FORECASTING DEMAND IN HEALTH SERVICES:
The case of University of Nairobi Clinics

BY

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DECLARATION

This Management Research Project is my original work and has not been presented for a degree in any other University.

Signed : _____ Date: 7/1/94

CYRUS IRAYAH MWANGI.

This Management Research Project has been submitted for examination with my approval as University supervisor.

Signed : _____ Date: 6TH JUNE 1994

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LECTURER, DEPARTMENT OF MANAGEMENT SCIENCE.

DEDICATION

In memory of my father, Irayah Kabaiku, for the love he had for me and the encouragement he gave me, without which I would not have made it this far. And to JESUS CHRIST for accepting to die for me.

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I would not forget to thank Mr. Danny Fernandes who has been more like a counsellor in my whole M.B.A. course and more specifically during the preparation of this study.

Sincere thanks to M.B.A. (1991/1992) students for the encouragement and challenges they posed to me during the course.

Finally, I cannot fail to appreciate the love that my mother and other members of the family have shown me. Special thanks to Ruth for her love and for taking care of Sammy in the course of my University education.

Cyrus Irayah.
June 1993.

ABSTRACT

The provision of health services is an important aspect of socio-economic development and improving them plays an important role in raising people's standard of living.

Taking a quick glance at any hospital or clinic in Kenya, ones attention is attracted to whether the management of these health programs has taken due consideration to the challenges the program poses. On several occasions, Kenyans face a number of problems in trying to use the few facilities available in these hospitals and clinics.

This study set out to model demand patterns for the University of Nairobi Health Clinics by developing time series forecasting models for each of the clinics and for all the clinics together. These models, it is hoped, can assist in the prediction of demand for the health services in the University Clinics.

The result of the study indicates that the attendance process can be modelled using time series analysis. This is supported by the F- test carried out. This test showed that all the clinics except Upper Kabete (Staff) had significant F- ratios (at 95% significance level) and thus the demand is time dependent. The models were validated and predictive powers of between 95.47% and 71.78% were achieved for the specific models developed. The overall model has a predictive power of 91.7%.

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND

Good health is clearly something consumers desire for themselves. Better health contribute to the production capacity of the economy by increasing the supply of potential man-hours through a reduction in mortality and decrease in time lost because of illness or disability. Better health may also increase production by improving productivity through increasing output per man-hour.

So as to have healthy students and staff large institutions provide medical services to the same, in the form of clinics run by these institutions, free of charge. The University of Nairobi is one such institution providing health services to its students, employees and their qualifying dependents.

These clinics are similar to public health clinics in the way they are run and managed. Their major goal is to offer high quality services at a reasonable cost so as to satisfy the people consuming their services. However, they face several problems some of which have been identified by researchers. For example Malika B. and Sarma G.V.[1] state that public

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[1] Malika B. & Sarma G. " Outpatient Queues at the Ibn-Rochd Health Centre", J.O.R.S. Vol. 42 No. 10, 1991

health centers lack several infrastructural facilities like enough waiting space and seating for the patients, so that waiting is often far from pleasant. Being lower-paid than those in private consultancy, and overworked, the doctors lack the motivation to put in a little extra time beyond that scheduled.

Another problem facing clinics is that of long queues as identified by Worthington[2] who states:

> hospital waiting lists are a major problem to many hospitals. It is very tempting to think of them simply as queues of patients waiting for health services which can be removed by simply providing more services. ... However, they require the understanding of OR and Management Science tools.

Cost control is another area which every health clinic should consider. A study done by Griffith, Hancork, and Munson[3] over a period of four years, recommended four issues to be considered in controlling costs. These are planning of facilities and services, scheduling of patients and patient services, control and utilization of medical facilities, and administration control of manpower and expenditures.

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[2] Worthington "Hospital Waiting List Management Models", J.O.R.S. Vol. 42 No. 10, 1991.

[3] Griffith, Hancorck & Munson " Practical ways to contain hospital costs" Harvard Business Review, Nov.-Dec, 1973.

In virtually every decision he makes, the executive must consider some kind of forecast. Sound predictions of demand is a necessity if the manager has to cope with seasonality, sudden changes in demand levels, strikes, and large swings of the economy. The importance of forecasting has been emphasized by Hamburg[4] by stating the following:

> Decisions in private and public sector enterprises depend on perceptions of future outcomes that will affect the benefits and costs of possible courses of action. Not only must managers forecast these outcomes, but also they must plan and think through the nature of activities that will permit them to accomplish their objectives. Clearly, managerial planning and forecasting are inseparable from forecasting.

There are three basic types of forecasting techniques that could be used in demand prediction. These are:

a). **Qualitative techniques**, used when data is scarce and therefore the use of human knowledge is highly required. The objective is to bring together in a logical, unbiased and systematic way all information and judgments which relate to the factors being forecasted.

b). **Time series analysis** is a statistical technique used when several years' data for a product are available and when relationships and trends are both clear and relatively stable. It is based on the assumption that the existing pattern will continue into the future. This assumption is more likely to be correct in the short term than it is over

[4] Hamburg Moris, Statistical Analysis for Decision Making, Harcourt Brace Jovanovich, 1983

the long run, and for this reason, this technique provide us with reasonably accurate forecasts for the immediate future.

c). **Causal Models** are used when historical data is available and enough analysis has been performed to spell out explicitly the relationship between the factor to be forecast and other factors.

In the event that one is required to undertake a task, then such a person should be in a position to know in advance where he is heading to. If no such prediction is readily available, then a useful guide would be trends in the past. In such a case the manager will be called upon to choose a forecasting method. Chambers et. al.[5] gives guidelines to be considered in choosing the same. These guidelines are summarized below:

-the context of the forecast

-the relevance and availability of historical data

-the degree of accuracy desirable

-the time period to be forecast

-the cost / benefit of the forecast to the company, and

Makridakis[6] in a paper entitled the forecasting accuracy and the assumption of constancy, identified the major functions in forecasting which are summarized in figure 1.1 below:

[5] Chambers et. al. " How to choose the right forecasting technique", Harvard Business Review, July - August 1971.

[6] Makridakis S. "Forecasting Accuracy and the Assumption of Constancy" Omega Vol 9. No. 3, 1981

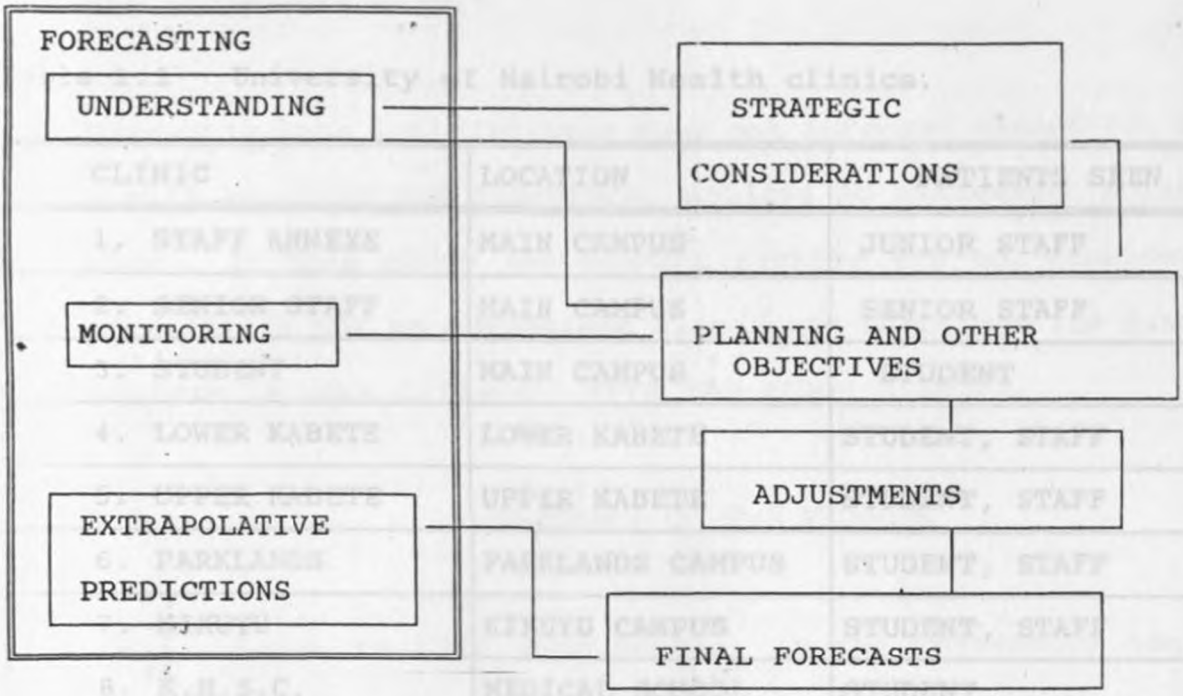

Fig. 1.1 Major functions in forecasting.

This study used time series analysis in developing the forecasting model. This is because demand is likely to be affected by seasons since the University operates on semester basis. Climatic conditions also affects the demand for health services.

1.2 UNIVERSITY HEALTH SERVICES

The University of Nairobi operates ten clinics for its students, staff and their dependents. These clinics are administered from a central office in the University of Nairobi Main Campus. The clinics, their location and the

patients they serve are summarized in table 1.1.

Table 1.1 University of Nairobi Health clinics.

CLINIC	LOCATION	PATIENTS SEEN
1. STAFF ANNEXE	MAIN CAMPUS	JUNIOR STAFF
2. SENIOR STAFF	MAIN CAMPUS	SENIOR STAFF
3. STUDENT	MAIN CAMPUS	STUDENT
4. LOWER KABETE	LOWER KABETE	STUDENT, STAFF
5. UPPER KABETE	UPPER KABETE	STUDENT, STAFF
6. PARKLANDS	PARKLANDS CAMPUS	STUDENT, STAFF
7. KIKUYU	KIKUYU CAMPUS	STUDENT, STAFF
8. K.M.S.C.	MEDICAL SCHOOL	STUDENT
9. STUDENT SICKBAY	MAIN CAMPUS	STUDENT
10. MCH/FP	MAIN CAMPUS	STAFF

There is an administrator who is involved with the planning and administration of the clinics. He reports to the Chief Medical Officer who is involved with the administrative as well as medical duties.

Before a patient is seen in any of the clinics, he/she has to sign the attendance record book. At the end of the day the record's clerk records the total number of patients seen during the day in a Monthly Summary Form. This form is totaled at the end of each month. The original is then sent to the administrator in Main Campus while a copy is filed in

the individual clinic.

Currently, the administrator does not forecast demand for the health services and therefore, applies no management science model. In this study the student sickbay was not considered since it is not an outpatient clinic and therefore its demand pattern is very different from the other clinics.

1.3 STATEMENT OF THE PROBLEM

It is common to find long queues in the University health clinics during the busy seasons while in other seasons the attendance is very low. This implies that the students and the workers waste their time which could otherwise be used in other activities. The clinics' employees are also overworked during the busy seasons while they are idle during the slack seasons. This problem could have been caused by several reasons such as lack of adequate facilities, low calibre of personnel, low level of technology or lack of sufficient data to assist in planning.

The last mentioned reason (i.e. planning) is the easiest to tackle in the short-run, if we were able to forecast demand for the health services with some reasonable degree of accuracy. There is, therefore, a need for a predicting tool to help the administrators of these clinics in planning for

the expansion of physical resources, medicine acquisition and scheduling of staff. This study therefore sought to answer the question whether such a predicting tool can be developed.

1.4 OBJECTIVES OF THE STUDY

The objectives of this study are;

(i) To model demand patterns for the University of Nairobi Health Clinics by developing and validating a time series forecasting model for each of the clinics. An overall model is also to be developed and validated.

(ii) To use the models to predict demand for the health services in these clinics.

1.5 IMPORTANCE OF THE STUDY

(i) The study will be of value to the University Management in planning for medicines and expansion of the available facilities.

(ii) The model, it is hoped, will assist in planning for the clinics' staff annual leave.

(iii) It may also be used by other health clinics, especially those belonging to institutions of higher learning, in their planning, or in developing their own forecasting models.

CHAPTER TWO

LITERATURE REVIEW

Health services have been defined by Juma[7] as services rendered by the personnel engaged in medical occupation such as doctors, dentists and nurses, plus other paramedical personnel working directly under their supervision, such as practical (interns) nurses, orderlies, and receptionists, the plant and equipment used by these personnel such as hospitals and X-rays, and the intermediate goods and services such as drugs, bandages, purchased laundry services and other related materials.

There is a lot of work that has been done on public health services in Kenya. Most of it has concentrated on the rural health development, mainly in the form of researches done by masters students for their thesis. Mburu[8] in a paper presented at the conference of the Eastern African Universities Research Program, Arusha, Tanzania, said that

[7] Juma A. "The impact of present population growth rates on Health expenditure in Kenya" Msc Thesis, University of Nairobi, 1985.

[8] Mburu F.M. " Socio-political imperatives in the history of health development in Kenya." Institute of Development Studies, University of Nairobi, Working paper no. 374, 1980.

Kenya and other African countries are always in demand for more and better health services, even if not the most technologically sophisticated. He continued to say that in Kenya rural health development, hospital development and maintenance absorbs the lion's share of the health budget, while in staff development, post graduate training (specialization) is stressed in a country where the population-doctor ratio is over 50,000:1.

Mburu continues to say that although the public health system should provide health care to all equitably, the philosophical goals specified by the government health plans and international agencies were yet to be attained. The largest and best equipped hospitals are actually 'Islands of Excellence' which though in urban areas, are always full and thus the need for better equipped urban dispensaries and rural health centers. In another contribution in the same paper, he analyses the structure, health policy, health planning and development problems for rural health care provision. He notes that hospitals take precedence over community health and its preventive component. He attributes this to lack of effective planning in the sector. He further examines the distribution of medical institutions and health personnel, noting that there is a serious shortage and

maldistribution of resources. The shortage of sufficient and competent medical personnel at all levels in the country has compounded an already existing problem for the delivery of health care. He also discusses other factors like distance to the service facilities, lack of means of transport, cost of travel, travel time and time spent waiting to be served as affecting accessibility to the available services.

Henin et. al, (1979) in their study on the impact of current and future population growth trends on social and economic development in Kenya, touch on certain issues concerning the provision of health services. They discuss the effect of population on the demand and supply of health services as well as future requirements. They argue that population growth makes increasing demands on the country's health services and that increasing number of births due to high fertility, demand an increasing number of maternal and child health services as well as trained personnel to deliver them. Using projections, they estimate future requirements in terms of health centres and hospital beds to the year 2000 and conclude that the increases are very drastic and that with uncontrolled fertility, the required health costs will rise sharply. Their study is somehow related to this study especially this time that the University of Nairobi's population is rapidly increasing.

Another study by the World Bank (1980) gives a description of health service situation and projects future requirements in terms of facilities and health personnel. By examining accessibility to rural health units, it is pointed out that health centre/population ratio is declining in the rural areas. From the given estimates, more than 60% of the population would have a service ratio of well over 1:70,000 by 1983. Due to the continued improvement of the rural health services, this ratio has even gone down, today. It gives future requirements of health facilities, personnel and cost implications. It concludes that the burden of providing health services is great whether or not the services are improved.

A study by Maina Githinji[9] on the out-patients satisfaction with the treatment provided in a District Hospital in Kiambu, Kenya, found out that the satisfaction of out-patients, was significantly related to their level of expectation. Thus the greater the length of waiting time spent in the out-patient department by the outpatients, the less was the level of satisfaction with the treatment. The level of satisfaction by the outpatients was positively correlated with the level of satisfaction with the staff-patient

[9] Maina G.E. "The out-patient and the staff satisfaction with the treatment provided in a district hospital in Kiambu, Kenya" M.A. Thesis, University of Dar-es-salam, 1977.

relationship in the outpatient department. Further, they concluded that the social and demographic characteristics of outpatients did not influence satisfaction.

Ingbar and Taylor[10] analyzed an extensive array of variables that could affect the demand of health services. Some of these variables include, size of hospitals, maternity activities, radiology activities, utilization and length of stay, surgical, ambulatory, and pediatric activities. The most significant measures were selected for use in the multiple regression analysis. Two models developed were:

-Operating expense per available bed-day,

-Expense per patient day of utilization.

In the first model, it was found that medical and surgical physician expense per patient day was significant in relation to size and volume. In the second model, radiology, surgical, size, volume, ambulatory activities and beds appeared to be significant variables in the regression equation. Further, it was found out that the coefficient of utilization was negative and highly significant, indicating that higher utilization was associated with lower unit costs for hospitals of all sizes.

[10]Ingbar M.L. & Taylor, L.D. "Hospital costs in massachusetts", Health Economics, 1968.

In a study by Malika and Sarma[11] (entitled "Outpatient queues at the Ibn-Rochd Health Centre) it was observed that in most of the developing and underdeveloped countries, consultancy is offered free in public sector health centers. In some countries, private consultancy is still in its infancy or is unavailable. When it is available it entails much higher fees, which are not always within the economic means of the average citizen. Public health centers are better equipped with diagnostic gadgets and hence attracts the rich as well as the poor. Thus there is usually a very high demand at public sector health centers. Although many such centers have been created over the years, the high rate of population growth and incidence of diseases have created a demand not adequately met by the existing number of such centers.

Using nation-wide data on 3147 US voluntary short term general hospitals, Carr and Feldstein[12] determined the optimal hospital size for the purpose of area wide planning. By using multiple Regression Analysis, they isolated the partial relationship between the total operating expenses and hospital size in holding constant such variable as the number of

[11] Malika B. and Sarma G.V. opcit pp2

[12] Carr W.J. & Feldstein P.J. "Case study of Hospital size- the empirical evidence", Health Economics, 1967

outpatient visits, range and scope of service facilities available, and the presence or absence of training and research activities. They concluded that as size of general hospitals increased, unit costs tend to initially decline and then rise.

On the allocation of funds, Abel et. al.[13] identified several ways by which health services in developing countries are financed in government and private sector. They found out that more money was spent in the private sector than in the government sector, mainly on doctors, dentists, traditional practitioners, drugs and herbal remedies. In the case of budget allocation within the health services, about 75% of the budget went to 10% high income urban population as opposed to a budget spent on 90% rural and low-income population. In terms of unit costs for hospital use, consultation, vehicle-miles, number of students duration of courses and drop-out rate of health personnel were of paramount importance for financial feasibility of operations in health planning. The sources of finance for health services are the government, compulsory insurance, charity funds, and foreign aid.

[13] Abel, Smith and Leiserson "Makirg use of the most scarce resourses" World Health Forum, Vol. 12 No. 2

Kwamina (1974), in his study on the topic " Planning of environmental health infrastructure and sanitary facilities in health institution in Kenya" concluded that health manpower resources in Kenya are limited, a situation encountered in many developing countries. The health institutions lack modern amenities and it would require a lot of capital to install such amenities. Maintenance of health institutions is a major problem, while a large number of dispensaries and health centers are in various stages of construction. He recommended that a program for national inspection of these health institution should be initiated to provide the necessary information for planning a rehabilitation and construction program in order to bring all centers to modern standard of design.

CHAPTER THREE

RESEARCH DESIGN

3.1 THE POPULATION

The population of interest in this study consisted of monthly attendance number of all the students, staff and their dependents who qualify to be treated in the university clinics. Each of the clinics was studied separately since the demand pattern is likely to differ due to the fact that the University time table is different for each faculty. However an overall model combining the attendance of ten clinics was also developed. The study was further categorized between staff and students.

3.2 SAMPLE AND SAMPLING DESIGN

Historical data on the patients' attendance number from Jan. 1988 up to Dec, 1991 was used for the model development purposes. Data for 1992 was used for out-of-sample model validation. However, some clinics were started after 1988 (for example Lower Kabete campus clinic was started on 24th Oct. 1988). Therefore, data from the time they were started to the end of 1991 was used for model development while 1992 was used for model validation.

Some records were not available from the Main Campus offices and therefore, the individual clinics were visited to obtain this data. All the clinics except Kikuyu Campus Clinic and Kenyatta Medical School clinic had their records in order. For the above mentioned clinics records for 1991 and 1992 could not be obtained. For this reason, data from Jan. 1987 to Dec. 1989 was used for model development purposes for K.M.S.C. and 1990 data was used for model validation. Since Kikuyu campus opened in October 1988, the available data points were only 24. These points were used for the model development purpose. (Note that this model was not validated). When developing the overall model, Kikuyu campus clinic and Kenyatta Medical School clinic (K.M.S.C.) were not included for the above reason.

Monthly data for a period of 4 years consists of 48 data points which are considered adequate for detecting an existing pattern. Chambers et. al.[14] gives 24 data points as the minimum for short term forecasting (especially when using moving averages). Twelve data points contained in monthly data for 1992 was sufficient in validating the model.

[14] Chambers et. al. "How to Choose the Right Forecasting Technique," Harvard Business Review, July-August 1971.

3.3 DATA COLLECTION METHODS

Monthly data on patients' attendance was obtained from the monthly return forms in the university health clinics' offices at Main Campus. Some records that were missing from this office were obtained from the respective clinics. The row data is shown in appendix 1.

3.4 DATA ANALYSIS TECHNIQUES

The data was analyzed by time series using the classical decomposition technique. This technique was used since the system that governs the variations in the patients attendance is not clearly understood, and therefore causal analysis would be hard to perform. The technique is simple and it fairly suits short-term forecasting purposes. The use of this technique can be justified by a research carried out by Mentzer and Cox[15] on USA companies with turnover ranging from $3 million to $10,000 million. 160 of these companies replied and the result was analyzed as shown in table 3.1. From this table it is clear that many pecple have a knowledge of, and actually use moving average more than other forecasting techniques.

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[15] Mentzer J & Cox J " Familiarity, application and performance of forecasting techniques" J. O. Forecasting, Vol. 3, 1984.

Table 3.1 Familiarity and satisfaction with Forecasting technique

TECHNIQUE	% FAMILIAR WITH TECH.	% SATISFIED WITH TECH.	% USING TECH. FOR		
			3-4 M	3-24M	OVER 24 M
SUBJECTIVE	80	48	32	32	20
MOVING AVE.	85	58	24	22	5
ST. LINE P.	82	32	13	16	10
EXPONEN. P.	73	67	24	17	6
TREND	67	58	21	28	21
T-S DECOMP.	42	55	9	13	5
BOX-JENKINS	26	30	5	6	2
REGRESSION	72	60	14	26	28

The data was initially tested for autocorrelation by the use of line graphs and the F-test carried out by the use of MICRO-MANAGER package in the micro-computers in the faculty of Commerce, University of Nairobi. Most statistical methodology is concerned with independent sets of observations. Lack of independence is usually considered highly undesirable, and one of the object of a good experimentation is to eliminate dependence. However, with time series analysis, we are concerned with data which develops through time; and where in general each observation depends on earlier observations. It is in fact this dependence which is of interest. We therefore, consider the internal correlation structure of the

series, which reflects (to some extent) that of its parent process. From this, we can always infer the statistical structure for the recorded time series history, which can be represented by some suitable model.

The inferred auto-correlation structure, as represented by the model can be used to forecast future values of the series. This is because, other things being equal, the same sort of dependence, observed in the past, can be expected to continue into the future.

The classical time series model assume that different variables, even though we restrict ourselves to one independent variable of time, are responsible for the trend. To some extent, the passage of time itself may bring changes in the dependent variable but factors other than time are believed to be the real independent variables in almost all cases. This approach to time series asserts that each factor or force exerts its influence within a certain span of time. The various time spans are studied individually and separately. The forces operative within each are thus grouped together for the study. The number of these groups of forces to be studied depend on the nature of the series but most economic time series can be conveniently divided into four groups which reveal themselves in four types of movements;

(i). The secular trend

(ii). The seasonal variation

(iii). The cyclical fluctuations

(iv). The irregular or random movements.

The secular trend of an economic series is a long, continuous, smooth, underlying movement. Two factors are especially important in their effects on most series; population change and technical progress. According to Gupta and Gupta[16] the trend, also called secular or long term trend is the basic tendency of a series to grow or decline over a period of time. The concept of trend does not include short range oscillations, but rather the steady movements over a long time.

Climate and custom are two dominating factors in seasonal variations, which are movements that tend to follow the same pattern year after year. These variations in a time series are due to the rhythmic forces which operate in a regular and periodic manner over a span of time less than a year. Cyclical fluctuations are wave-like movements, with a duration of over nine years, from the trough of one depression to the trough of the next. These are oscillatory movements in a time series with period of oscillation greater than one year. These movements in any business activities are the

16 Gupta S.C. & Gupta I. Business Statistics, Himalaya Publishing House, 1990.

outcome of the so called Business Cycles which are the four-phased cycles comprising prosperity (boom), recession, depression and recovery from time to time.

Trend, seasonal variations and cyclical fluctuations are thought of as continuous functions. Actual data, however, does not generally show such smoothness, so that trend, seasonal variations and cyclical fluctuations cannot be considered the sole factors operating in a series. There are erratic movements, in nearly every time series, that go back and forth around the trend, the cycle and the seasonal pattern. Such movements may be called irregular or random. They are attributed to non-predictable factors such as, floods, wars, pestilences and the like. Such variations do not exhibit any definite pattern and there is no regular period or time of their occurrence. Normally, they are short-term variations but sometimes their effect is so intense that they may give rise to new cyclical or other movements. Because of their absolutely random character, it is not possible to isolate such variations and study them exclusively nor can we forecast or estimate them precisely. The best that can be done about such variations is to obtain their rough estimates.

The general mathematical representation of the decomposition

approach is:

$$X_t = f(S_t, T_t, C_t, E_t)$$

Where X_t is the Time series at period t

S_t is the Seasonal component at period t

T_t is the Trend component at period t

C_t is the Cyclical component at period t

E_t is the Random component at period t

MATHEMATICAL MODELS FOR DECOMPOSING A TIME SERIES

The following are the two models commonly used for the decomposition of a time series into its components :

a). **Additive Model**

According to the additive model, the time series can be expressed as:

$$X_t = T_t + S_t + C_t + E_t$$

An additive model assumes that all the four components of the time series operate independently from each other so that none of these components has any effect on the remaining three. However, this assumption is not true in most of the economic and business time series, where the four components are not independent of each other. For example, the seasonal or cyclical variations may virtually be wiped off by very sharp rising or declining trend. Similarly, strong and

powerful seasonal swings may intensify or even precipitate a change in the cyclical fluctuations.

b). **Multiplicative Model**

Most of the business and economic time series are characterized by the following classical model:

$$X_t = S_t * T_t * C_t * E_t$$

This model assumes that the four components of the time series are due to different causes but they are not necessarily independent and they can affect each other. In this model S_t, C_t and E_t are not viewed as absolute amounts but rather as relative variations. Except for the trend component, T_t, the other components are expressed as rates or indices fluctuating above or below T_t such that the geometric means of all the S_t, C_t, or E_t values in the long term period are unity.

Since the multiplicative form is the one most commonly used by researchers, it was also used in this study.

CHAPTER FOUR

THE MODEL CONSTRUCTION

4.1 THE TIME SERIES PATTERN

The LOTUS package was used to draw the initial attendance pattern. This is shown by figure 4.1 to 4.13.

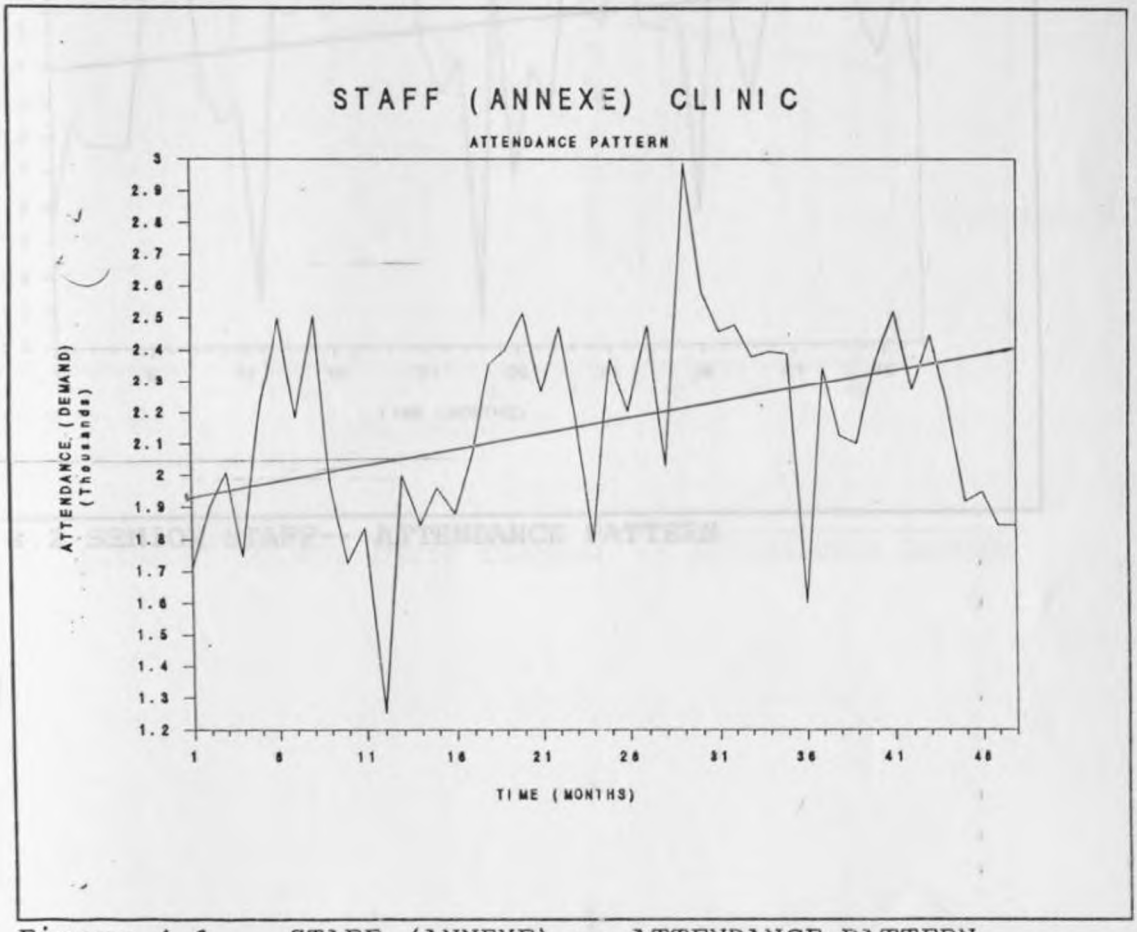

Figure 4.1 STAFF (ANNEXE) --- ATTENDANCE PATTERN

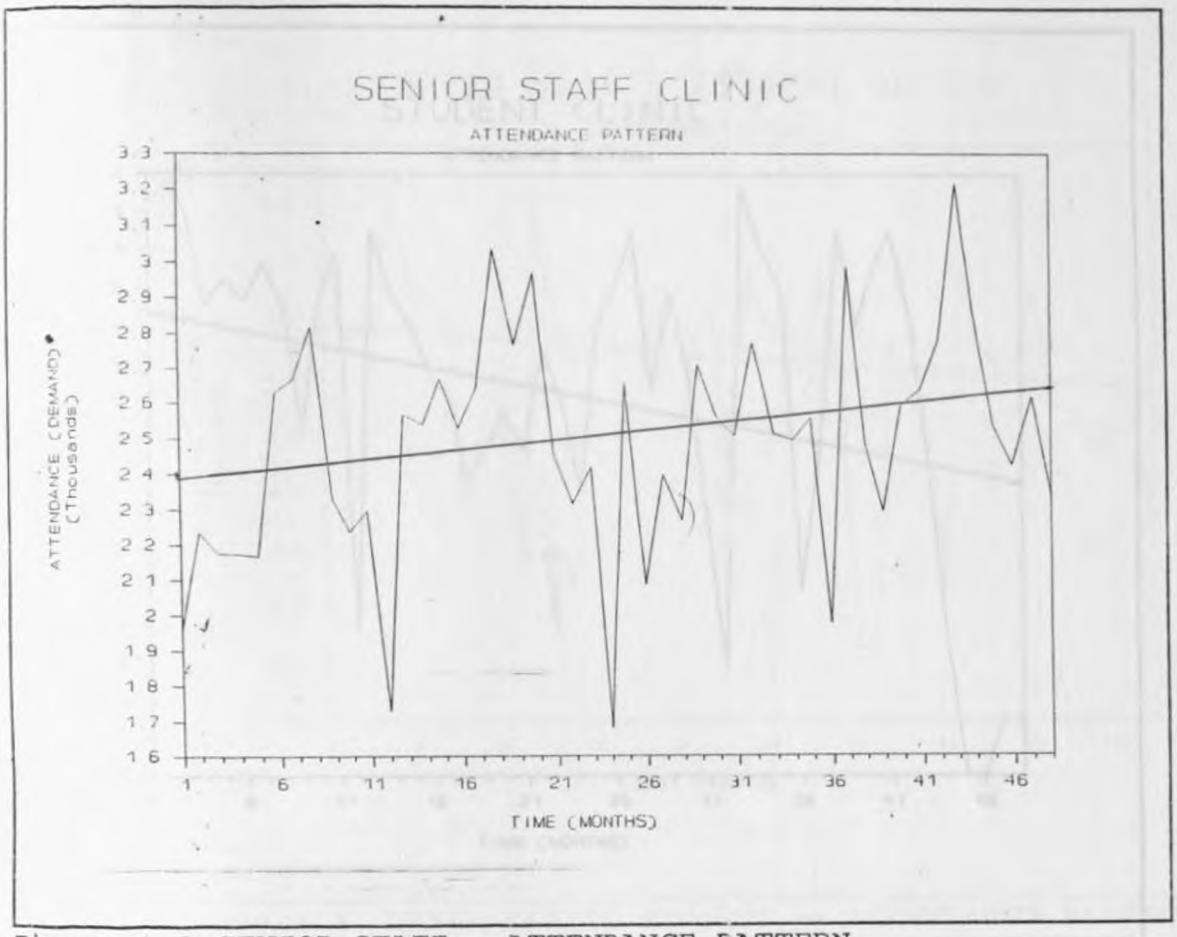

Figure 4.2 SENIOR STAFF-- ATTENDANCE PATTERN

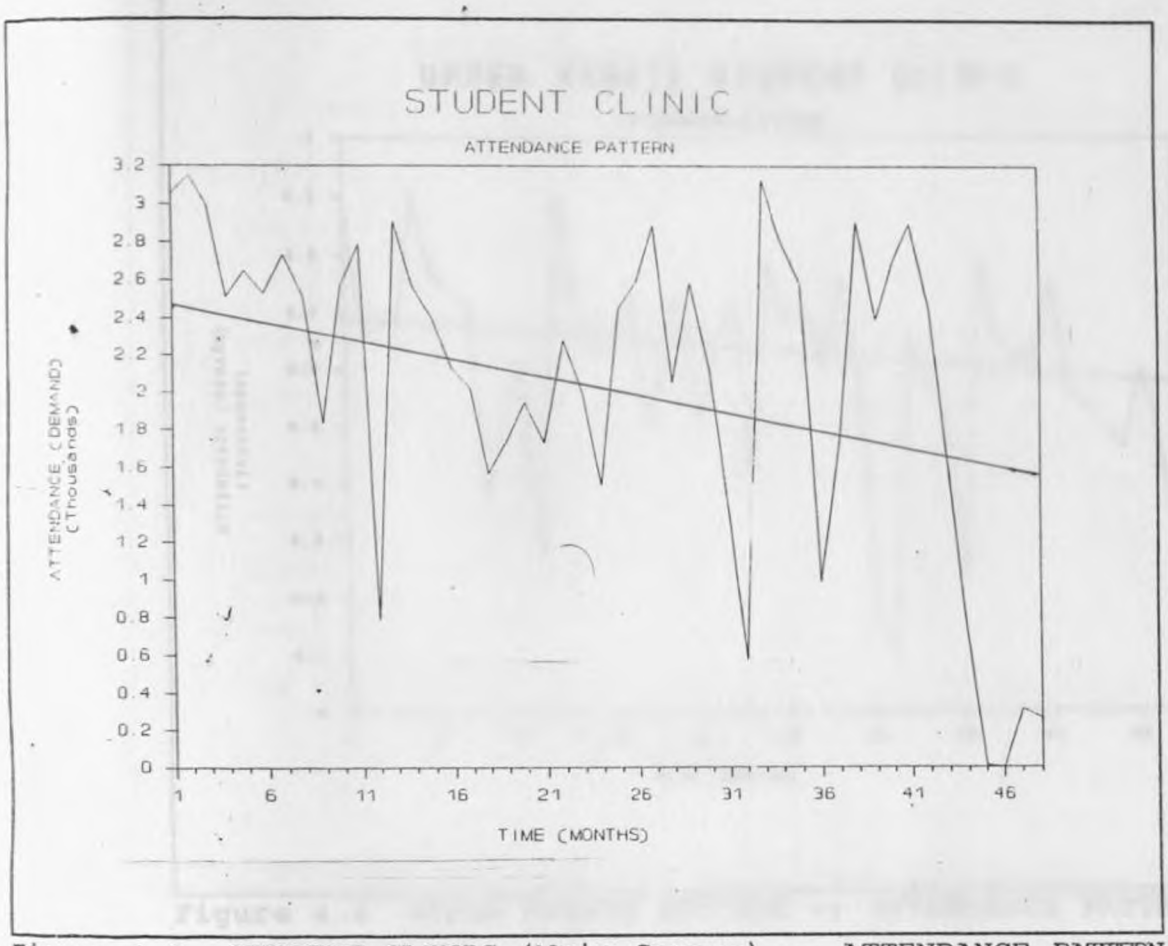

Figure 4.3 STUDENT CLINIC (Main Campus) -- ATTENDANCE PATTERN

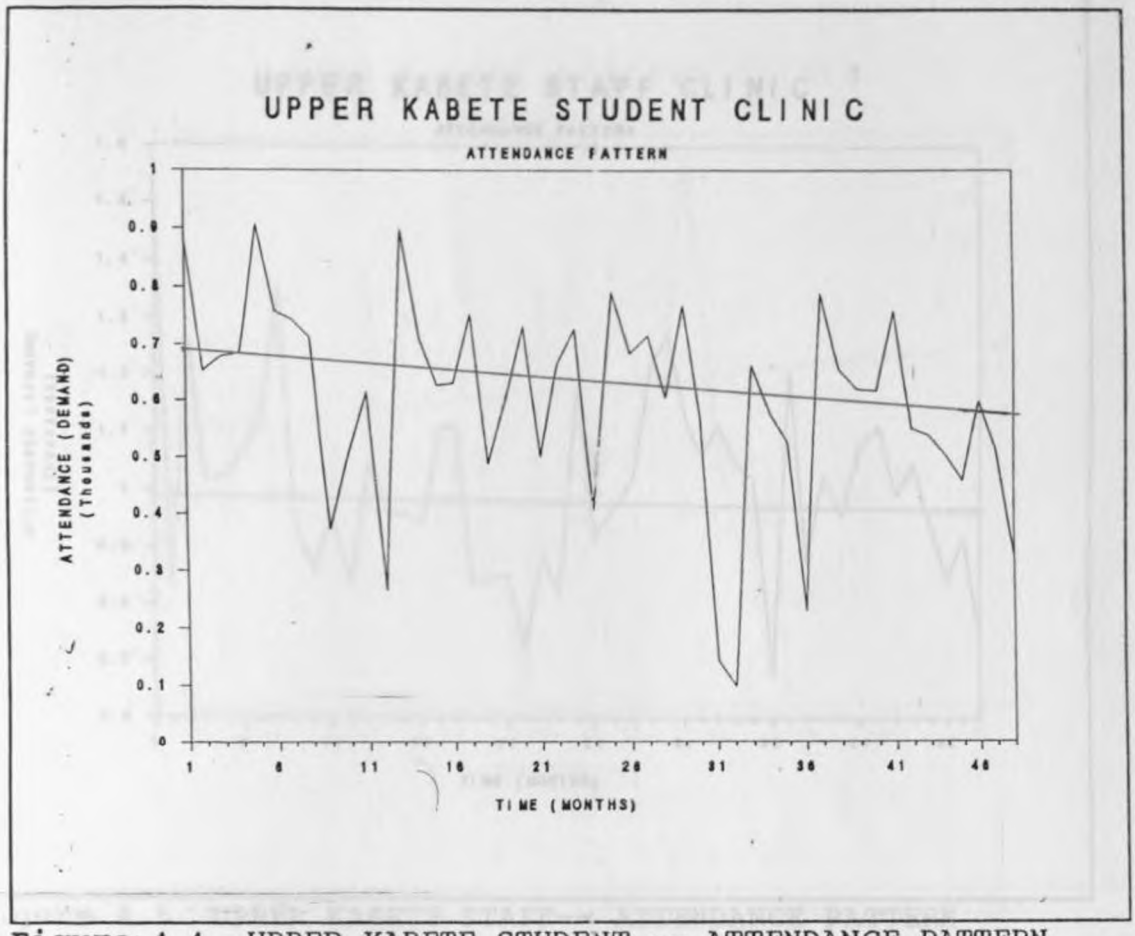

Figure 4.4 UPPER KABETE STUDENT -- ATTENDANCE PATTERN

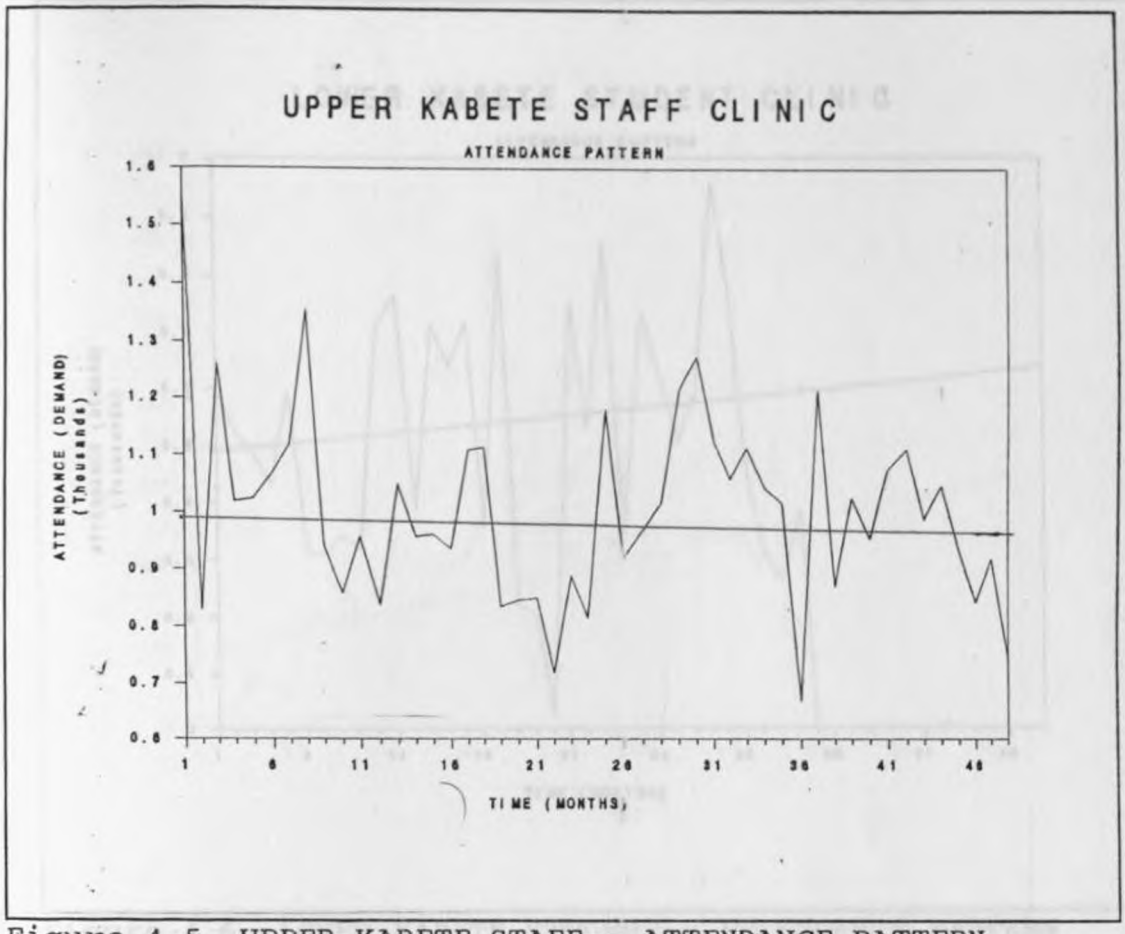

Figure 4.5 UPPER KABETE STAFF-- ATTENDANCE PATTERN

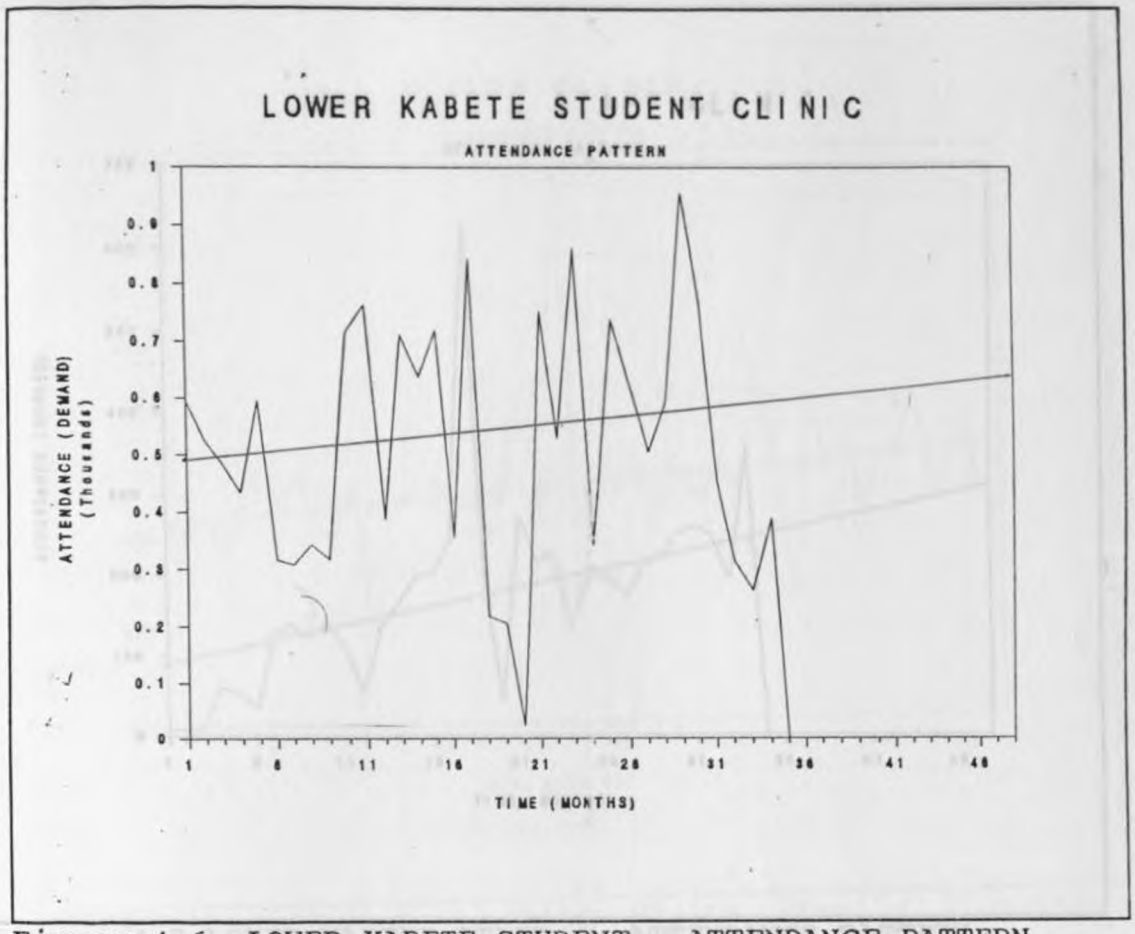

Figure 4.6 LOWER KABETE STUDENT-- ATTENDANCE PATTERN

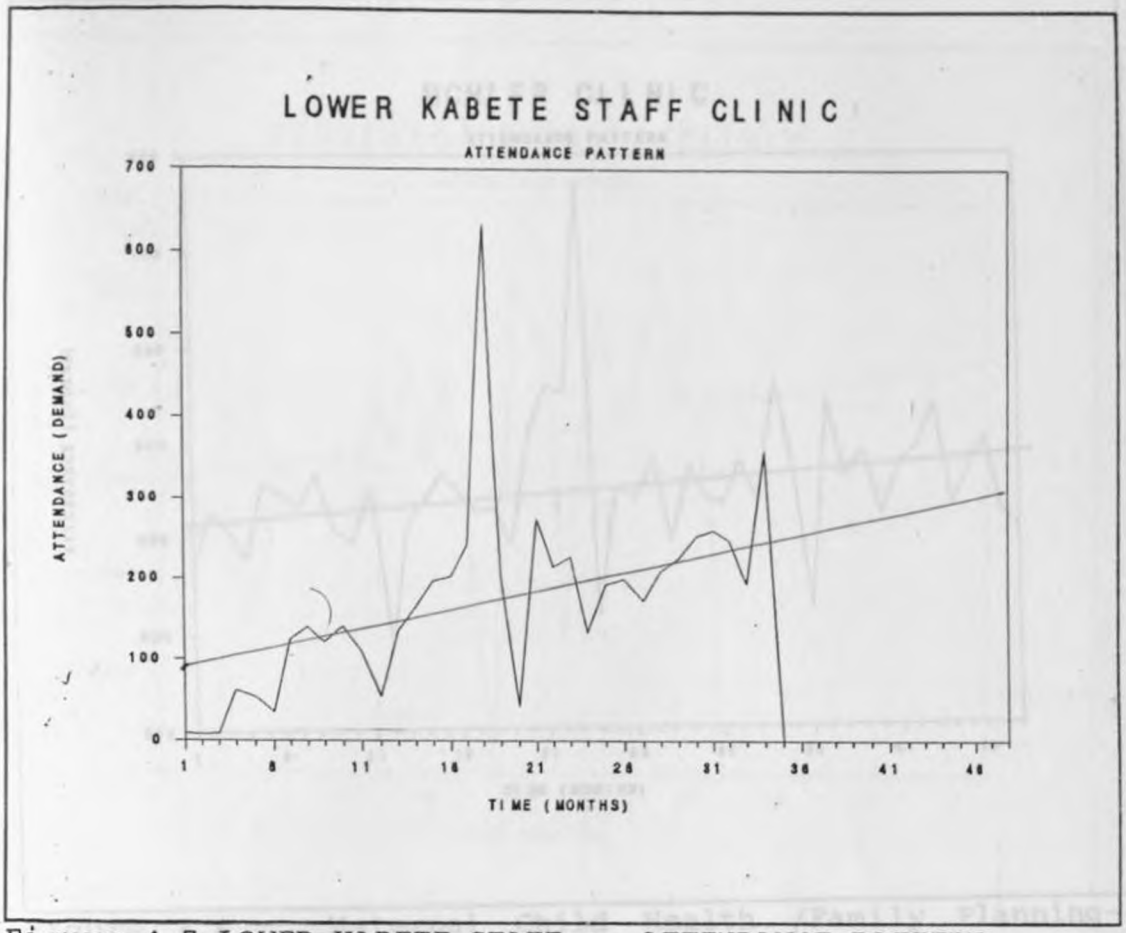

Figure 4.7 LOWER KABETE STAFF -- ATTENDANCE PATTERN

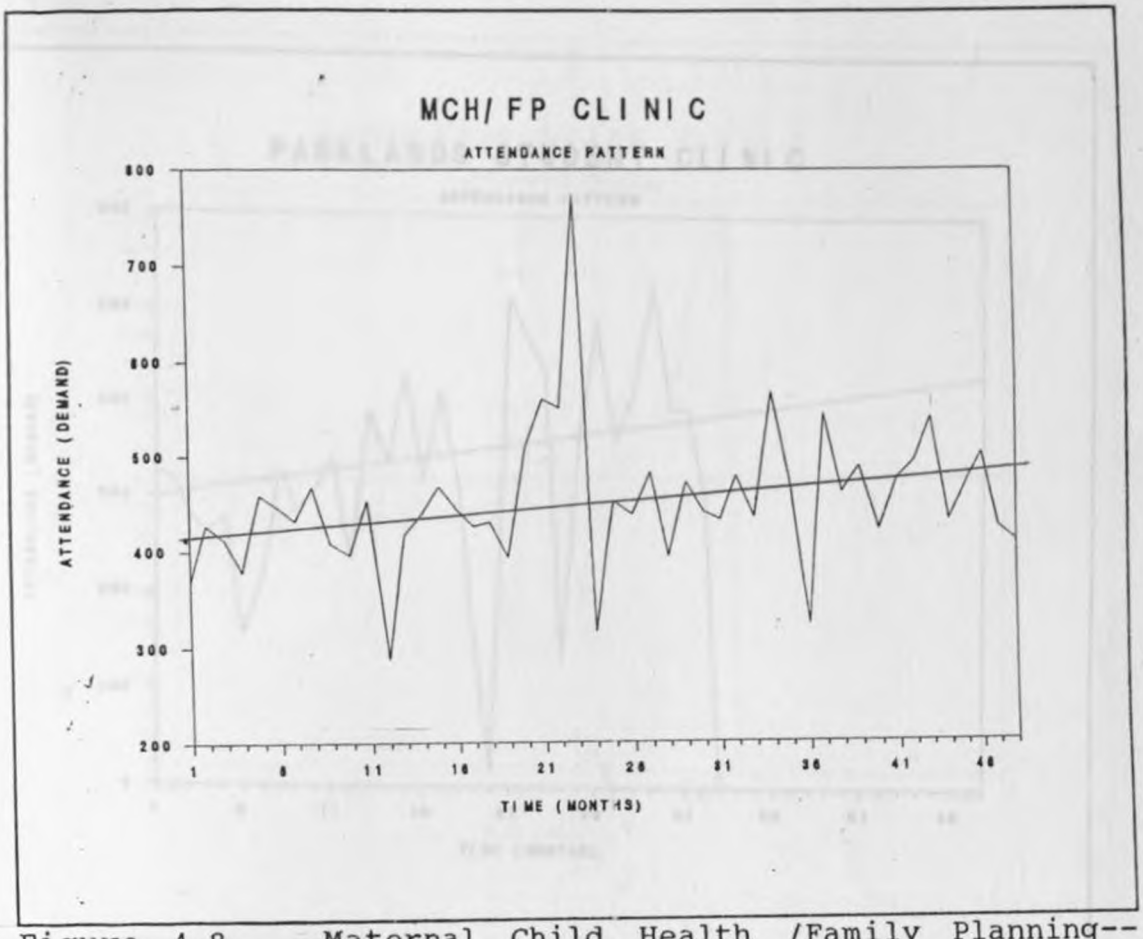

Figure 4.8 Maternal Child Health /Family Planning--ATTENDANCE PATTERN

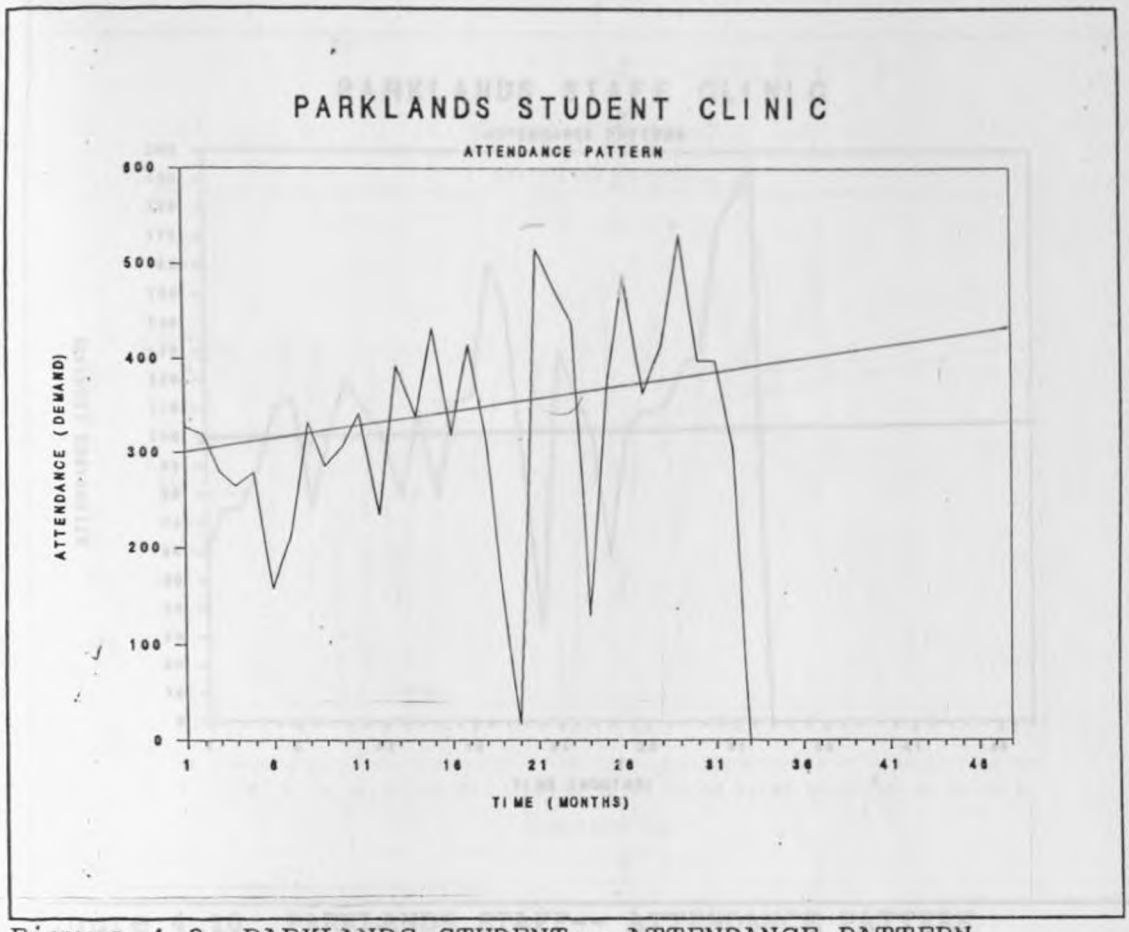

Figure 4.9 PARKLANDS STUDENT-- ATTENDANCE PATTERN

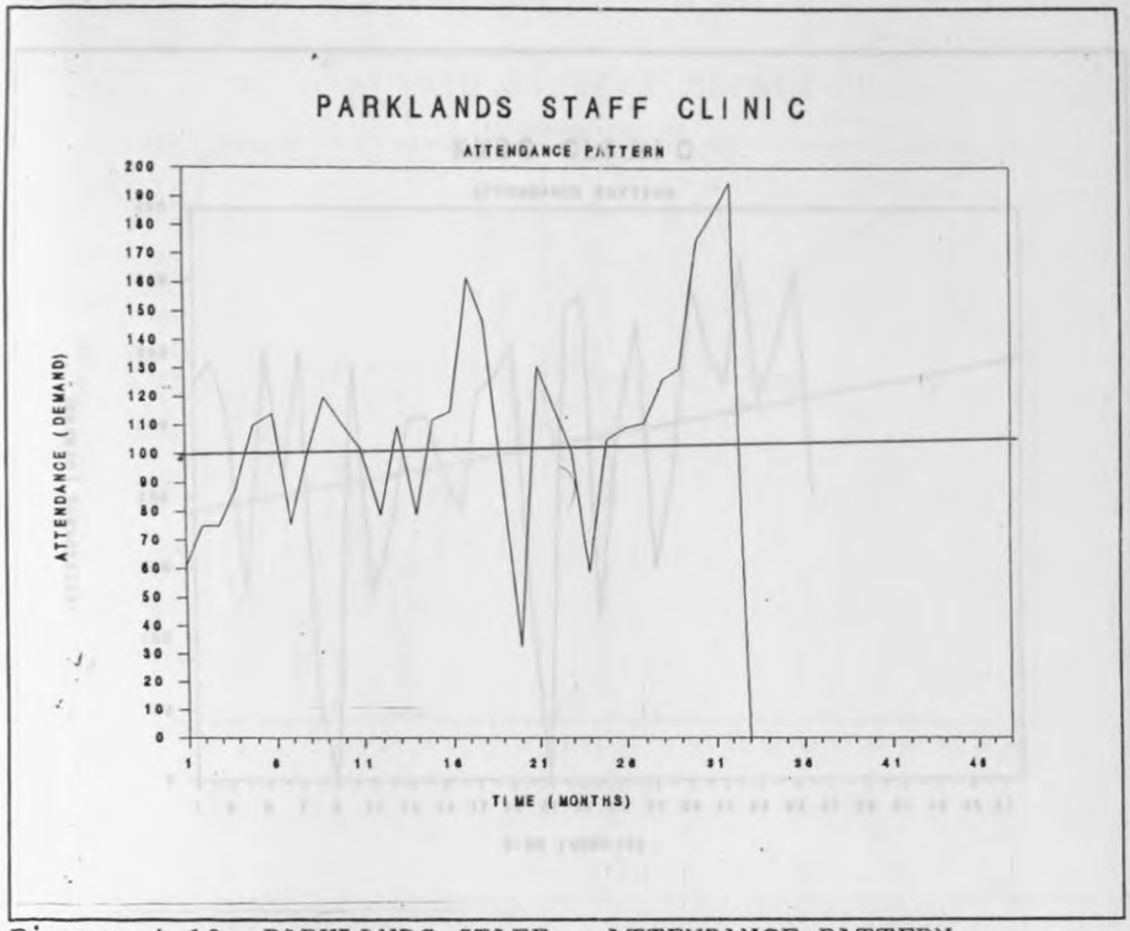

Figure 4.10 PARKLANDS STAFF-- ATTENDANCE PATTERN

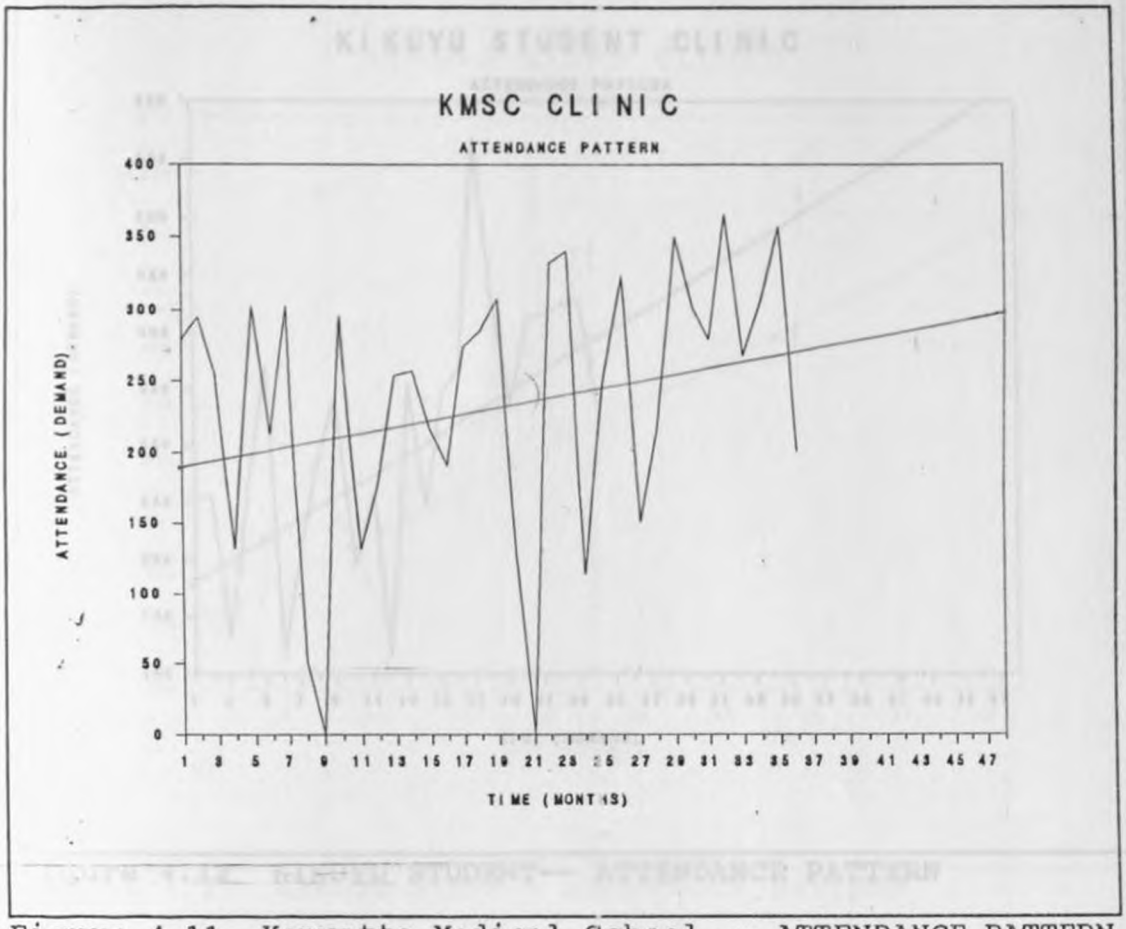

Figure 4.11 Kenyatta Medical School -- ATTENDANCE PATTERN

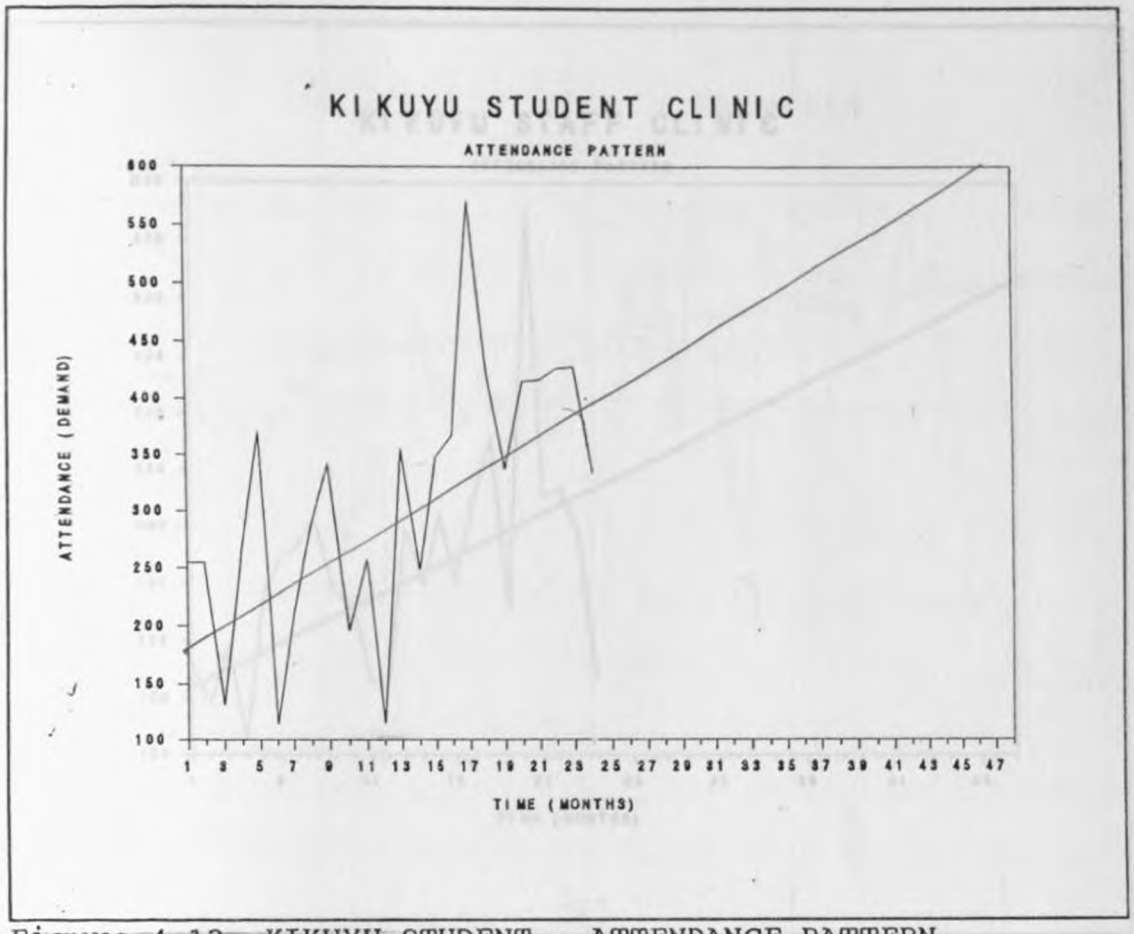

Figure 4.12 KIKUYU STUDENT-- ATTENDANCE PATTERN

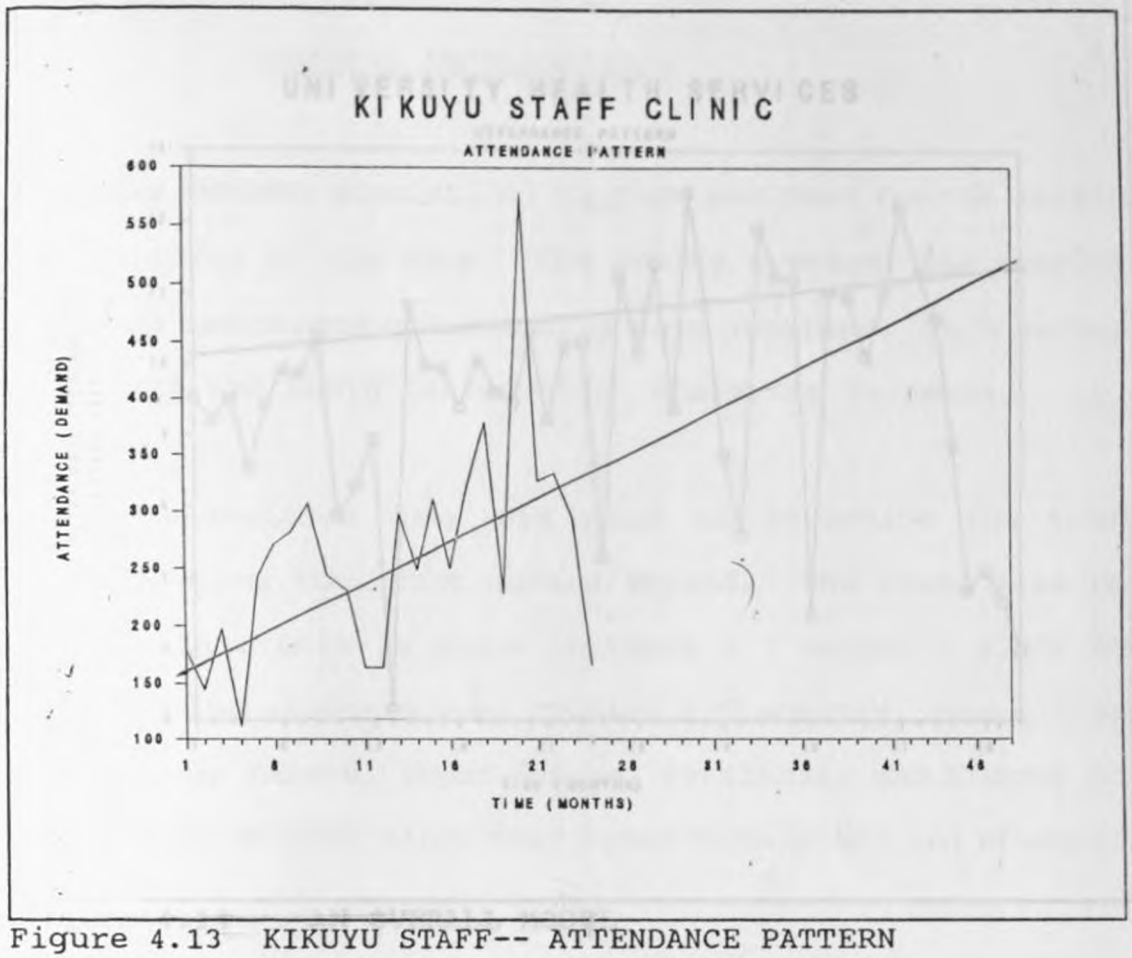

Figure 4.13 KIKUYU STAFF-- ATTENDANCE PATTERN

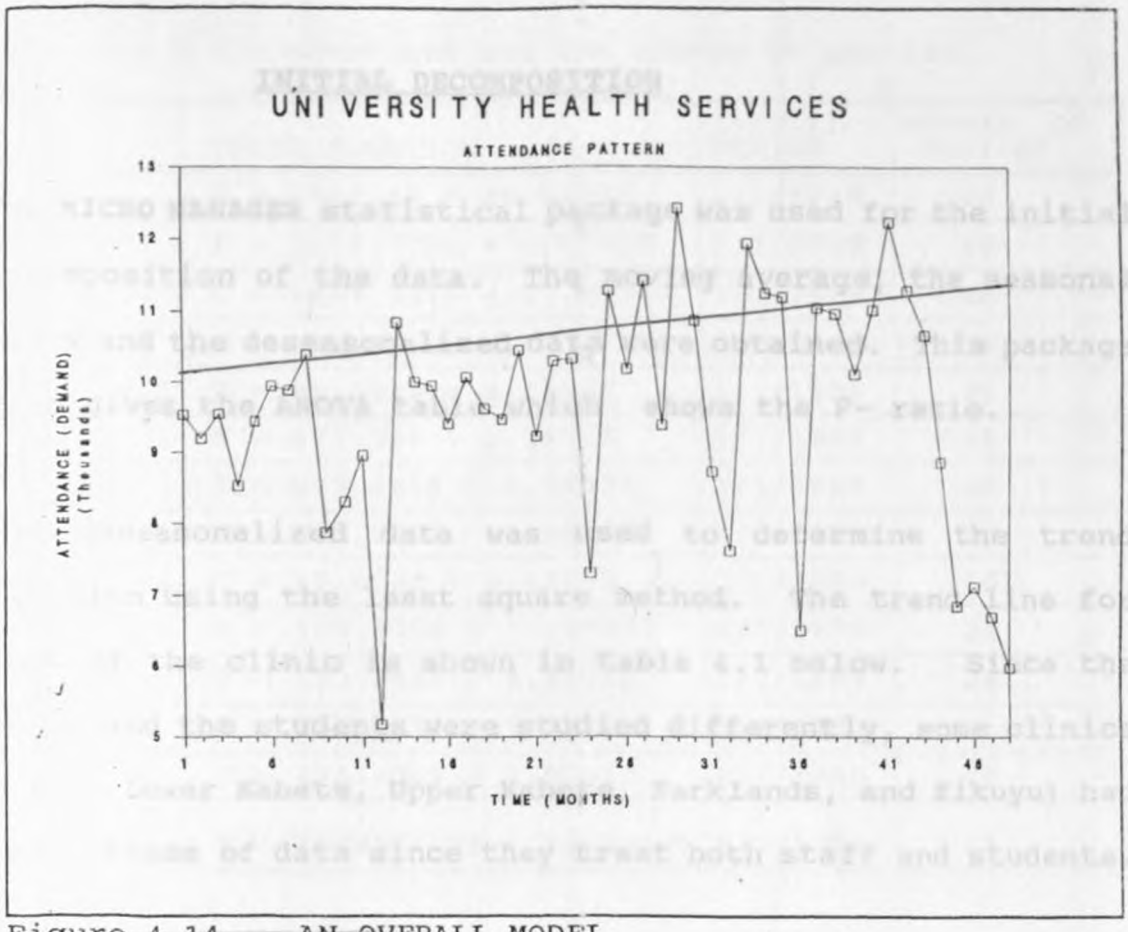

Figure 4.14 AN OVERALL MODEL

It can be seen from the graphs that the attendance pattern can be said to be time dependent for all the clinics. The highest demand occurs mostly during the month of June or July while the lowest occurs in the month of December each year, as explained in the conclusion.

4.2 INITIAL DECOMPOSITION

The **MICRO MANAGER** statistical package was used for the initial decomposition of the data. The moving average, the seasonal index and the deseasonalized data were obtained. This package also gives the ANOVA table which shows the F- ratio.

The deseasonalized data was used to determine the trend equation using the least square method. The trend line for each of the clinic is shown in table 4.1 below. Since the staff and the students were studied differently, some clinics (i.e. Lower Kabete, Upper Kabete, Parklands, and Kikuyu) had two streams of data since they treat both staff and students.

Table 4.1 also show the initial period at which X = 1. This is the reference point and should be considered when using the models in forecasting. For example Staff Annexe Clinic has 1/1/1988 as the origin. For this clinic then, Jan. 1988 is taken to have a value X = 1, while in Dec 1991 the X value is 48. The number of periods used in the development of the models are also shown in the same table.

Table 4.1 The trend equations and the number of periods.

CLINIC	TREND EQUATION	INITIAL PERIOD	NUMBER OF PERIODS
STAFF ANNEXE	T = 1943.43 + 10.0377X	1/1/1988	48
SENIOR STAFF	T = 2378.7722 + 4.6785X	1/1/1988	48
STUDENT	T = 2427.9184 - 11.9576X	1/1/1988	48
LOWER KABETE1*	T = 487.984 + 2.0399X	1/1/1989	36
LOWER KABETE 2	T = 88.7016 + 5.1212X	1/1/1989	36
UPPER KABETE 1	T = 677.310 - 3.3656X	1/1/1988	48
UPPER KABETE 2	T = 979.1658 + 0.7033X	1/1/1988	48
PARKLANDS 1	T = 285.9603 + 1.9646X	1/1/1989	36
PARKLANDS 2	T = 97.8730 + 0.4363X	1/1/1989	36
KIKUYU 1	T = 128.6159 + 13.4474X	1/1/1989	24
KIKUYU 2	T = 153.5435 + 8.5565X	1/1/1989	24
K.M.S.C.	T = 162.3714 + 3.3313X	1/1/1987	36
MCH/FP	T = 421.4947 + 1.3701X	1/1/1988	48
OVERALL	T = 10580.4935 + 34.1016X	1/1/1988	48

* 1 refers to student, while
2 refers to staff

T = The Trend Component.
X = Time in Months.

From the above table, it can be seen that the student clinic (at Main Campus) and Upper Kabete Student Clinic had a negative gradient. This implies that the attendance will continue decreasing. Although this should not be expected to continue in the future, it can be explained by the openning up of more campuses which somehow reduced the attendance in these two clinics.

4.3 THE TREND, SEASONAL COMPONENTS AND THE FORECAST

Table 4.2 to 4.14 summarizes the trend forecast, the seasonal components, the forecast and the actual attendance for each of the clinics. Table 4.15 summarizes the overall models' results. Note that the trend value should be multiplied by the seasonal(S) component of the related month so as to compute the forecast.

Table 4.2 STAFF (ANNEXE) - TREND AND SEASONAL FACTORS

YEAR OF VALIDATION: 1992				
MONTH	TREND FORECAST	S. FACTOR	FORECAST	ACTUAL
JAN.	2435.326	0.996	2426.608	1961
FEB.	2445.366	0.953	2331.155	1981
MAR.	2455.406	1.006	2470.242	2086
APR.	2465.445	0.935	2304.803	1647
MAY	2475.485	1.139	2820.562	2132
JUN.	2485.525	1.130	2809.543	2128
JUL.	2495.565	1.096	2734.724	2192
AUG.	2505.604	1.124	2815.583	2154
SEP.	2515.644	0.979	2463.889	2005
OCT.	2525.684	0.974	2459.033	1788
NOV.	2535.724	0.937	2375.963	--
DEC.	2545.764	0.730	1858.557	--

Table 4.3 SENIOR STAFF - TREND AND SEASONAL FACTORS

YEAR OF VALIDATION: 1992				
MONTH	TREND FORECAST	S. FACTOR	FORECAST	ACTUAL
JAN.	2616.344	1.031	2698.494	2760
FEB.	2621.276	0.950	2489.837	2546
MAR.	2626.209	0.967	2539.141	2535
APR.	2631.142	0.967	2543.794	2394
MAY	2636.075	1.024	2699.195	2404
JUN.	2641.007	1.109	2929.625	3107
JUL.	2645.940	1.121	2966.460	3263
AUG.	2650.873	1.146	3036.682	3103
SEP.	2655.806	0.985	2615.986	2836
OCT.	2660.739	0.947	2519.196	1996
NOV.	2665.671	0.986	2628.456	2322
DEC.	2670.604	0.767	2049.267	2249

Table 4.4 STUDENT CLINIC - TREND AND SEASONAL FACTOR

YEAR OF VALIDATION:1992				
MONTH	TREND FORECAST	S. FACTOR	FORECAST	ACTUAL
JAN.	1841.316	1.194	2199.363	--
FEB.	1829.338	1.347	2463.561	424
MAR.	1817.360	1.285	2335.117	1887
APR.	1805.382	1.143	2063.915	--
MAY	1793.404	1.247	2236.027	2382
JUN.	1781.427	1.066	1898.273	2489
JUL.	1769.449	0.903	1597.724	--
AUG.	1757.471	0.685	1203.767	--
SEP.	1745.493	0.819	1430.198	1464
OCT.	1733.515	0.930	1612.685	1353
NOV.	1721.537	0.939	1617.382	2185
DEC.	1709.559	0.441	754.435	1183

Table 4.5 MATERNAL CHILD HEALTH/FAMILY PLANNING - TREND AND SEASONAL FACTOR

YEAR OF VALIDATION: 1992				
MONTH	TREND FORECAST	S. FACTOR	FORECAST	ACTUAL
JAN.	488.620	0.997	487.155	475
FEB.	489.989	0.990	485.207	400
MAR.	491.359	1.034	508.029	518
APR.	492.728	0.912	449.520	534
MAY	494.098	1.018	503.055	607
JUN.	495.467	1.002	496.293	473
JUL.	496.837	0.990	491.870	510
AUG.	498.207	1.041	518.625	476
SEP.	499.576	1.029	514.163	489
OCT.	500.946	1.100	551.179	448
NOV.	502.315	1.161	583.403	594
DEC.	503.685	0.725	365.089	429

Table 4.6 LOWER KABETE STUDENT - TREND AND SEASONAL FACTORS

YEAR OF VALIDATION: 1992				
MONTH	TREND FORECAST	S. FACTOR	FORECAST	ACTUAL
JAN.	561.635	1.417	795.702	---
FEB.	563.640	1.232	694.423	---
MAR.	565.644	1.181	668.227	591
APR.	567.649	0.945	536.257	191
MAY	569.653	1.626	926.474	799
JUN.	571.658	0.869	496.957	600
JUL.	573.663	0.654	375.045	680
AUG.	575.667	0.462	265.921	659
SEP.	577.672	0.900	519.743	637
OCT.	579.676	1.109	642.951	381
NOV.	581.681	1.108	644.664	460
DEC.	583.685	0.497	289.850	724

Table 4.7 LOWER KABETE STAFF - TREND AND SEASONAL FACTORS

YEAR OF VALIDATION: 1992				
MONTH	TREND FORECAST	S. FACTOR	FORECAST	ACTUAL
JAN.	278.115	0.720	200.275	---
FEB.	283.232	0.778	220.394	---
MAR.	288.350	0.791	227.942	178
APR.	293.467	1.027	301.356	205
MAY	298.585	1.083	323.371	222
JUN.	303.702	1.869	567.746	238
JUL.	308.820	1.223	377.757	266
AUG.	313.937	0.885	277.814	195
SEP.	319.055	1.182	376.984	216
OCT.	324.172	1.334	432.348	199
NOV.	329.290	0.721	237.461	172
DEC.	334.407	0.387	129.545	262

Table 4.8 UPPER KABETE STUDENT - TREND AND SEASONAL FACTORS

YEAR OF VALIDATION: 1992				
MONTH	TREND FORECAST	S. FACTOR	FORECAST	ACTUAL
JAN.	512.391	1.364	698.725	454
FEB.	509.026	1.105	562.224	358
MAR.	505.661	1.085	548.730	---
APR.	502.296	1.046	525.428	505
MAY	498.931	1.321	659.305	494
JUN.	495.566	0.983	487.173	493
JUL.	492.201	0.838	412.639	544
AUG.	488.836	0.849	414.996	448
SEP.	485.471	0.854	414.623	415
OCT.	482.105	1.006	484.853	537
NOV.	478.740	1.018	487.411	587
DEC.	475.375	0.531	252.390	----

Table 4.9 UPPER KABETE STAFF -TREND AND SEASONAL FACTORS

YEAR OF VALIDATION: 1992				
MONTH	TREND FORECAST	S. FACTOR	FORECAST	ACTUAL
JAN.	1013.661	1.248	1265.402	1065
FEB.	1014.366	0.893	905.518	943
MAR.	1015.071	1.052	1068.306	----
APR.	1015.776	0.978	993.514	969
MAY	1016.481	1.101	1118.845	1080
JUN.	1017.186	1.136	1155.484	1099
JUL.	1017.891	1.011	1028.877	1151
AUG.	1018.596	1.071	1091.008	1025
SEP.	1019.301	0.953	971.048	927
OCT.	1020.006	0.859	876.117	936
NOV.	1020.711	0.938	957.094	837
DEC.	1021.416	0.761	776.908	----

Table 4.10 PARKLANDS STUDENT - TREND AND SEASONAL FACTOR

YEAR OF VALIDATION: 1992				
MONTH	TREND FORECAST	S. FACTOR	FORECAST	ACTUAL
JAN.	359.288	1.267	455.285	----
FEB.	361.280	1.319	476.508	-----
MAR.	363.271	1.239	449.981	344
APR.	365.263	1.135	414.572	376
MAY	367.255	1.378	506.178	484
JUN.	369.246	0.968	357.423	323
JUL.	371.238	0.847	314.335	423
AUG.	373.230	0.739	275.710	108
SEP.	375.222	0.916	343.791	206
OCT.	377.213	0.888	334.961	103
NOV.	379.205	0.886	335.805	286
DEC.	381.197	0.419	159.614	196

Table 4.11 PARKLANDS STAFF - TREND AND SEASONAL FACTORS

YEAR OF VALIDATION: 1992				
MONTH	TREND FORECAST	S. FACTOR	FORECAST	ACTUAL
JAN.	113.734	0.957	108.875	----
FEB.	114.168	0.910	103.894	----
MAR.	114.603	1.027	117.704	96
APR.	115.037	1.130	129.944	121
MAY	115.471	1.379	159.219	170
JUN.	115.905	1.483	171.877	147
JUL.	116.340	1.193	138.762	170
AUG.	116.774	1.099	128.330	82
SEP.	117.208	0.869	101.804	149
OCT.	117.643	0.783	92.077	124
NOV.	118.077	0.698	82.359	107
DEC.	118.511	0.474	56.156	90

Table 4.12 KIKUYU STUDENT - TREND AND SEASONAL FACTORS

YEAR OF VALIDATION: NONE				
MONTH	TREND FORECAST	S. FACTOR	FORECAST	ACTUAL
JAN.	462.865	1.361	632.564	-----
FEB.	478.317	1.112	531.862	-----
MAR.	491.769	0.841	413.590	-----
APR.	505.221	1.153	582.417	-----
MAY	518.678	1.601	830.385	-----
JUN.	532.125	0.775	412.491	-----
JUL.	545.577	0.832	454.028	-----
AUG.	559.029	1.035	578.813	-----
SEP.	572.481	1.092	625.047	-----
OCT.	585.933	0.801	469.594	-----
NOV.	599.385	0.876	524.800	-----
DEC.	612.837	0.521	319.231	-----

Table 4.13 KIKUYU STAFF -TREND AND SEASONAL FACTORS

YEAR OF VALIDATION: NONE				
MONTH	TREND FORECAST	S. FACTOR	FORECAST	ACTUAL
JAN.	367.602	1.100	404.426	----
FEB.	376.169	0.869	326.758	----
MAR.	384.737	1.089	419.115	----
APR.	393.305	0.719	282.718	----
MAY	401.873	1.145	460.189	----
JUN.	410.440	1.260	517.275	----
JUL.	419.008	1.008	422.152	----
AUG.	427.576	1.562	667.702	----
SEP.	436.144	1.006	438.739	----
OCT.	444.712	0.958	426.207	----
NOV.	453.279	0.740	335.605	----
DEC.	461.847	0.544	251.131	----

Table 4.14 KENYATTA MEDICAL SCHOOL - TREND AND SEASONAL FACTORS

YEAR OF VALIDATION: 1990				
MONTH	TREND FORECAST	S. FACTOR	FORECAST	ACTUAL
JAN.	285.824	1.233	352.469	355
FEB.	289.161	1.338	336.943	305
MAR.	292.498	0.968	283.213	284
APR.	295.835	0.778	230.103	253
MAY	299.172	1.344	402.082	357
JUN.	302.509	1.126	340.510	410
JUL.	305.846	1.266	387.289	342
AUG.	309.183	0.678	209.675	134
SEP.	312.520	0.308	96.215	347
OCT.	315.857	1.263	398.786	322
NOV.	319.197	1.053	336.098	352
DEC.	322.531	0.645	208.091	127

Table 4.15 OVERALL MODEL - TREND AND SEASONAL FACTORS

YEAR OF VALIDATION: 1992				
MONTH	TREND FORECAST	S. FACTOR	FORECAST	ACTUAL
JAN.	10614.595	1.135	12043	----
FEB.	10648.697	1.068	11370	----
MAR.	10682.798	1.083	11572	9529
APR.	10716.900	1.006	10784	9270
MAY	10751.002	1.154	12411	8670
JUN.	10785.103	1.089	11745	9996
JUL.	10819.205	1.010	10923	11418
AUG.	10853.306	0.974	10571	10935
SEP.	10887.408	0.929	10114	9662
OCT.	10921.510	0.955	10433	8100
NOV.	10955.611	0.959	10501	9604
DEC.	10989.713	0.638	7015	8345

It can be seen from the tables above that the forecasted attendance is very close to the actual attendance for all the clinics. It is also clear that December has the lowest attendance. This is expected since the University closes for at least two weeks during this month. In most clinics, the attendance figures for the staff are higher than the students'. This implies that the staff (together with their dependants) use the health services more than the students.

4.4 MODEL SUITABILITY AND THE PREDICTIVE POWER

The next step was to analyze the suitability of the use of time series to fit the model. This was done by the use of the F - ratios which were computed by the MICRO MANAGER package. As can be seen in table 4.15 below, it is only Upper Kabete 2 (i.e. staff) that has an F - ratio that is less than the critical F at 5 percent significance level. This implies that for all the other clinics we reject the hypothesis that the attendance is not time dependent. We therefore accept the hypothesis that the attendance is time dependent. This together with the line graphs shown in section 4.1 can also be used to conclude that the data for these clinics is autocorrelated and thus suitable for fitting a time series model.

For the Upper Kabete 2 data we accept the hypothesis that the data is not time dependent and therefore not autocorrelated. However, when validating this model it was found to have a very low Theil's U coefficient and thus a high predictive power. For this reason, the model for this clinic was also included in the analysis.

Table 4.15 also shows the computed Theil's U- coefficient. (The U formula is shown on section 3.4). From the table, it can be seen that the models have a relatively high predictive power. The

highest having a predictive power of 95.47% while the lowest's power is 71.78%. 1992 was used for the validation for all the clinics except Kenyatta Medical school (for which 1990 was used) and Kikuyu Campus Clinic (for which data for validation was not available and thus the predictive power could not be ascertained). However, it is expected that the developed model is suitable given the fact that the clinic operates like any other clinic in the University.

Table 4.16 Models' fitness and the predictive power.

CLINIC	COMPUTED F - RATIOS	CRITICAL F - (.05)	THEIL'S U COEFFIC.	PRED. POWER
STAFF ANNEXE	36.423	4.12	0.1243	87.57%
SENIOR STAFF	23.833	4.12	0.0494	95.06%
STUDENT	21.765	4.12	O.2223	77.77%
LOWER KABETE 1	4.707	4.28	0.2277	77.23%
LOWER KABETE 2	30.933	4.28	0.2822	71.78%
UPPER KABETE 1	50.995	4.12	0.1252	87.48%
UPPER KABETE 2	1.012	4.12	0.0453	95.47%
KIKUYU 1	777.982	4.84	--- *	---
KIKUYU 2	760.989	4.84	--- *	---
K.M.S.C.	138.935	4.28	0.1559	84.41%
MCH/FP	23.044	4.12	0.0594	94.06%
PARKLANDS 1	6.122	4.28	0.1706	82.94%
PARKLANDS 2	5.115	4.28	0.1218	87.82%
OVERALL	45.213	4.12	0.0883	91.17%

* Data to validate the model was not available.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

The major objective of this study was to determine predictive models which can be used to predict demand for the University health services. This was mainly with a view of using the model to predict demand for these services in the future.

Time series models of the form $Y = b_0 + b_1T$ (where Y= Demand, T= time in months and b_i's =constants) were therefore developed and validated for each of the outpatient clinics in the University. These clinics are:

-Staff (Annexe) clinic

-Senior staff clinic

-Student clinic

-Maternal Child Health/ Family Planning (MCH/FP)

-Kenyatta Medical School Clinic (KMSC)

-Upper Kabete student clinic

-Upper Kabete staff clinic

-Lower Kabete student clinic

-Lower Kabete staff clinic

-Parklands student clinic

-Parklands staff clinic

-Kikuyu student clinic

-Kikuyu staff clinic

Their predictive power was also assessed. It was found that the models had a predictive power of between 95.47% and 71.78%. The F-test was also carried on each of the clinics indicating that twelve out of the thirteen models are time dependent and thus justifying the use of time series analysis. The overall model was also developed and its predictive power is 91.17%.

From the developed models, it is evident that the number of patients attending the clinics on monthly basis can be predicted with reasonable accuracy. Therefore, the clinics' administrator can be able to forecast (at least in the short run), using these models, the number of both students and staff who will require the clinics' services on a monthly basis. It is hoped that these models will help in shortening the long queues in the clinics. The prior estimate of the demand will also help in timely acquisition of drugs and other facilities required in the clinics, and in scheduling the clinics' staff.

Some clinics are not very careful in the way they handle the attendance records and some of the people keeping these records are not trained. It is recommended that such people should be trained and the records well filed. The clinics administrator should make sure that these records are in order.

5.2 LIMITATIONS

Although there were no problems encountered in data collection and analysis, certain limitations were evident such as:

1. All the Public Universities in Kenya have been faced by frequent closures due to lecture boycots and scheduling of term dates. Although this has become a frequent phenomena, the 1991 closure cannot be termed as normal. This is a time when the University was closed for almost six months. (From Oct. 1991 to Mar. 1992). This meant that some clinics were closed while others operated below capacity. This was treated as an irregular pattern and so no adjustment was carried out on the data. This however may have affected some models' predictive power, especially the ones dealing with students.

2. In some clinics, especially Kikuyu and Kenyatta Medical School(KMSC), data on certain periods was missing. For this reason, only twenty four data points were available for Kikuyu Campus clinic, and therefore the model could not be validated.

3. The data for this study was obtained from monthly summaries which are computed from the original record books. Some students sign the book but do not wait to be treated. For this reason the

attendance total may be exaggerated. However, this is not a very common phenomena.

4. Time series models are generally for short term forecasting and thus cannot be of use in long term forecasting. However, this problem could be overcome if the models can be revised regularly by incorporating recent data as it becomes available.

5. Moving averages tend to deflate, or depress, the magnitude of oscillations in a series. The larger the number of terms employed in the average, the greater the deflation. Therefore, the greater the degree of smoothing, the less realistic the resulting movements. This would make the predictive power of the models to be low. However, the models developed were found to have a high predictive power and thus the above problem is not likely to have occurred.

6. Not only do moving averages deflate the magnitude of the movements, but also they anticipate rapid changes before the changes occur. They, therefore can cause considerable difficulties since they tend to produce cyclical movements in data, even though such movements do not exist in the original data. In others words, if one starts with a set of random data and applies a moving average to such data, one may generate a new series that appears to have fairly regular cyclical movements in

it. The practical implications of this undesirable property of moving averages is that the business analyst who uses moving averages to smooth data, while in the process of trying to discover business cycle, is likely to come up with non- existence cycle. This may have affected the analysis in this study.

5.3 RECOMMENDATIONS FOR FURTHER STUDY

There are factors which may influence the demand for the health services in the University clinics such as the number of students in the campus at any particular time, the service rate of the doctors, the number of personnel or the availability of drugs. Therefore, it is recommended that any further study in this area could try to establish if any relationship exist between these factors. This may result to better causal predictive models.

It has also been pointed out that the staff clinics have more attendance figures than the student clinics. It would be interesting to study this relationship and come up with explanations for this tendancy.

A similar study may also be done in other University clinics before the models can be generalized for the use in these clinics.

APPENDIX

THE MODEL DEVELOPMENT DATA

STAFF ANNEXE CLINIC

	1988	1989	1990	1991
JAN	1715	2001	2374	2345
FEB	1899	1846	2204	2126
MAR	2011	1963	2478	2102
APR	1749	1881	2031	2358
MAY	2220	2073	2989	2522
JUN	2501	2354	2580	2273
JUL	2184	2401	2458	2448
AUG	2510	2518	2479	2230
SEP	1975	2267	2379	1919
OCT	1727	2474	2395	1951
NOV	1838	2178	2390	1847
DEC	1253	1794	1603	1846

SENIOR STAFF CLINIC

	1988	1989	1990	1991
JAN	1961	2568	2658	2986
FEB	2235	2542	2088	2491
MAR	2176	2669	2399	2296
APR	2175	2531	2271	2592
MAY	2168	2644	2712	2636
JUN	2631	3038	2560	2780
JUL	2669	2770	2509	3217
AUG	2819	2969	2775	2850
SEP	2333	2456	2514	2539
OCT	2238	2319	2497	2426
NOV	2298	2421	2559	2618
DEC	1730	1680	1978	2343

STUDENT CLINIC

	1988	1989	1990	1991
JAN	3055	2912	2448	1732
FEB	3153	2570	2598	2910
MAR	2999	2402	2889	2392
APR	2515	2128	2052	2697
MAY	2652	2021	2589	2898
JUN	2533	1568	2101	2457
JUL	2733	1733	1374	1592
AUG	2517	1946	579	700
SEP	1838	1732	3132	10
OCT	2571	2278	2813	0
NOV	2790	1994	2581	312
DEC	793	1504	992	262

MCH/FP CLINIC

	1988	1989	1990	1991
JAN	368	417	451	542
FEB	427	439	437	460
MAR	412	468	482	487
APR	378	443	393	420
MAY	459	426	471	473
JUN	445	430	439	492
JUL	432	393	431	538
AUG	468	508	477	430
SEP	408	559	434	470
OCT	396	550	565	500
NOV	453	773	468	422
DEC	289	316	323	407

UPPER KABETE STUDENT CLINIC

	1988	1989	1990	1991
JAN	883	900	790	788
FEB	653	710	583	652
MAR	679	626	715	618
APR	685	629	604	615
MAY	906	753	768	759
JUN	758	488	569	549
JUL	744	601	142	537
AUG	713	733	98	501
SEP	373	500	660	458
OCT	506	663	574	597
NOV	614	727	524	514
DEC	265	406	228	325

UPPER KABETE STAFF CLINIC

	1988	1989	1990	1991
JAN	1552	1050	1180	1215
FEB	829	958	921	871
MAR	1266	962	969	1026
APR	1019	937	1015	955
MAY	1024	1109	1214	1076
JUN	1068	1114	1274	1112
JUL	1118	835	1124	989
AUG	1356	846	1059	1048
SEP	942	850	1113	934
OCT	859	719	1043	843
NOV	958	889	1016	920
DEC	838	816	669	746

LOWER KABETE STUDENT CLINIC

	1989	1990	1991
JAN	594	712	739
FEB	527	638	622
MAR	487	721	506
APR	435	356	591
MAY	596	842	955
JUN	317	218	760
JUL	309	206	454
AUG	343	24	314
SEP	318	752	263
OCT	717	530	390
NOV	763	860	0
DEC	389	342	0

LOWER KABETE STAFF CLINIC

	1989	1990	1991
JAN	9	136	194
FEB	8	166	200
MAR	9	198	174
APR	62	203	210
MAY	54	243	226
JUN	35	634	254
JUL	125	207	261
AUG	141	43	248
SEP	122	275	195
OCT	142	216	360
NOV	111	228	0
DEC	55	135	0

PACKLANDS STUDENT CLINIC

	1989	1990	1991
JAN	327	393	365
FEB	319	339	488
MAR	280	434	364
APR	265	319	415
MAY	279	416	531
JUN	159	314	398
JUL	213	153	398
AUG	333	18	305
SEP	286	517	0
OCT	306	475	0
NOV	342	439	0
DEC	235	131	0

PARKLANDS STAFF CLINIC

	1989.	1990	1991
JAN	61	110	105
FEB	75	79	109
MAR	75	112	111
APR	88	115	126
MAY	110	162	130
JUN	114	147	175
JUL	76	94	185
AUG	100	33	195
SEP	120	131	0
OCT	111	116	0
NOV	102	101	0
DEC	79	59	0

KIKUYU CLINIC

	STUDENT		STAFF	
	1988	1989	1988	1989
JAN	255	356	179	298
FEB	255	249	145	249
MAR	132	348	198	311
APR	264	367	112	250
MAY	371	571	243	324
JUN	114	425	271	379
JUL	209	337	282	228
AUG	287	415	307	579
SEP	342	416	244	327
OCT	196	426	231	334
NOV	258	428	164	294
DEC	115	334	164	166

KMSC CLINIC

	1988	1989	1990
JAN	279	254	251
FEB	295	257	324
MAR	254	217	151
APR	132	191	217
MAY	303	274	350
JUN	213	285	301
JUL	303	308	279
AUG	51	123	366
SEP	0	0	268
OCT	296	332	307
NOV	132	340	357
DEC	178	114	201

THE OVERALL MODEL

	1988	1989	1990	1991
JAN	9535	10852	11277	11048
FEB	9198	10008	10179	10967
MAR	9542	9956	11424	10115
APR	8528	9415	9387	10019
MAY	9434	10082	12435	12247
JUN	9942	9635	10866	11292
JUL	9887	9475	8729	10662
AUG	10391	10457	7617	8865
SEP	7878	9231	11940	6833
OCT	8307	10301	11258	7113
NOV	8962	10323	11201	6680
DEC	5180	7298	6496	5977

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