STATISTICAL FORECASTING AS A METHOD OF MANAGEMENT AND CONTROL OF INVENTORY A CASE FOR GUEST SOAP AT BLOCK LODGES A SUBSIDIARY OF BLOCK HOTELS MANAGEMENT LIMITED

BY

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A PROJECT SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTERS OF BUSINESS ADMINISTRATION

FACULTY OF COMMERCE
UNIVERSITY OF NAIROBI
N A I R O B I, KENYA

SEPTEMBER, 1983

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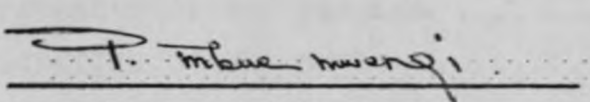

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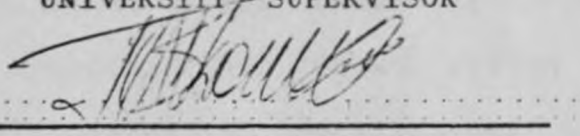

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SYNOPSIS

Guest Soap is a twenty grammes soap tablet supplied to overnight guests in all Block Lodges and Hotels. It is one of the seven hundred items purchased and supplied to Block Lodges and Hotels by the Central Stores of Block Lodges. Guest Soap is purchased from East African Industries in cartons of 144 specially labeled guest soap tablets.

Due to continously increasing cost of capital, Block Lodges Management have made various studies in an attempt to reduce inventory management costs, through improved management and control systems. Currently, inventories are managed and controlled through a periodic-review-system.

In this project, the author uses Economic Ordering Quantity Model and Statistical Forecasting Techniques in an attempt to reduce inventory management costs, at the same time improving management and control systems. This system has resulted to a $33\frac{1}{3}\%$ reduction in inventory management cost. Besides the cost reduction, it provides a more efficient and reliable system of inventory management and control at the Block Lodges Central Stores.

ACKNOWLEDGEMENT

This study is dependent on data and information gathered from various departments of Block Hotels (Management) Limited. The main sources includes the Block Lodges Central Stores and the Accounts Department. I would like to extend my thanks to the respective heads of departments and their subordinates for providing me with useful information and data.

I would like to thank Block Hotels (Management) Limited, my employer, for providing me with a grant to undertake this study. Special thanks go to Mr. D.J. Francis the Executive Director for the support and encouragement. I am particularly indebted to Mr. J.B. Lukoma my supervisor for his inspiration and guidance, Mr. J.O. Onyango for his advice and Mr. Tom Kityo for introducing me to inventory models. Special appreciation goes to my beloved wife Minnie for her understanding, patience and encouragement while I worked late hours.

To all those whose views and comments helped me with my first draft, I express gratitude. I am especially grateful to P. King'ori for devoting long hours to typing the final draft.

CHAPTER 1

INTRODUCTION

Block Lodges is a subsidiary of Block Hotels (Management) Limited. The other subsidiaries are; Nyali Beach Hotel, Norfolk Hotel, Bacchus Club, and Block Hotels properties division. Seven hotels and lodges form the Block Lodges, these are; Lake Naivasha Hotel, Lake Baringo Club, Outspan Hotel, Treetops, Keekorok Lodge, Samburu Lodge, and River Lodge Samburu. These Hotels and Lodges are situated in different parts of the country, which have tourist attraction. Due to dispersion of the Hotels and Lodges, and their locality in remote parts of the country, a Central Stores Department was established and located in Nairobi. The purpose and function of these stores is to purchase and deliver goods to all units of Block Lodges.

One of the items purchased and delivered to the lodges by the Central Stores is the Guest Soap. This is a 20 grammes soap tablet supplied to overnight guests and all units of Block Lodges. Guest Soap is purchased from the East African Industries in cartons of 144 soap tablets. To maintain the expected high level of service in the tourist industry, Central Stores must ensure that adequate quantities of Guest Soap are available whenever required by the Lodges and Hotels. The aim of this study is to use economic ordering quantity model, and statistical forecasting techniques, to reduce the current level of inventory management cost, at the same time providing improved management and control techniques of inventories at the Block Lodges.

I. Statement of the Problem

Management of inventories is just as important as management of cash, since inventory is "cash" (resources) temporalily held idle in the form of goods. As at

financial year ending 30th September 1982, the book value of inventories formed 40% of Block Lodges working capital, being second to debtors. This shows the high degree of importance that should be attached to its proper management. Cash is tightly controlled, with monthly cash flow forecasts being prepared and presented to the financial director for review. Debtors position is reviewed during a monthly meeting between the credit manager and the Financial Director. This is in addition to other reports prepared by the credit control department for use by the financial Director and the managing Director in their day to day planning. On the other hand, important inventory management decisions are made by the purchasing manager based on his personal experience. These are decisions such as re-order levels, the most economic lot to order, safety stocks etc. No formal inventory management tools are used in respect to inventory decisions. Forecasting for the future needs and discount evaluations are all based on the rule of thumb. This paper will atempt to provide objective statistical techniques of managing inventories, particularly with respect to Block Lodges.

II. Objective of the Study

The objective of this study is to provide an objective and efficient method of managing and controlling of inventories. The following are some of the advantages that will be realized.

(a) Optimization of inventory management costs (i.e carrying cost and ordering costs)

(b) Ensuring that, the right quantity of goods are ordered and held in stock, at the right time to avoid stockouts and finally,

(c) Future being so uncertain, the forecasting technique will be used to keep these uncertainity to a minimum, at the same time provide ways and means of measuring and accounting for it in a well-designed inventory control system.

III. Importance of the Study

The study will be of importance to Block Lodges and Hotels as it provides a tool for reducing inventory management costs. It also provides an efficient and more reliable techniqe of Managing and Control Inventory.

The study will also be of importance to other parties that will be interested with the inventory problem of a company. For example, management consultants and public accountants will from time to time be interested in evaluating the competence of inventory management in a company on behalf of their clients. This study will form a good basis of evaluation, as it recommends the appropriate inventory management tools to be used under different business environmental conditions such as trends, seasonality, randomness etc.

The study will also be of importance to financial and management accountants other than those in the tourist industry. The peculiarity of inventory problem in this industry is the defined seasonal patterns occuring at specific times of the year. These types of seasonal patterns are also experienced in agricultural industry, which depends on seasonal rainfalls in the greater parts of the country. Also, the luxury good industry usually have a higher demand pattern around Christmas and other important public holidays, just to name a few. Finally as it will mean an optimum allocation of resources.

1V. Research Methodology

The item of study in this paper is "Guest Soap". It was selected using stratified sampling technique. This method was used as it improves the representativeness of the sample, besides allowing use of smaller samples

than does simple random sampling, with greater precision and consequent savings on sampling time. There are 700 different items in the Block Lodges stock population. These items were subdivided into four major groups namely: Food, Beverage and Cigarettes, Household, and Printing and Stationery as they appear on the stock ledger. Operating equipment most of which is imported and other imported items were excluded from the population as they have added complexity of Government import restriction. This aspect is beyond the scope of this study. Randomly, Household was selected from the four major inventory sub-sets. The household sub-group by itself had 200 different items. These were sub-divided into sub-stratas of tens based on their numerical sequence on the stock ledger. Out of the twenty groups generated, one group of ten items was randomly selected. A listing of the ten items of the final sub-group selected was made on small square papers of equal sizes. Again one item "Guest Soap" was randomly picked from the ten items.

The study is confined to Block Lodges Central Stores. Secondary data was collected from the stock ledger cards of Guest Soap. Since forecasting will be used here and thereafter to mean projection of the past into the future, only past data will be required for the purpose of the analysis. To derive reasonably accurate results using exponential smoothing (the forecasting model that will be used), monthly usage data for the past two or three years is sufficient. Therefore Guest Soap usage data for 1978/79, 1979/80 and 1980/81 is collected on a monthly basis to project usage for 1981/82. This is the most current financial year that has been completed by the time of carrying out the study. Actual usage data for the same period is also available for the purposes of comparison.

Informal discussions were held with the Block Lodges Operations Manager, Purchasing and Stores Manager, and the Store Keeper incharge of Guest Soap inventories. These discussions were aimed at improving my understanding of the current inventory management system at the Block Lodges.

CHAPTER 2

LITEREATURE REVIEW

Does a company have to hold its resources in the form of inventories? Thierauf, N.J. and Klekamp, R.C. gave four reasons for maintenance of inventories by a company.

> First, the process and movement inventories sometimes called the pipeline stock are necessary where significant amount of time is required to transport goods from one location to another ..... Second, there is lot size inventory where more units are purchased or manufactured than needed for present use .... Third, when demand (or usage) for an item is known to be variable or seasonal ..... lastly where fluctuation inventories may be required if an adequate supply of items is to be available for the consumer when he wants them and stock outs are to be minimized[1].

Only the second reason is not applicable to Block Lodges inventory problem. All inventories maintained by Block Lodges are purchased from outside suppliers, a period of time must expire between the placement and receipt of any order placed. This period is commonly referred to as the "lead time". Demand is also variable from one season to the other, but, even if one was able

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[1] Thierauf, N.J. and Klekamp, R.C. Decision Making Through Operations Research: 2nd Edition, John Wiley & Sons. New York 1975, p.343.

to forecast the seasonal variability accurately, there is an element of randomness in usage that may be fairly difficult to forecast reasonably without using the proper statistical tools. Finally, for Block Lodges to be able to provide high-level service, they must also maintain adequate inventories to ensure that items are available when they are needed. Therefore from the above deductions one can safely conclude that inventories are an important prerequisite of Block Lodges day to day operations.

Some of the most common but most perplexing and buffling questions that each inventory manager must answer are, what will be the usage in the next week, month or year? how much and how often should orders be placed? These questions are difficult and mind searching due to the inherent inability of the human mind to project into the future with accuracy. Forecasting models are tools designed to aid a manager in projecting past data to determine the future within a "reasonable" degree of confidence. The word reasonable is used here to emphasize that, no forecasting model can predetermine the future with absolute accuracy. R.G. Brown gave the following remarks in regard to this issue:

> Demand for a product is generated by a complex interaction of many factors. If it were possible to understand the effect of each of these factors, and how they interact. We would build a mathematical model that could give a very accurate estimate of the future demand[2]

Factors that influence demand could be grouped into two broad categories. Firstly, there are those factors

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[2] Brown R.G. Less Risk in Inventory Estimates; Harvard Business review, July-August, 1959 p. 104.

that influenced demand in the past and continue to do so in the future, secondly, there are factors that were non-existent in the past, but will influence the future demand. Where the first category is dominant in influencing demand for a product, routine methods such as regression analysis may be used to forecast future demand with reasonable accuracy. However, where the second factors are dominant as is the case in Block Lodges, forecasting is more complicated and new methods must be devised to deal with the problem. It is important at this stage to distinguish the terms forecasting and prediction as used in this paper. Forecasting will be used to refer to projection of the past into the future, and prediction to refer to anticipation of changes, and new factors affecting demand. This paper will only deal with forecasting as related to Block Lodges inventory management problems.

An executive must consider some kind of forecast in every decision he makes. To deal with the varying forecasting problems, there are many techniques that have evolved in the recent years. Each technique has its most suitable use. Care must be exercised in selecting a correct technique for a particular application. "Selection of a method depends on many factors - 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 the time available for making analysis"[3].

Forecasting methods have been grouped into three broad categories by Chambers, Mullick, and Smith[4].

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[3] Chambers, J.C., Mullick, K.S., Smith, D.D. How to Choose the Right Forecasting Technique. Harvard Business Review, July - August, 1971 p. 45.

[4] Ibid

(a) Qualitative techniques.

They are techniques that use qualitative data such as expert opinion, and information about special events. Within this category are the Delphi method, market research, panel concesus, visionary forecast, and historical analogy.

(b) Time Series Analysis and Projection

These methods forecast on patterns and pattern changes and thus relies entirely on historical data. Within this group are; moving average, exponential smoothing model, Box-Jenkins model, X-11, and trend projections.

(c) Causal Models

They use highly refined and specific information about relationships between systems elements. They are powerful enough to take special events formally into account. Asin time series, past information is important in causal models. Within this group are the Regression model, Econometric model, intention - to buy model, input - output model and Diffusion index model.

Of the three broad categories, time series are the most suitable for inventory problems. "These are statistical techniques used when several years' data for a product or product line are available and when relationships are both clear and relatively stable"[5]

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[5] Chambers J.C., Mullick K.S., Smith, D.D. How to Choose the Right Forecasting Technique. Harvard Business Review, July - August, 1971 p.50.

All the five time series models can be used for inventory forecasting. However, given that Block Lodges do not have a computer at its disposal, one must settle for a model that could be computed manually. Therefore, although X-11 has been recommended as an excellent model for short term inventory forecasting, it is both expensive, and difficult to compute manually. Box -Jenkin model is ideal model in inventory forecasting for large volume items and could be used for the Block Lodges problem, however, it is equally efficient as exponential smoothing, but much more costly to implement. Moving average is fairly good for inventory forecasting for low volume items, with a stable trend and randomness but without seasonal variability. The last aspect is dominant in the inventory problem at the Block Lodges.

Therefore exponential smoothing model is preferred for Block Lodges inventory forecasting problem as it is cheap, and can be computed manually. Besides, the model allows for trend, random, and seasonal fluctuations of inventories. In the next two sections of these chapter, I will discuss exponential smoothing model in the first part, and economic ordering quantity model in the second part. The two models will then be used side by side in the rest of the paper to determine the optimum inventory management and control system for the Block Lodges.

I Exponential Smoothing Model

Block Lodges experience trend, random, and seasonal fluctuations of its inventories like any other company engaged in tourist trade in Kenya. Due to these fluctuations, the most ideal inventory forecasting model for the firm must take into consideration these fluctuations.

> The exponential smoothing model "washes" out all random fluctuations; it allows for trends, and it takes seasonal fluctuations into account in determining a forecast. And as time unfolds, it updates the influence which each of these time series has on forecast values[6].

Exponential smoothing, sometimes referred to as geometrical smoothing is a very special kind of weighted average. Its operation is based on period to period adjustment of the latest forecasted average "f_{t-1}" by adding (or subtracting) a fraction α (known as the smoothing constant) of the difference between the actual demand in the current period D_t and the last forecasted average F_{t-1}. The end result is the new forecasted average for period F_t. In a mathematical format, it may be represented as follows:

$$F_t = F_{t-1} + \alpha(D_t - F_{t-1}) \quad \ldots \quad (2.1)$$

For ease of calculation this equation may be rearanged as follows:

$$F_t = \alpha(D_t) + (1-\alpha).(F_{t-1}) \quad \ldots \quad (2.2)$$

$$\text{Average} = \alpha(\text{New Demand}) + (1-\alpha)(\text{Old Average})$$

The technique is generally known as the exponential smoothing because the weights assigned to demand (or usage) observations are derived by raising a fraction to successfully higher powers or exponents. Derivation and mathematical justification of this equation can be

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6 Moore, F.G., and Hendrick, T.E., Production/Operations Management. Richard D. Irwin, Inc. Homewood Illinois. Seventh endition 1977 p. 457.

found in many statistical forecasting books written by various inventory forecasting authorities such as R. G. Brown,[7] J.N. Prichard and R.H. Eagle[8] just to name a few. Therefore no attempt will be made to derive these formulas in this paper. The main concentration will be on the choice of appropriate parameters and application of the model for inventory management and control.

One important decision in exponential smoothing model is the determination of an appropriate value for the smoothing constant α. The value chosen determines how much of past demand has a significant effect in the new estimated average. Value for α ranges between 0 and 1.0. However the most commonly used values are between 0.1 and 0.3. Large values of α will cause the forecasted average to respond quickly to changes in actual demand, reflecting a fraction of random changes in demand, as well as actual shifts in demand.

Equition 2.1 above, smooths out random variations in actual usage. However, if there is a consistent increase in actual demand, the new average F_t will be consistently understated, and vise versa. This problem of overstatement or undertatement can be corrected by making allowance for trend variation in the forecast. This can be done using the following formula.

$$\text{New trend} = \alpha\left(\begin{matrix}\text{New}\\ \text{Average}\end{matrix} - \begin{matrix}\text{Old}\\ \text{Average}\end{matrix}\right) + (1 - \alpha)\left(\begin{matrix}\text{Old}\\ \text{trend}\end{matrix}\right)$$

$$T_t = \alpha (F_t - F_{t-1}) + (1 - \alpha)\ T_{t-1} \quad \ldots (2.3)$$

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[7] Brown R.G. Statistical Forecasting for Inventory Control McGraw-Hill book company, Inc., New York 1959.

[8] Prichard J.W. and Eagle R.H. Modern Inventory Management, John Wiley and Sons., Inc., New York 1965

Expected demand after random and trend adjustment is then derived by combining equation 2.2 and 2.3 as shown below:

$$\begin{array}{lcl} \text{Expected} & & \text{New} \\ \text{Demand} & = & \text{Average} \end{array} + \frac{(1-\alpha)}{\alpha} \begin{array}{l} \text{New} \\ \text{Trend} \end{array} + \begin{array}{l} \text{New} \\ \text{Trend} \end{array}$$

$$E_t = F_t + \frac{(1-\alpha)}{\alpha} T_t + T_t \quad \ldots\ (2.4)$$

One major advantage of exponential smoothing model is the ease of information storage. For purposes of future updating, manually or mechanically, one is only required to store data for the new average, (equition 2.2) and new trend (equition 2.3).

When introducing forecast for the first time, a problem that is commonly encountered is of deciding the old average forecast, and the old trend. Brown R.G. recommends that "the average can be the average of last years demand. As for the trend it is frequently practical to assume that it is zero"[9]. This will let the forecast determine its own trend over time.

Seasonal variability is the third factor that must be considered if one is to develop a comprehensive forecasting model for Block Lodges inventories. The seasonal variations are clearly distinct, and occur at the same period during the year. April and August are high season months. These are the months during which many parents take their children for holidays to game reserves and other holiday "resorts". December to February is a high season period due to influx of tourists from Europe in a bid to escape winter cold.

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[9] Brown R.G. Less Risk in Inventory Estimates. Havard Business Review, July - August 1959 p.111.

These seasonal patterns can be confirmed by a quick study of the usage figures presented on appendix 1 and the Guest Occupancy table on appendix 7. In the next few paragraphs, a discussion of how to introduce seasonal patterns in Exponential smoothing forecasting model will be discussed.

Seasonal Patterns

There are different methods of accounting for seasonal variability in inventory forecasting. one of the most commonly used method that is easy to compute both manually as well as by use of machines is the "Base Series" technique. This method is not only able to incorporate the seasonal variations, but the random and trend components. This section will be devoted to computation procedures, where as practical application of these procedures will be demonstrated in chapter five. The technique has six steps starting with computation of Base Series, demand ratio, Forecast average ratio, average, trend adjustment, expected ratio and finally, the expected demand which is computed as a product of the Base series and the expected ratio.

(a) Base Series

Base series are calculated using past experience of usage of an item to determine its seasonal patterns. The commonly used method of computing base series are two. The first method takes an average of period by period usage of the previous years. For example to compute base series for June 1982, one would take the average of June 1981, June 1980 etc. The second method averages months surrounding the month under consideration. In this case, one would have taken the average of May, June and July 1981 to obtain base series for June 1982. The first technique is used when peaks and valleys of usage are known to fall on the same months from year to year, while the second method is

used where peaks and valleys of usage are know to move backward and forward from year to year. The best base series is the one that has similar pattern as the usage pattern of the item under consideration. D.A. Barret suggests two problems of using base series "Firstly, it is necessary to keep a permanent record of the twelve base series values, which increase the record-keeping problem. Secondly, the base series values have to be updated in some way in case there is change in seasonal shape"[10]. Even after considering these two problems Base Series technique is by far one of the easiest methods of accounting for seasonal variations in forecasting problems.

(b) Demand Ratio (Dr_t)

Demand ratio is a simple ratio of actual usage for the period and the base series. It represents randon variations between the actual usage and the base series.

(c) Forecast Average Ratio (FAR_t)

Forecast average ratio represents smoothed demand ratio using the following formulae.

$$FAR_t = \alpha DR_t + (1 - \alpha) FAR_{t-1} \quad \ldots\ldots\ldots \quad (2.5)$$

The procedure is no different from that discussed earlier in the chapter for deriving the new average (equation 2.2)

(d) Average Trend Adjustment

The average trend adjustment is similar to that discussed for equition 2.3. What one should note is that this is the trend for $\alpha(FAR_t - FAR_{t-1}) + (1 - \alpha) T_{t-1}$ ...(2.6)

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[10] Barret, D.A. Automatic Inventory Techniques: Business Books Ltd., London, Second Impression, 1972. p.32

Where $FAR_t - FAR_{t-1}$ represents the apparent trend for the period.

(e) Expected Ratio

It is sum of FAR_t and a fraction of smoothed trend. In an equation form. It is represented as follows:

$$\text{Expected Ratio} = FAR_t + \frac{(1 - \alpha)}{\alpha} T_t \quad \ldots\ldots (2.7)$$

(f) Expected demand (Et)

This is the final step in the forecast that is derived by taking the product of expected ratio and the Base Series for each period. The results obtained at this stage is the forecast for these period and best estimate for the next period that is adjusted for random trend and seasonal variations.

To obtain optimum benefit from forecasting, the results must be used side by side with the Economic Ordering quantity model. Therefore the next section will be devoted to the discussion of EOQ model.

II Economic Ordering Quantity Model

The Economic Ordering quantity model has been in use in American Coporations for a long time. In his article, "Early history of Economic lot size"[11] R.F. Mannel traced reference to the formula in literature back in 1904. Hadley and Whitin in their book "analysis of inventory systems"[12] recall that theearliest derivation of what is

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11 Mannel, R.F. Early History of the Economic Lot Size: American production and inventory Society Journal, quarterly Bulletin Vol.2 No.2 April 1961 pp.19-22

12 Hadley G. and Whitin, T.M., An analysis of inventory Systems: Prentice-Hall Inc. Englewood Cliff, N.J. 1963, p. 3.

often called simple lot size formulae was obtained by Ford Harris[13] of the West House Corporation in 1915. However, a full text dealing with the inventory problem was written by Fairfield Raymond[14] while at the MIT in 1931. The book contained not the theory or derivation of the lot size model, but it attempted to explain how various extensions of the simple lot size model can be used in practice.

Development and growth of mathematical technique of inventory analysis has been closely associated to industrial development, especially industrial engineering. After the second world war more attention was directed to inventory problems when management science and operations research emerged.

As concluded in the earlier parts of this chapter, the decision faced by a manager is not whether inventories should be held, but how much inventory should be held. Two types of costs will be incurred for holding inventories, namely carrying cost and ordering costs. A third type of cost known as "outage cost" will be incurred for not holding any or adequate inventories. In the next section of the chapter, a discussion on the implications of these costs and how they come about will be carried out:

(a) Carrying Costs

Inventories represent investment which is not providing any apparent return. If it were possible to reduce the level

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13 Harris F. Operations and Costs; Factory Management Series Chicago A. W. Show Co. 1915 pp.46-52.

14 Raymond F.E., Quantity and Economy of Manufucture; McGraw-hill Inc., New York 1931.

of average inventories, the company would invest the money and earn a sum equal to opportunity cost.

Other costs of holding inventories are such as insurance cost, which depend on the size of inventory, value and degree of risk. Storage cost, maintenance cost, e.g. painting, maintenance of deep-freeze, temperature control devices etc., and obsolescence. All these costs must be balanced with the advantage of holding inventories. The higher the average inventories held, the higher the carrying cost. Ackoff and Sasieni defined carrying cost as follows: "They are costs that increase in direct proportion with increase in inventory and the time for which the stocks are held"[15]. Mathematically carrying costs should be represented as follows:

$$\text{Carrying Cost} = \frac{Q}{2} C I \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (2.8)$$

where Q = Order Size in units

C = Cost value of one unit

I = Inventory carrying cost, expressed as a percentage of the value of average inventory.

(b) Ordering Cost

This is the cost incurred in getting an item to the companys stores. The ordering cost operating functions are such as cost of obtaining the quotation, placing the orders, trucking, receiving and placing the items in the store. Ordering cost is incurred any time an order is

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15 Ackoff, R. L., and Sassieni, M. W. Fundamentals of Operations Research: John Wiley & Sons, Inc., New York. 1968 p.180.

placed. It is indipendent of the size of order, and therefore the annual ordering cost will be a direct function of the frequency of ordering. Total ordering cost mathematically may be expressed as follows:

$$\text{Totoal ordering Cost} = \frac{R\,S}{Q} \quad \ldots\ldots\ldots\ldots\ldots (2.9)$$

where R = Total annual quanity requirement and
S = Ordering cost per order placed.

The period between placing an order and receiving it is called lead time. D.A. Barret Spelt out three components of lead time in the following terms:

> It is time to recognize an order should be placed ..... Time between placing of the order and its receipt, which will depend on the clerical procedure, stock position and delivery method of the supplier, ... and time taken to inspect the delivery; move it to the storage area and report the receipt to the stock records[16].

In a manufacturing concern, the equivalent of ordering cost is the time to set up and tear down the machine for the batch being run, production control cost, and ordering cost to provide raw material for the batch order.

(c) Economic Ordering Quantity Model

"Our ability to quantify and develop rigorous models of most managerial problems is dependent on the determination

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16 Barret, D.A., Automatic Inventory Techniques Business Books Ltd. London, Second impression, 1972. p. 9.

of behaviour of relevant costs"[17] and for costs to be relevant to particular decision, "it must be an expected future cost, and must be an element of difference between alternatives"[18]. In the basic economic ordering quantity model, only ordering cost and carrying costs are relevant for decision making (assuming no unit cost variations with increase in quantity purchased). The objective of every inventory manager is to order a quanitity that will minimize costs. The order quantity will be achieved at the point where ordering cost is equal to carrying cost. This fact can be proved using calculus as follows:

$$TRC = \frac{RS}{Q} + \frac{QCI}{2} \quad \ldots\ldots\ldots\ldots \quad (2.10)$$

where TRC = Total relevant costs

by taking the first derivative

$$\frac{d(TRC)}{dQ} = -\frac{RS}{Q^2} + \frac{CI}{2}$$

Equating the derivative to zero

$$\frac{CI}{2} = \frac{RS}{Q^2}$$

Therefore $Q = \sqrt{\frac{2RS}{CI}}$

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17 Buffa, E.S., Production Inventory Systems, Planning and Control, Richard D. Irwin, Inc., Homewood Illinois, 1968 p. 50.

18 Hongren, C.T. Cost Accounting, a Managerial Emphasis 2nd edition Prentice-Hall Inc. Englewood Cliff, 1977 p.353.

The first derivative is set equal to zero in order to determine where the rate of change of the total variable cost curve relative to quantity ordered is equal to zero. A second derivative is taken to determine whether total variable costs are at a minimum or maximum with respect to the optimum quantity (Q). Therefore,

$$\frac{d^2(TRC)}{dQ} = + \frac{2RS}{Q^3}$$

A minimum cost point, rather than a maximum is indicated by a plus sign in the second derivative test. There are other methods of deriving the EOQ model. However, they all fall short of proving that the optimum quantity ordered (Q) is at the point where total relevant costs are at the minimum.

The basic EOQ model calculated above assumes orders of equal size will be received at the point where the previous order is fully exhausted. However, in reality this is not the case. "Both usage and acquisition lead time fluctuate in a manner not completely predictable. In case where these two factors are relatively constant and known, the previous inventory model would provide us with a close approximation of reality"[19]. Due to these fluctuations management must maintain a quantity of inventory over and above that provided by EOQ model in the form of safety stock. Safety stock as defined by Magee is; "the additional inventory on hand which can be drawn upon in case of emergency during the period between placement of an order and receipt of the material to fill the order"[20]

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[19] Thierauf R.J and Klekamp R.C. Decision Making Through Operations Research John Wiley & Sons, New York. Second edition 1975 p. 361.

[20] Magee F.J. Guide to Inventory Policy II. Problem of Uncertainity; Harvard Business Review, March-April 1956 p. 106

The size of safety stock will depend on the level of service the management intends to offer. The higher the safety stock the lesser will the firm experience stock out, and the more the carrying cost. Any additional unit of safety stock buys relatively less protection. Therefore, "the key of setting safety stock i.e. the reasonable maximum usage during lead time. What is reasonable depends on, ... the nature of short term fluctuations in the rate of sales (or usage) .... and the risk that management is prepared to face running out of stock"[21].

In setting the level of safety stock, the inventory manager should then aim for a level where marginal cost of providing more inventory is equal to marginal value of providing better service.

Under such conditions of uncertainty, two basic approaches of setting out an appropriate safety stock have been followed. These are the "fixed-order system" and the "periodic review system." Under the fixed order system, an order is placed of optimum size as inventory reaches a predetermined level (or reorder point). Under fixed period system, the inventory situation is reviewed periodically and a decision made on whether to order and how much to order. This second system is known to yield higher safety stock, and therefore higher carrying cost. However, despite this problem, the system would be recommended for Block lodges inventory problem, as it has other advantages that exceed the savings in lower safety stock experienced if fixed-order quantity is used. Mehta in his book puts it this way, "We find that the safety stock under

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21 Magee, F. J. Guide to Inventory Policy II. Problems of Uncertainity; Harvard Business Review, March-April 1956 p. 106.

fixed period system turns out to be larger than under the fixed-order system but this does not indicate that the fixed-order-system is superior because other cost considerations ..... must be accounted for in choosing a system"[22].

Taking the example of Block Lodges, under fixed period system, the inventory manager is able to review all other items supplied by East African Industries (suppliers of Guest Soap) together with the Guest Soap review. This way, the firm is able to save on transportation, stationery, and follow-up cost as a result of joint review and re-order. In addition to this, the system provides tighter control over inventories, (especially for slow moving items) which are reviewed more frequently under this system.

Workings of the system may begin by a determination of the review period (R) which is calculated by dividing the EOQ with the average daily usage. Therefore safety stock in days is the sum of review period (P) and the lead time (L). Standard deviation in units for the usage during lead time (σ_t) is calculated using the following formula.

$$\sigma_t = \sqrt{(R + L)D^2} \quad \ldots\ldots\ldots\ldots\ldots \quad 2.11$$

where D = The standard deviation of daily usage.

The safety stock is then a product of σ_t and a safety factor that will be determined by the management depending on the level of service they wish to offer. The higher safety stock under fixed-period system is caused by the additional review days. Optimum number of review days will be determined by deviding the annual quantity requirement (or usage) by the most economic lot to order.

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[22] Mehta, D. R., Working Capital Management. Prentice-Hall Inc., Englewook Cliff, New Jersey, 1974 p. 47.

The quantity ordered under fixed-periodic review system varies depending on the usage during the immediate past period. "The order size is the difference between inventory on hand and present level of 'M', the maximum inventory on hand and on order"[23] Mathematically "M" is calculated as follows:

$$M = B + U(R + L) \quad \ldots\ldots\ldots \quad 2.12$$

where

B = Buffer (or Safety) Stock
U = Daily (or Weekly) Usage
R = Review Period
L = Lead time

Average inventory under this system is determined as follows:

$$\text{Average inventory during the year.} = B + \tfrac{1}{2}(UR) \quad \ldots\ldots \quad 2.13$$

The formula may be used where safety stock component is constant during the year. Where safety stock varies from period to period, an average safety stock must be computed before being applied to the formula.

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23 Buffa, E.S. Production-Inventory System Planning and Control. Richard D. Irwin, Inc., Homewood Illinois 1968 p. 94.

CHAPTER 3

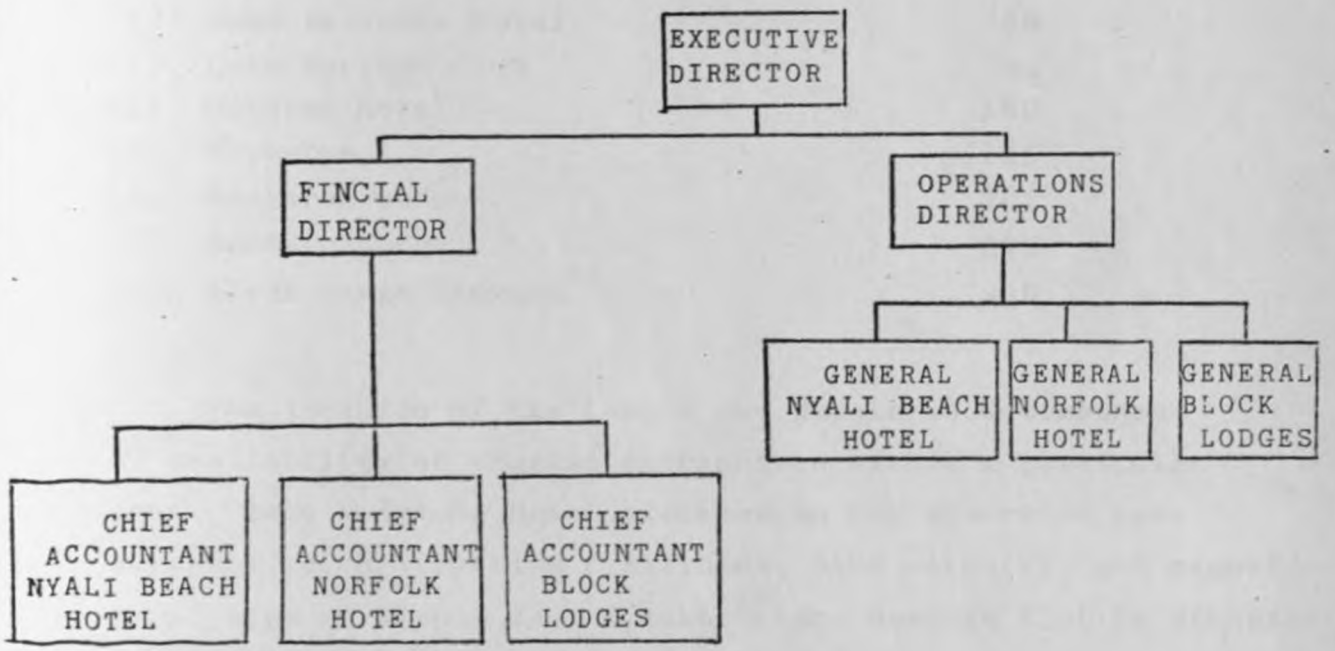
BACKGROUND OF BLOCK LODGES AND HOTELS

Block Lodges is one of the three main subsidiaries of Block Hotels (Management) Limited (BHML). The other two subsidiaries are the Nyali Beach Hotel in Mombasa, and Norfolk Hotel in Nairobi. Each subsidiary is under a General Manager who is responsible to the Group's Operations Director. The Financial Director is incharge of all financial aspects of the group, with Chief Accountants representing him at the subsidiary levels. Both Operations Director, and the Financial Director report to the Executive Director as shown on the organizational chart below:

Figure 3.1

BLOCK HOTELS MANAGEMENT LIMITED

Organizational Chart



Each subsidiary is run indipendently, and has its own stores and purchasing department which are run by a purchasing/ stores manager. Unlike the other two subsidiaries

BlockLodges is a group of lodges and Hotels that are situated around the country. The General Manager of Block Lodges is based at the BHML Head offices, situated along the airport road in industrial area. The Central Stores occupy the ground floor and the first floor of the same building. The group of Hotels and Lodges that comprise the Block Lodges, with their distances from Nairobi are shown on the table below:

Table 3.1

HOTELS AND LODGES THAT FORM BLOCK LODGES

	Name	Distance from Nairobi (in Kilomentres)
(1)	Lake Naivasha Hotel	90
(2)	Lake Baringo Club	290
(3)	Outspan Hotel	160
(4)	Treetops	175
(5)	Keekorok Lodge	265
(6)	Samburu Lodge	325
(7)	River Lodge Samburu[24]	330

The location of the Lodges and Hotels is determined by availability of tourist attractions within a particular area. Lake Naivasha Hotel situated on the shores of Lake Naivasha, offers fishing facilities, bird watching, and magnificent view of hippos in the lake. Lake Baringo Club is situated o

[24] Management contract of River Lodge Samburu was terminated in early 1983.

shores of Lake Baringo. It is an ideal place f
watchers. Outspan is a base of expeditions t
treetops. Treetops is Kenya's world famous ga
out where a princess of England became a queen.
Lodge is a good base for safaris in Masai Mara
Reserve. This reserve is famous for its black
lions, elephants and vast herds of plain game.
Samburu Lodge and River Lodge Samburu are situ
the banks of Uaso Nyiro River in the Samburu G
This reserve is famous for its rare wildlife s
including, Grevy's Zebra, Oryx, Reticulated Gi
Gerenuks.

I. Purpose and Functions of Block Lodges

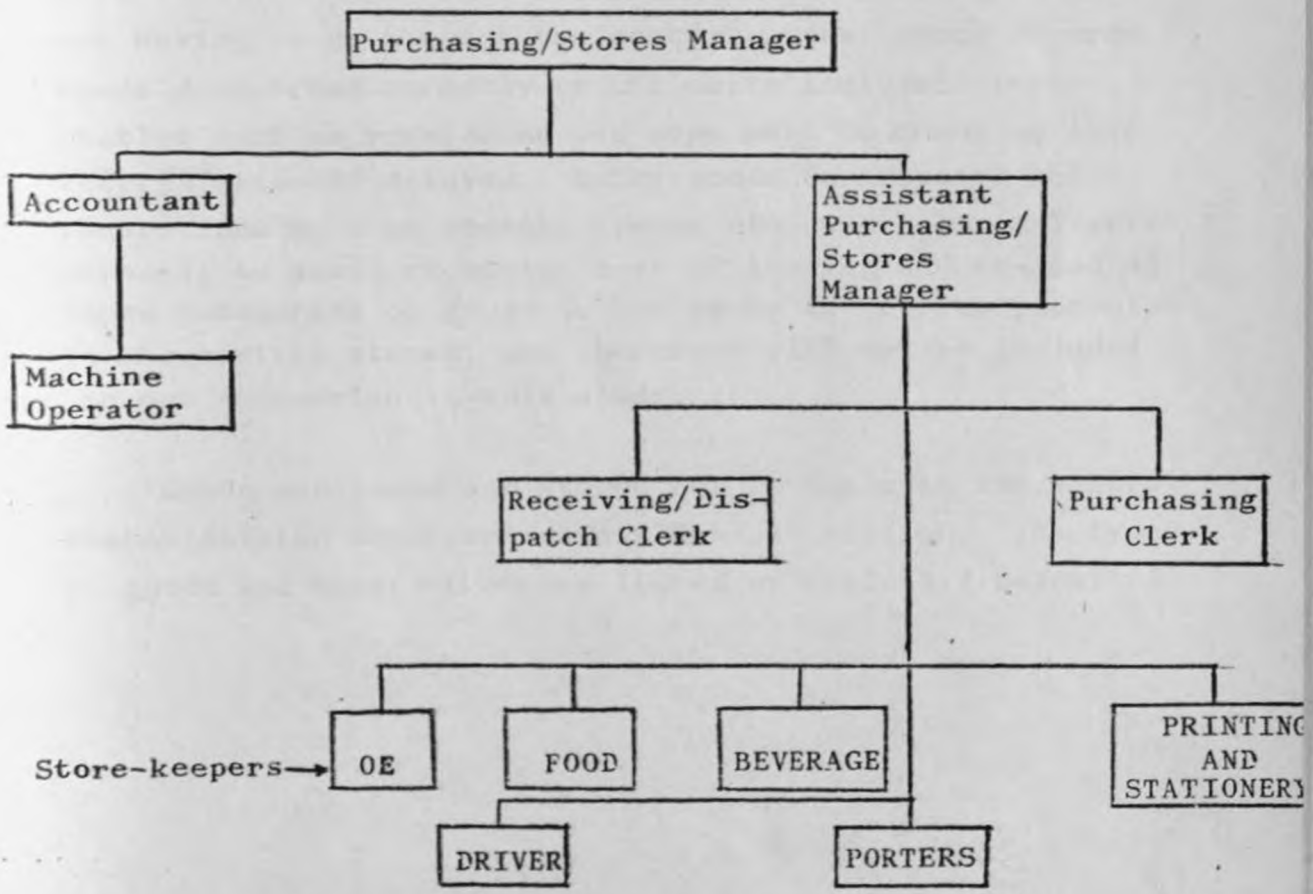
Central Stores

The main purpose of Block Lodges Central Stores is to purchase, store, and dispatch goods to all lodges and hotels under Block Lodges. The central stores is under stewardship of a purchasing/stores manager, assisted by an assistant purchasing/stores manager, a stores accountant, purchasing and dispatch clerks, store-keepers and porters as shown on the organisational chart below:

Figure 3.2

CENTRAL STORES

Organisational Chart



O/E = Operating equipment

Some of the goods purchased by the Central Stores in Nairobi are available at local urban centres closer to the Lodge or Hotel. However, Block Lodges management insist on buying from Nairobi to ensure they offer the best quality of goods to their clients, even if it means paying a little more. Certain perishable goods such as milk, or goods whose quality is of little significance to the image of BHML such as charcoal and firewood are purchased locally by individual unit managers if they are available.

Goods worth over Ksh.36 million (as per Block Lodges purchase day book) were purchased during the financial year ending 30th September 1982. Out of these, goods worth Kshs.26 millions were purchased and delivered directly to the hotels or lodges that ordered them, without having to go through the central stores stock records. Goods dispatched directly to the units included perishables such as vegetables and some meat to guard against deterioration if delayed. Bulky goods for repairs and renovations such as cement, timber etc, were also delivered directly to avoid excessive cost of loading and re-loading. These categories of goods do not pause an inventory problem to the central stores, and therefore will not be included in our discussion in this study.

Goods purchased and stored for re-issue at the central stores totaled to approximately Kshs.10 million. The types of goods and their values are listed on table 3.2 below:

Table : 3.2

STOCK ITEMS DISPATCHED TO LODGES AND HOTELS BY THE CENTRAL STORES[25]

DESCRIPTION	VALUE IN KSHS.
Food	5,030,000
Beverages and cigarettes	2,100,000
Operating equipment	990,000
Household	820,000
Printing and stationery	890,000
Total	9,830,000

There are many advantages that will be enjoyed by Block Lodges as a result of Group Purchasing. These advantages can be categorized into, Economies of Scale, Quality Control, Training and Self Correcting Systems. In the following section, each of these advantages will be discussed briefly.

(a) Economies of Scale

Due to group purchasing, the company is able to save on a few areas such as transport. If each Lodge or Hotel was to

[25] Figures extracted from the stores issues books maintained by Block Lodges accounts department. All figures are to the nearest Kshs.10,000.

send its van to East African Industries depot to collect a few cartons of detergents, there would be six vans dispatched as opposed to one in the case of central stores. Besides, certain suppliers such as the East African Industries provide transport to customers buying in large quanties, a facility that is at the moment enjoyed by the central stores.

Bulk of accounting documents is reduced as a result of group ordering which leads to group invoicing, and payment . In addition to these, the company is in a better position to negotiate favourable discounts and better credit terms from suppliers.

(b) Quality Control

High quality service must go hand in hand with quality goods. Items purchased by the central stores are quality controlled on receipt from suppliers. For example all meats and vegetables are inspected by quality control supervisor who is appointed by the Chef. If each unit was to exercise similar degree of caution, they would be required to have such a person accompanying the purchasing team to Nairobi during each trip. All other goods are inspected by the purchasing manager. If certain goods are substandard, they can easily be returned to suppliers for substitution.

(c) Training

Due to centralization of the purchasing system, the volume of work and level of responsibility is large enough to attract highly qualified personnel. These people can in turn be used to train the unit's store keepers who are normally untrained form four school leavers. The training can take the form of exchange programme between the central stores and the respective hotels and lodges. Modern

techniques of inventory management such as inventory models and forecasting can also be introduced with minimum resistance.

(d) Self Correcting System

On certain ocassions, random variations between actual and anticipated demand will occur. This results either in overstocking or understocking in some units. To avoid holding idle stock in the case of overstocking, central stores provides an ideal avenue for inter-unit transfers of goods.

CHAPTER 4

COST IMPLICATIONS OF THE CURRENT BLOCK LODGES INVENTORY MANAGEMENT AND CONTROL SYSTEM

Management and control of inventories at Block Lodges is through a periodic- review system. In this system as discussed in chapter two, action is triggered periodically rather than by an order point. This facilitates review of inventories both for re-order and for control purposes. Unlike fixed-order system, periodic review system has the advantage of having inventories reviewed more frequently and at equal intervals. This enables management to check and review future inventory levels of slow moving items with the view of reducing carrying costs. Thus orders of different items from one supplier are placed together to cut down ordering costs.

Lead time (L) for Guest Soap is 1.4 weeks[26] while inventories are reviewed once every two weeks. Therefore, replenishment cycle which is the sum of review period (R) and lead time is 3.4 weeks. Standard deviation of daily requirement is 7.7 cartons [27] where as the average daily requirement is 4 cartons. Therefore standard deviation of acquisition lead time(σ_t) in units can be calculated using equition 2.11.

$$\sigma_t = \sqrt{(L + R)D^2}$$

$$= \sqrt{(7 + 10)(7.7)^2}$$

$$= 31.74 \text{ cartons}$$

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[26] Reference Appendix 4. 7 days converted into weeks of 5 working days.

[27] Reference Appendix 5.

(lead time and review period in the calculation above are used in days to be in line with standard deviation of daily requirements).

Block Lodges provides 97.5% level of services for its inventories. This means a safety factor of 1.96 [28]. Therefore safety stock is simply computed as the product of safety factor and the standard deviation of usage during time (σ_t) in units.

Safety Stock (B) = 31.74 X 1.96 = 62.21 cartons.

The next step will be to determine the maximum level of inventory on hand and on order (M). This level is related to the review period (R) and the lead time (L) It is calculated using equation 2.12. as shown below:

$$M = B + U(R + L)$$
$$= 62 + 20\ (2 + 1.4)$$
$$= 130 \text{ cartons}$$

Both the safety stock level and maximum inventory on order and on hand are shown on figure 4.1. This graph shows the inventory balances, review periods and order sizes for the first three months of the Block Lodges financial year, 1981/82. The initial level of physical inventory is set at "M". Then the first order to be received in the middle of October is placed 1.4 weeks earlier, ie. the lead time

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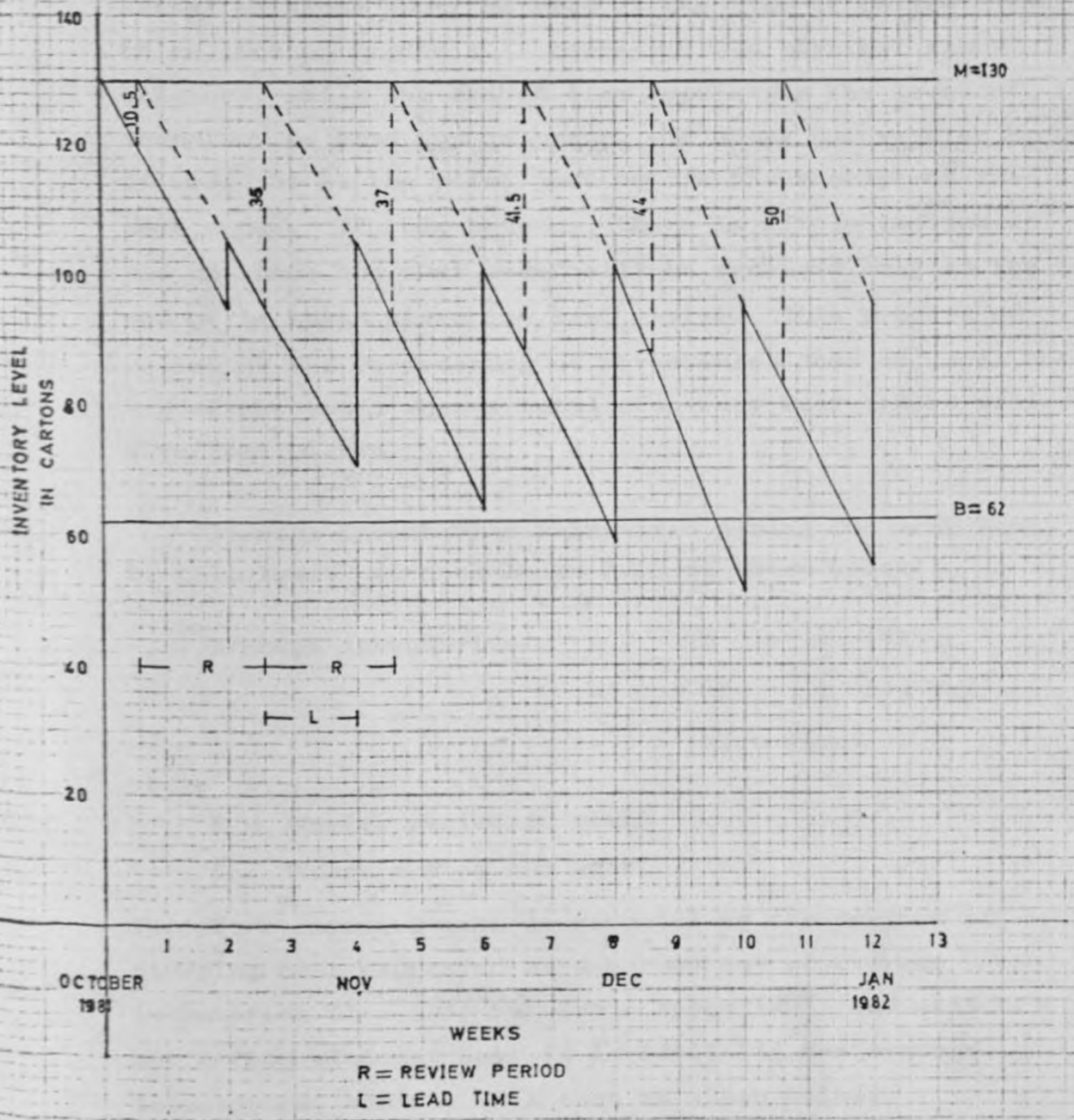
[29] The safety factors can be checked from the table of area under the curve given in appendix 6. This implies a .975 probability that stock out will not occur.

FIGURE 4:1

INVENTORY BALANCES OF GUEST SOAP FOR BLOCK LODGES USING PERIODIC REVIEW SYSTEM
1981/82



R = REVIEW PERIOD
L = LEAD TIME

period. This order is equal to the actual usage in the first three days of October which is 10.5 cartons. Usage is assumed constant during the month. The next review is two weeks after the first review, and the order is equal to actual usage in the past two weeks which is 35 cartons. An alternative way of computing the order size during a review is to take the difference between 'M', and the actual physical stock on hand at the time of review. The thick line on figure 4.1. represent the physical stock balances, while the dashed line represents the level of inventory on hand and on order. If stock outs were to occur, it would be at the point just before the receipt of the next order. If this happens, there is little management can do since the next order will be received only at the end of 14 weeks since the last review. This process of reviewing and re-ordering of inventories goes on until the end of the year, when a total of twenty four orders will have been placed.

Average inventories maintained during the year can be calculated using equition 2.13 as shown below:

$$\text{Average inventories} = B + \tfrac{1}{2}(UR)$$
$$= 62 + \tfrac{1}{2}(20 \times 2)$$
$$= 82 \text{ cartons}$$

where

R = Review period in weeks

U = Usage during the week

Therefore carrying cost is computed as the product of carrying cost expressed as a percentage of average inventories (I = 30%, reference appendix 3 and unit cost per carton of Guest Soap is Kshs.114/75), the average inventories, and the unit cost as shown below.

$$\text{Carrying cost} = \frac{Q}{2} \times C \times I$$
$$= 83 \times 144/75 \times .30$$
$$= 2822/85$$

In other words it costed Block Lodges a total of 2822/85 to hold an average of 82 cartons of Guest Soap for the whole year.

Ordering cost on the other hand is computed as the product of number of orders (N) per year, and ordering cost per order (Ordering cost S = 33/=, reference appendix 2). Therefore,

$$\text{Ordering cost} = S \times N$$
$$= 33 \times 24 = 792/=$$

Thus, the total inventory management cost at Block Lodges for the financial year 1981/82 was Ksh.3,614/85. This is the sum of carrying cost and ordering cost calculated above.

CHAPTER 5

STATISTICAL FORECASTING FOR INVENTORY MANAGEMENT AND CONTROL

In this chapter, statistical forecasting and economic ordering quantity model will be used as tools for inventory management and control system of Block Lodges. The chapter is subdivided into three sections. In the first section, exponential smoothing model discussed in section one of chapter two will be used to forecast annual usage for 1981/82. The annual usage figure is required for the determination of optimum number of orders that should be placed during the year.

The second part of the chapter will be devoted to forecasting month by month usage of Guest Soap for 1981/82. As in part one, exponential smoothing will be used, this time with additional adjustment for seasonal variability. Seasonal adjustments were left out when forecasting aggregate annual usage in part one because, seasonality only falls within the range of one year, and therefore has no effect on annual usage forecasts.

The third and the final part of this chapter will review inventory management system discussed in chapter four, this time taking into consideration the forecasted statistics and the EOQ model. Cost implication of this new system will be computed for purpose of comparison.

1. Annual Usage

The aggregate annual usage for 1981/82 will be forecasted using historical data for 1977/78 through 1980/81. More data could have been used, but previous stock records were unavailable. However, four years usage history is

adequate for purpose of forecasting using exponential smoothing model, especially where seasonal component is not being considered. Therefore, since only random and trend variations will be taken into account, then equition 2.2, 2.3, and 2.4 shown below will be used for these purposes.

$$F_t = \alpha D_t + (1 - \alpha) F_{t-1} \quad \ldots\ldots\ldots \quad 2.2$$

$$T_t = \alpha (F_t - F_{t-1}) + (1 - \alpha) T_{t-1} \quad \ldots 2.3$$

$$E_{t+1} = F_t + \frac{1 - \alpha}{\alpha} T_t + T_t \quad \ldots\ldots\ldots\ldots \quad 2.4$$

A smoothing constant of $\alpha = 0.3$ will be used in this problem. This large smoothing constant is selected to facilitate quick adjustment of the forecast to random variations. Heavy randomness is apparent during the period due to taking over by block lodges management of new hotel and lodges. The new units and their dates of take over are, Lake Naivasha - March 1980, Lake Baringo Club - May 1980, and River Lodge Samburu - February 1981. The initial trend of 27% is the actual trend for the period. The high trend will be quickly adjusted by the high smoothing constant, and therefore will have little significance to the future forecasts. By simple substitution of the above data, and the actual usage data given in appendix 1, forecast for the three year period can be worked out as shown below:

1978/79

$$F(t) = 0.3(616) + 0.7\,(601) = 605.50$$

$$T(t) = 0.3(15) + 0.7(1.27) = 5.39$$

$$E(t+1) = 605.50 + 2.23(5.39) + 5.39 = 623.45$$

1979/80

F(t)	=	0.3(740)	+	0.7(605.50)	= 645.85
T(t)	=	0.3(40.25)	+	0.7(3.39)	= 15.85
E(t+1)	=	646.35 + 2.33(15.85) + 15.85			= 698.65

1980/81

F(t)	=	0.3(993)	+	0.7(645.85)	= 750.00
T(t)	=	0.3(104.06)	+	0.7(15.85)	= 42.31
E(t+1)	=	750.00 + 2.33(42.31) + 42.31			= 891.00

The best estimate (E_{t+1}) of annual usage for 1981/82 is 891 cartons. "At first sight we may reject exponential smoothing on grounds that it is too cumbersome to calculate. Parodixically it turns out to be even easier than ordinary moving average"[30]. When forecasting for 1982/83, we only need to retain two figures in our file, i.e T(t) = 42.31 and F(t) = 750.21. Minor calculation errors will quickly adjust themselves over time in exponential smoothing model.

Using carrying cost (I), ordering cost (S) and unit cost (C) data from chapter 4, the most economic lot to order can be derived using the economic ordering quantity model as follows:

$$Q = \sqrt{\frac{2RS}{CI}}$$

Therefore, $Q = \sqrt{\frac{2(891 \times 33)}{114/75 \times .30}}$

$= 41.33$ cartons

summary

30 Battersby, A., Sales Forecasting: Cassell & Company Ltd. London, 1968 p. 48.

The optimum number of orders (M) is calculated by dividing the annual requirement with the economic lot size.

Therefore;

$$N = \frac{E(t+1)}{EOQ} = \frac{891}{41} = 21.7 \text{ orders}$$

The following formula provides an alternative direct method of computing optimum number of order (N).

$$N = \sqrt{\frac{AI}{2S}}$$

Where;

A = Annual Usage in Shillings

Therefore;

Optimum number of orders

$$(N) = \sqrt{\frac{(114/75 \times 891)\ (0.3)}{2 \times 33}}$$

$$= 21.56 \text{ orders}$$

The number of orders should be rounded to 22 to eliminate fraction orders.

II. Monthly Usages

Seasonal variability was established to be an indispensable phenomenon of Block Lodges inventory problem and tourist industry in general. For this reason, "Base Series" technique will be used to forecast monthly inventory usage of Guest Soap for 1981/82 at the Block Lodges. Table 5.1.(a),(b) and (c) show step by step workings of the system. A large value of the smoothing constant has been used to enable the forecast to respond quickly to the high randomness observable in the usage figures.

Computation of Expected Usage for Guest Soap Using a Base Series of Average of The Same Months in the Preceding Years $\alpha = 0.3$

Table 5.1 (a)

	1	2	3	4	5
Month	1978/79	1979/80	1980/81	Base Series	Demand Ratio
Initial					
October (1981)	64	44	123	77	.91
November	60	68	36	55	1.51
December	56	72	88	72	1.39
January (1982)	56	60	73	63	1.43
February	36	32	85	51	1.67
March	68	88	82	79	0.86
April	28	76	72	59	1.71
May	36	36	29	34	1.32
June	48	64	57	56	1.79
July	44	64	116	74	1.42
August	72	76	88	79	1.03
September	48	60	114	84	0.60
	616	740	993	783	-

Table 5.1 b

	6	7	8	9	10
MONTH	FAR(t)	Apparent Trend	T(t)	Expected Ratio	Expected Usage
Initial	1.00	0	0	-	-
October (1981)	0.97	-.03	-.009	.949	73
November	1.13	.16	.042	1.228	68
December	1.21	.08	.053	1.334	96
January (1982)	1.28	.08 07	.061	1.422	90
February	1.39	.11	.076	1.567	80
March	1.23	-.16	.005	1.218	96
April	1.37	.14	.046	1.477	87
May	1.36	-.01	.029	1.292	44
June	1.49	.13	.059	1.628	91
July	1.47	-.02	.035	1.388	103
August	1.34	-.13	.0145	1.306	103
September	1.12	-.22	.076	.943	79
	-	-	-	-	1010

Table 5.1 c

	11	12	13	14
MONTH	Actual Usage	|MAD|	Smoothed MAD	Safety Stock
Initial	-	-	26.5	52
October (1981)	70	3	19.4	38
November	83	15	18.1	35
December	100	4	13.9	27
January (1982)	90	0	9.7	19
February	85	5	8.3	16
March	68	28	14.2	28
April	101	14	14.2	28
May	45	1	10.2	20
June	100	9	9.9	19
July	105	2	7.5	15
August	81	22	11.9	23
September	50	29	17.0	33
	978	132	-	301

(The vertical bars surrounding MAD on table 5.1.c indicate that the value is to be taken as positive without regard of the actual sign).

Table 5.1 above is subdivided into three sections, a, b, and c, for easier representation. Otherwise it is one table with fourteen columns.

Column 1, 2, and 3 shows the actual monthly usage of Guest Soap for 1978/79, 1979/80 and 1980/81 respectively. The average of the three figures in each month is computed to form the base series in column 4. Demand ratio which is a simple ratio of actual usage (column 11) and the base series is shown on column 5. For example to compute demand ratio for October 1981 one should divide the actual usage for October 1981 with the base series figure for the same period (i.e 70 ÷ 77 = 0.91). The result will represent random variations between actual usage and the base series.

Forecast average ratio (column 6) represents exponentially weighted demand ratios. The initial FAR_{t-1} is assumed to be zero for the forecast to set its own FAR_t. This column is computed using equition 2.5 which is shown below:

$$FAR_t = \alpha DR_t + (1 - \alpha) FAR_{t-1} \qquad 2.5$$

Apparent trend represented on column 7, shows the trend of usage. The initial trend is assumed to be zero. Other trend figures are computed by taking the difference between the current FAR_t and the previous FAR_{t-1}. This apparent trend is smoothed to determine the trend for each month.

Expected average ratio is the sum of FAR_t and a fraction of the smoothed trend. This is computed using equation 2.7 as shown below.

$$\text{Expected Ratio} = FAR_t + \frac{(1-\alpha)}{\alpha} T_t \qquad 2.7$$

The last step on the forecast procedure is to compute the expected demand, or the forecast. This is done by computing the product of expected ratio (column 9) and the base series (column 4). Graphically, the results have been compared on figure 5.1. The dashed line on the graph represents forecast, while the dark line represents actual usage for 1981/82. The forecast has been able to trace the actual usage reasonably well except for a few months. For example the average usage for November 1981 being 83 cartons had a random variation of 28 cartons from a base series of 55 cartons. However, our exponentially smoothed forecast has been able to reduce the difference to 15 cartons, having forecasted a usage of 68 cartons for the same period.

Table 5.1.c shows workings of the standard deviation of Guest Soap at Block Lodges. "For normal distribution, the average value of the absolute difference between the actual current demand and the previous calculation of the expected demand is proportional to this standard deviation"[30] Therefore column 12 of table 5.1.c shows the mean absolute deviation. Column 13 shows the exponentially smoothed weighted average of the mean absolute deviation using the equation shown below:

$$\text{New mean absolute Deviation} = \alpha \left| \text{Current deviation} \right| + (1 - \alpha) \text{Old mean absolute deviation} \qquad 2.8$$

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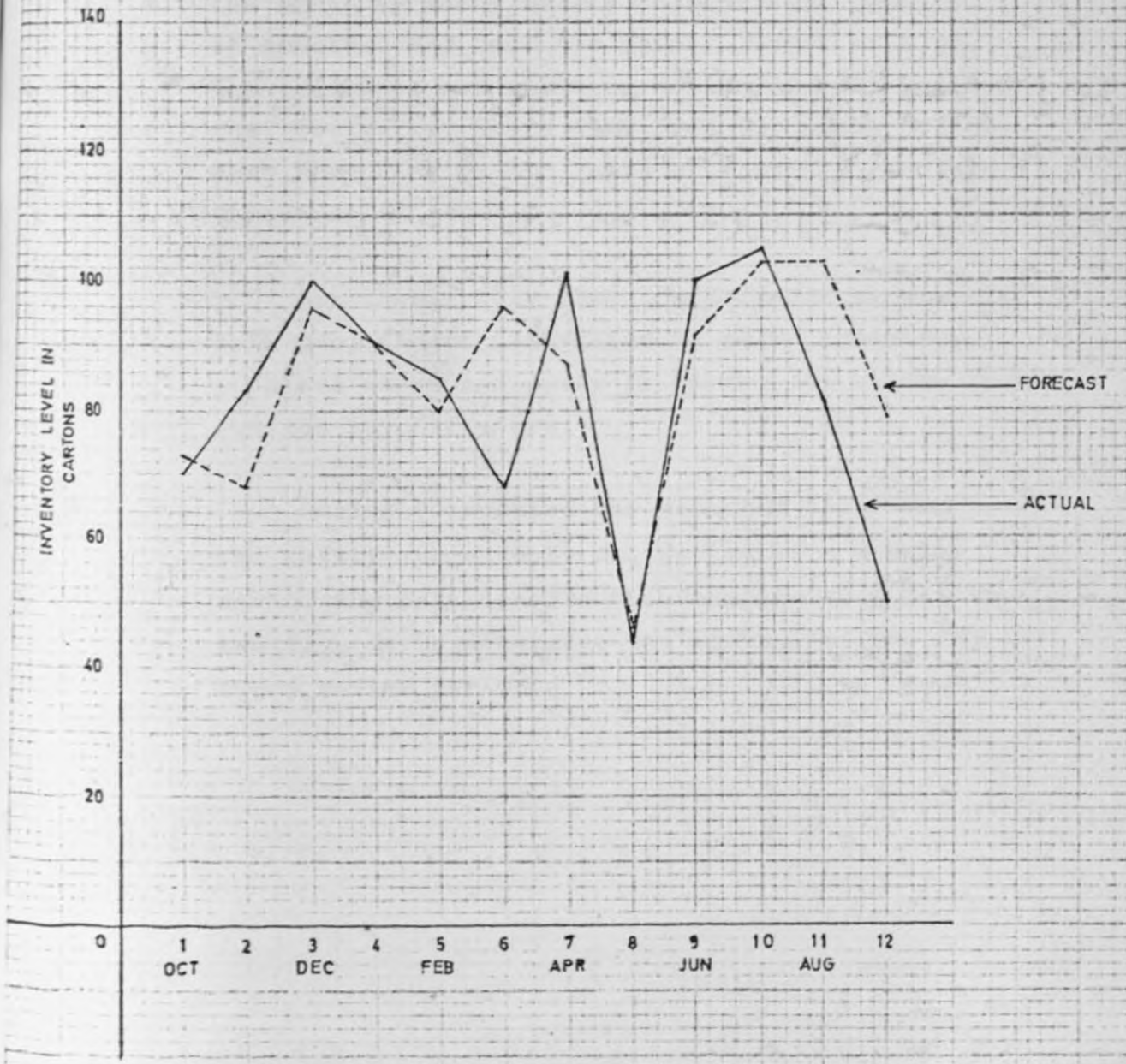
[30] Brown, R. G., Less Risk in Inventory Estimates Harvard Business Review, July-August 1959 p. 116.

FIGURE 5.1

INVENTORY FORECASTS FOR 1981 / 82

$\alpha = 0.3$



To provide for a 97.5% level of service as provided by Block Lodges management (reference chapter 4), one needs to multiply the smoothed MAD_t with a safety factor of 1.96. (reference areas under the curve, appendix 6). Therefore the month by month safety stock is the product of smoothed MAD_t and the safety factor of 1.96. These figures are shown on column 14. It implies that the safety stock vary from one month to the next depending on the size of the mean absolute deviation.

One should note that the formulae as used in this project are restricted to solve inventory problems where a company is buying its stocks from outside manufacturers.

Having forecasted the expected usage and the safety stock to be maintained on a monthly basis, the next section this chapter will use the two figures to determine the optimum orders for every review period.

III. Application of the Forecasted Usage to the Periodic-Review System of Inventory Management

Optimum number of orders were determined as twenty two in section one of this chapter. However, for quick comparison of the current system of Block Lodges (see chapter 4) and the system presented in this chapter, the number of orders will be assumed to be twenty four per year. In other words the review period will remain as two weeks, and the lead time as 1.4 weeks. Safety stock varies depending on the smoothed mean absolute deviation shown on table 5.1.c column 14.

Maximum inventory on hand and on order (M), is re-computed on a monthly basis using equition 2.12. This differs with the block lodges system where level of 'M' was set at the beginning of the year. Table 5.2 shown below shows computation of 'M' for the twelve months period of 1981/82, using the equation 2.12 shown below.

$$M = B + U\ (R + L)$$

For example the maximum inventory on hand and an order 'M' for October 1981 is computed as follows:

$$M = 52 + 20\ (2 + 1.4) = 120 \text{ cartons}$$

Column 1 on table 5.2, represents safety stock, column 2 represents usage during replenishment cycle, while column 3 is the sum of column 1 and column 2.

Table 5.2

COMPUTATION OF MAXIMUM INVENTORY ON ORDER AND ON HAND, "M" AND AVERAGE MONTHLY INVENTORY LEVELS FOR BLOCK LODGES GUEST SOAP FOR 1981/82

MONTH	1	2	3	4
	B	M(R + L)	M= B+M(R+L)	AVERAGE INVENTORY
October (1981)	52	68	120	72
November	38	68	106	58
December	35	68	103	55
January (1982)	27	68	95	47
February	19	68	87	39
March	16	68	84	36
April	28	68	96	48
May	28	68	96	48
June	20	68	88	40
July	19	68	87	39
August	15	68	83	35
September	23	68	91	43
T O T A L	320	816	1136	560

Using periodic review system, the re-order pattern and quantity ordered per review period are shown on figure 5.2. The initial stock level on hand is set equal to the "M". It is important to note that safety stock is set by the previous months mean absolute deviation, being the best forecast of standard deviation for the current month. "M" used to determine the order quantity in November 1981 is 106 cartons. This is due to a decrease in the safety stock for the month. Therefore the re-order quantity is 23 cartons as opposed to 37 cartons that could have been ordered during the same period if the level of "M" ramined at 120 cartons, as is currently the case at Block Lodges.

Column 4 of table 5.2 shows the computation of monthly average inventories using this system. The figures have been computed using equation 2.13, shown below:

$$\text{Average inventory} = B + \tfrac{1}{2}(UR)$$

Therefore average inventories for October 1981 are derived as follows:

$$\text{Average inventories} = 52 \times \tfrac{1}{2}(20 \times 2) = 72 \text{ cartons}$$

The annual average inventories of Guest Soap for 1981/82 can then be computed as a simple average of monthly average inventories, which is 47 cartons. Therefore carrying cost for 1981/82 can be computed using equation 2.8 as shown below:

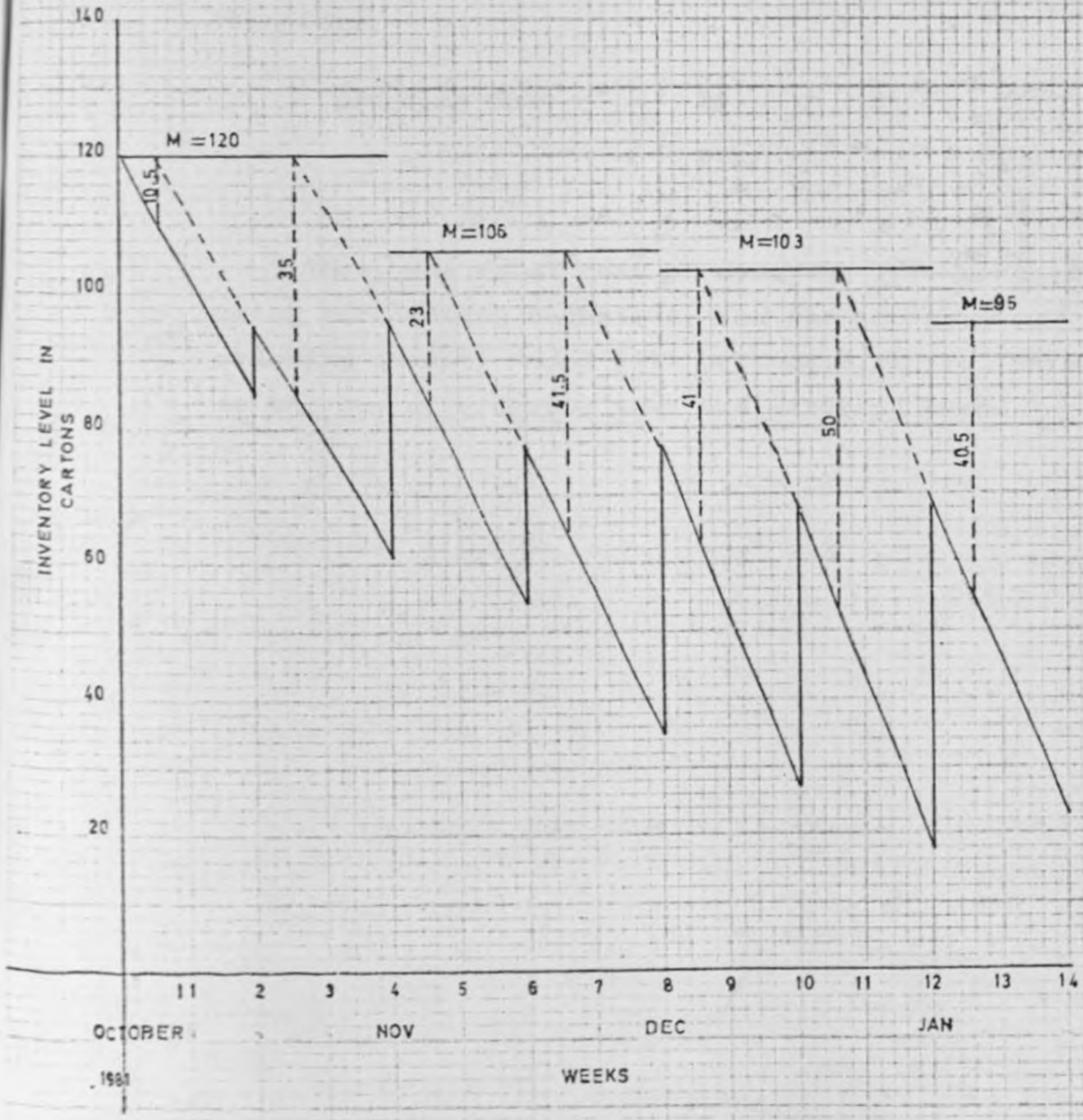
$$\text{Carrying cost} = \frac{Q}{2} \times C \times I$$

$$= 47 \times 114/75 \times .30$$

$$= 1618/=$$

FIGURE 5.2

INVENTORY BALANCES OF GUEST SOAP FOR BLOCK LODGES USING PERIODIC REVIEW SYSTEM AND STATISTICAL FORECASTING



Having established that twenty four orders will be placed during the year, the total annual ordering cost can then be computed as the product of ordering cost per order and the number of orders placed during the year.

Therefore,

$$\text{Ordering cost} = 24 \times 33/= $$
$$= 792/=$$

Thus, the total cost of managing inventories, using forecasting technique, and the economic ordering quanity model will be Kshs.2,410/=. This is the sum of ordering cost and carrying cost.

CHAPTER 6

SUMMARY AND RECOMMENDATION

I. SUMMARY OF THE RESULTS

The total inventory management cost[31] of Guest Soap under the current Block Lodges inventory management system is Kshs.3,614 per year. Under the proposed system which has used EOQ model and the exponential smoothing model to forecast future inventory usage, the total cost is Kshs.2410. Therefore, the net reduction of inventory management cost is Kshs.1,204/85 or 33.3% per year. This is a substantial percentage of cost reduction. If similar reductions could be realized on all the 700 different stock items held by Block Lodges Central Stores, the results would have a very significant impact on the profitability of the group.

The realization of these cost reductions has been facilited by a number of attributes built in the new system. Firstly, forecasting model allows the inventory manager to vary inventory levels depending on the anticipated level of usage. This is made possible by the ability of the model to trace seasonal fluctuations in usage. Secondly, the model is able to smooth out random variations. This aspect desists the manager from placing unnecessarily large orders in response to artificially high demands, or on the other hand placing small orders, in anticipation of a downword trend in usage. In conclusion, the new system determines the most optimal inventory that should be held in the stores, maintaining adequate allowance for irregular fluctuations in usage in the form of safey stock.

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[31] Inventory Management Cost here refers to the sum of Ordering Cost and the Carrying Cost.

11. RECOMMENDATIONS

One of the basic objectives of every profit making and non-profit making organisation is to minimize costs. The new model provided in this paper does exactly this for Block Lodges inventory problem. The model is easy to implement in both manual or mechanical inventory system. It does not require specialized staff, or any special training, and therefore can be implemented by the current store keepers without any problems.

The current structure of Block Lodges is such that, the stores are subdivided into five sub-sections. These are the food, beverages and ciggarettes, operating equipment, household, and printing and stationery. Each department has a storekeeper and an assistant. The storekeeper can be asked to spend a small proportion of his time at the beginning of each month to forecast the next month's inventory requirements for his section. Just like introduction of any other new system in any organisation, this system is expected to face some resistance from the storekeepers at the introductory stages. This is because it appears to be too involing in terms of calculations. However once the introductory stage which has more calculations than normal is over, the system will cease to look difficult. Therefore, I recommend implementation of the system by Block Lodges Central Stores.

APPENDIX 1

GUEST SOAP USAGE FOR 1978/79 TO 1981/82

(All figures are in cartons, each carton Having 144 Soap Tablets)

MONTH	1978/79	1979/80	1980/81	1981/82
October	64	44	123	70
November	60	68	36	83
December	56	72	88	100
January	56	60	73	90
February	36	32	85	85
March	68	88	82	68
April	28	76	72	101
May	36	36	29	45
June	48	64	57	100
July	44	64	116	105
August	72	76	88	81
September	48	60	144	50
Total	616	740	993	978

Figures extracted from Block Lodges, Central Stores Stock Ledger.

Actual usage for 1977/78 was 601 cartons.

APPENDIX 2

ORDERING COST

PARTICULARS	WORKINGS	AMOUNT	
1. Time to recognize an order should be placed and the related costs.		SHS.	CTS
(i) Inspection of Stock levels by the store-keeper and consequent issue of a purchase request.	Time taken plus 2 copies, one copy to the purchasing manager, and a second copy for the store keeper's file.		20
2. Placing of an order and its receipt:			
(i) Approval of purchase requested by the Assistant purchasing manager. 3 minutes	$\frac{8000/=}{10,800}^{32} \times 3$ [33]	2.20	
(ii) Obtaining quotations 3 telephone calls, @ /65 per call.		1.95	
(iii) Telephoning time 5 minutes per call i.e 15 minutes	$\frac{2000 \times 15}{10800}$	2.80	
(iv) Review of quotations and approval by the purchasing/stores manager.	$\frac{12,000 \times 5}{10,800}$	5.55	

[32] Salary figures are extracted from September 1982 payroll. They represent the actual cost of the employee to the company per month.

[33] 10,800 minutes represent the official working time per month (i.e 45 hours per week for 4 weeks in a month).

PARTICULARS	WORKINGS		AMOUNT SHS.	CTS
Cost one copy of L.P.O.	1 set with 4 carbonized copies	1.15		
Cost one purchase request	1 set with 2 ordinary copies	.20		
Writing up the LPO and presenting for approval	$\frac{2000/= \times 5}{10,800}$	.95		
Trucking or follow up average of 1 telephone call		.65	15	45
3. Time Taken to Inspect the Delivery and other related Functions:				
(i) Receiving Average of 15 minutes for each of the following employees:				
(a) Store-keeper	1500/= $\frac{4500 \times 15}{10,800}$	= 6.25		
(b) Receiving Clerk	2000/=			
(c) One porter	1000/=			
(ii) Accounting Cost:				
(a) Goods in words book + Receiving record book	1500			
(b) Posting into stock ledger and creditors ledger	3000 $\frac{5000 \times 10}{10,800}$	= 4.65		
(c) Matching invoices with the LPO, and posting into the purchase day book	$\frac{2250/= \times 15}{10,800}$	= 3.10		
(d) Approval of invoice by the stores and purchasing manager. 3 minutes	$\frac{12,000 \times 3}{10,800}$	= 3.35	17	
			33	

APPENDIX 3

CARRYING COSTS

	SHS.	CTS
(a) Rent for one year (Payable to Kulia Investments Ltd) 26,940/= x 12	323,280	=
(b) Overdraft interest: (Worked out at 15%; overdraft interest charges as at 30th September, 1982) on the average inventory for 1981/82. 2,330,000/= x 15%	349,500	=
(c) Insurance	5,640	=
(d) Stock write offs due to deterioration, breakages, etc. (Figure extracted from the trading statements).	30,000	=
	708,420	=

Carrying cost expressed as a percentage of average inventory $= \frac{708,420/= \times 100}{2,330,000}$

$= 30.40\%$

In the main text of the paper, carrying cost has been rounded to thirty percent.

APPENDIX 4

OTHER INFORMATIONS

DETAILS	
(1) Lead time (L) Once the order is placed it takes seven wording days to be received at the central stores ready for issuing out.	7 days
(2) Number of Working Days The number of workingdays have been computed as the number of weeks in a year, (i.e. 52 weeks) multiplied by the five working days in a week, less ten public holidays. The number may vary from years to years, depending on how many holidays fall on a working day.	250 days
(3) Unit Cost: (C)	114.75

APPENDIX 5

STANDARD DEVIATION OF DAILY USAGE

	DATE	x	$\bar{x}$	$x - \bar{x}$	$(x - \bar{x})^2$
1.	11/6/82	1	4	-3	9
2.	16/2/82	3	4	-1	1
3.	7/10/81	10	4	6	36
4.	3/11/81	20	4	16	256
5.	9/7/82	2	4	-2	4
6.	29/4/82	1	4	-3	9
7.	6/11/81	16	4	12	144
8.	18/11/81	16	4	12	144
9.	15/4/82	4	4	0	0
10.	12/11/81	2	4	-2	4
11.	5/12/81	6	4	2	4
12.	24/2/82	2	4	-2	4
13.	5/6/82	4	4	0	0
14.	30/3/82	3	4	-1	1
15.	15/2/82	8	4	4	16
16.	8/12/81	5	4	1	1
17.	25/1/82	4	4	0	0
18.	29/7/82	4	4	0	0
19.	25/8/82	30	4	26	676
20.	27/8/82	6	4	2	4
21.	29/6/82	19	4	15	225
22.	26/2/82	3	4	-1	1
23.	14/4/82	18	4	14	196
24.	30/3/82	3	4	-1	1
25.	9/12/81	6	4	2	4
26.	1/2/82	5	4	1	1
27.	24/3/82	8	4	4	16
28.	30/10/81	2	4	-2	4
29.	10/5/82	1	4	-3	9
30.	26/6/82	4	4	0	0
		216	120	96	1770

The standard deviation is calculated by taking random sample of 30 days of the 250 actual days of usage.

Standard deviation of daily usage

$$D = \sqrt{\frac{(x - \bar{x})^2}{n}}$$

$$= \sqrt{\frac{1770}{30}}$$

$$= \underline{7.68}$$

Approximately 7.7 cartons.

APPENDIX 6

AREA UNDER THE NORMAL CURVE

	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0.0	.50000	.50399	.50798	.51197	.51595	.51994	.52392	.52790	.53188	.53586
0.1	.53983	.54380	.54776	.55172	.55567	55692	.56356	.56749	.57142	.57535
0.2	.57926	.58317	.58706	.59095	.59483	.59871	.60257	.60642	.61026	.61409
0.3	.61791	.62172	.62552	.62930	63307	.63683	.64058	.64431	.64803	.65173
0.4	.65542	.65910	.66276	.66640	.67003	.67364	.67724	.68082	.68439	.68793
0.5	.69146	.69497	.69847	.70194	.70540	.70884	.71226	.71566	.71904	.72240
0.6	.72575	.72907	.73237	.73536	.73891	.74215	.74537	.74857	.75175	.75490
0.7	.75804	.76115	.76424	.76730	.77035	.77237	.77637	.77935	.78230	.78524
0.8	.78814	.79103	.79389	.79673	.79955	.80234	.80511	.80785	.81057	.81327
0.9	.81594	.81859	.82121	.82381	.82639	.82894	.83147	.83398	.83646	.83891
1.0	.84134	.84375	.84614	.84849	.85083	.85314	.85543	.85769	.85993	.86214
1.1	.86433	.86650	.86864	.87076	.87286	.87493	.87698	.87900	.88100	.88298
1.2	.88493	.88686	.88877	.89065	.89251	.89435	.89617	.89796	.89973	.90147
1.3	.90320	.90490	.90658	.90824	.90988	.91149	.91309	.91466	.91621	.91774
1.4	.91924	.92073	.92220	.92364	.92507	.92647	.92785	.92922	.93056	.93189
1.5	.93319	.93448	.93574	.93699	.93822	.93943	.94062	.94179	.94295	.94408
1.6	.94520	.94630	.94738	.94845	.94950	.95053	.95154	.95254	.95352	.95449
1.7	.95543	.95637	.95728	.95818	.95907	.95994	.96080	.96164	.96246	.96327
1.8	.96407	.96485	.96562	.96638	.96712	.96784	.96856	.96926	.96995	.97062
1.9	.97128	.97193	.97257	.97320	.97381	.97441	.97500	.97558	.97615	.97670
2.0	.97725	.97784	.97831	.97882	.97932	.97982	.98030	.98077	.98124	.98169
2.1	.98214	.98257	.98300	.98341	.98382	.98422	.98461	.98500	.98537	.98574
2.2	.98610	.98645	.98679	.98713	.98745	.98778	.98809	.98840	.98870	.98899
2.3	.98928	.98956	.98983	.99010	.99036	.99061	.99086	.99111	.99134	.99158
2.4	.99180	.99202	.99224	.99245	.99266	.99286	.99305	.99324	.99343	.99361
2.5	.99379	.99396	.99413	.99430	.99446	.99461	.99477	.99492	.99506	.99520
2.6	.99534	.99547	.99560	.99573	.99585	.99598	.99609	.99621	.99632	.99643
2.7	.99653	.99664	.99674	.99683	.99693	.99702	.99711	.99720	.99728	.99736
2.8	.99744	.99752	.99760	.99767	.99774	.99781	.99788	.99795	.99801	.99807
2.9	.99813	.99819	.99825	.99831	.99836	.99841	.99846	.99851	.99856	.99861
3.0	.99865	.99869	.99874	.99878	.99882	99886	.99899	.99893	.99896	.99900
3.1	.99903	.99906	.99910	.99913	.99916	.99918	.99921	.99924	.99926	.99929
3.2	.99931	.99934	.99936	.99938	.99940	.99942	.99944	.99946	.99948	.99950
3.3	.99952	.99953	.99955	.99957	.99958	.99960	.99961	.99962	.99964	.99965
3.4	.99966	.99968	.99969	.99970	.99971	.99972	.99973	.99974	.99975	.99976
3.5	.99977	.99978	.99978	.99979	.99980	.99981	.99981	.99982	.99983	.99983
3.6	.99984	.99985	.99985	.99986	.99986	.99987	.99987	.99988	.99988	.99989
3.7	.99989	.99990	.99990	.99990	.99991	.99991	.99992	.99992	.99992	.99992
3.8	.99993	.99993	.99993	.99994	.99994	.99994	.99994	.99995	.99995	.99995
3.9	.99995	.99995	.99996	.99996	.99996	.99996	.99996	.99996	.99997	.99997

APPENDIX 7

GUEST OCCUPANCY STATISTICS

(Physical Number of People)

MONTH	1979/80	1980/81	1981/82
October	9,808	12,250	14,564
November	8,192	10,268	13,172
December	8,691	11,656	13,554
January	10,463	12,865	13,952
February	10,764	15,184	15,018
March	10,022	12,288	12,720
April	9,727	9,812	10,177
May	6,400	8,074	8,197
June	9,704	10,611	11,569
July	11,974	13,726	14,750
August	12,935	16,059	13,537
September	10,198	12,485	11,987
	118,878	145,278	153,197

Figures extracted from Block Lodges monthly trading statements.

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