02497
nov	105.1913
dec	112.8183

## FORECASTS FOR 12 CONSECUTIVE MONTHS

1999	jan	112781.5
1999	feb	100448.5
1999	mar	132309.5
1999	apr	107875.5
1999	may	109515.3
1999	jun	92839.7
1999	jul	80024.88
1999	aug	76429.63
1999	sep	66757.66
1999	oct	80838.14
1999	nov	95327.63
1999	dec	100871.6