A STUDY OF GENERAL STORES INVENTORY MANAGEMENT AT METHODIST HOSPITAL, MEMPHIS, TENNESSEE

A Problem Solving Project Report

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CHAPTER I

INTRODUCTION

Federal health care legislation which became public law during the past decade has had an impact on the voluntary hospital system. One of the effects of this legislation was the imposition on the hospitals of guidelines to be followed in determining the cost of care to beneficiaries of federal health programs. The policy on which the guidelines was based is that the government is obligated only to pay that proportionate share of the hospital's total financial requirements which is related to the care given the beneficiaries of the program.[1]

The federal government's involvement in the financial management process of hospitals makes it more important than ever for hospitals to manage their resources in such a way that all purchasers of care--private-pay patients, non-government third-party payers, or government third-party payers--will accept and pay their allotted fair share of the hospital's total financial requirements. Given the circumstance of purchasers of hospital health care services accepting the obligation for the total financial requirements of the hospital, the hospital administrators assume the respon-

sibility to expend funds wisely in providing hospital service.[2] Administrators should apply the highest degree of management control to the use of operating funds in order to discharge this responsibility.

One important hospital subsystem that requires a high degree of managerial control, in financial matters, is the management of general stores inventory. Lack of control will increase unnecessarily the cost of maintaining an inventory of general stores items.

Inventory Management as a Modern Hospital Management Problem

All hospitals maintain inventories of general stores materials required for day-to-day operation. Depending on the size of the hospital and individual circumstances, inventories will carry between 1,000 to 3,000 general stores items.[3] This great variety of items causes general stores inventories to share several characteristics: (1) inventories are made up of heterogeneous items; (2) quantities of each item vary depending on demand for the item per period of time; (3) items must be periodically ordered to replenish the inventory; (4) replacement items can be ordered from multiple sources; and (5) the cost of inventory items is variable.

There are many more characteristics of the inventory, but the ones given are sufficient to illustrate the inventory management problem. Mr. Walter Schulz says that,

"each buying and stocking action must be preceded by a decision-making process which may be simple or complex, guesswork or mathematical, hasty or deliberate."[4] It is easy to see that a quality decision about what to stock, how much to stock, what vendor should supply the item, and what should be paid for each item, must be made in order to optimize the use of financial resources. Optimization is the state of having the least inventory investment under conditions of minimum inventory carrying costs and order costs. The decision-making process is continuous because a management decision has to be made each time an inventory item is used and has to be reordered, replaced by another item, or deleted from inventory.

It is generally accepted that the management of inventory involves two fundamental issues: what quantity of an item to buy at one time, and when to buy the quantity desired.[5] The inventory-management problem, then, is to determine the best answer to these two questions in order to optimize the use of financial resources. The problem of determining the best answers for these questions is a continuing one and of concern to hospital administrators. The best method of inventory management will vary from one hospital to another; therefore it is not possible to use one set of rules for all hospitals. There are, however, scientific inventory-management principles which have been developed, tested, and accepted by industry that can be applied to the

problem of managing hospital general stores inventory.[6] Successful inventory management requires the use of these principles modified by the individual circumstances of a particular hospital. Since hospitals have to maintain general-stores inventory, and hospital administrators have a responsibility for the wise use of financial resources, scientific inventory-management techniques should be used to accomplish both of these requirements in a controlled manner.

Inventory management is one of the most neglected management problems.[7] It is an obligation of hospital administrators to devote sufficient attention to inventory management to promote economy and efficiency.

Hospital setting and history

The Methodist Hospital, 1265 Union Avenue, Memphis, Tennessee, was founded by the Methodist Conferences of North Mississippi, North Arkansas, and the Memphis Conferences of the Methodist Church in 1918. The hospital started its operation with sixty-five beds and subsequently added additional beds in 1927, 1940, 1943, 1958, and 1966 to reach its present size of approximately 800 beds. Organizational relationships are illustrated by the organization chart in the Appendix (see Appendix A). The institution is a nonprofit, acute, short-term, general hospital with current occupancy rate of not less than 95 per cent. In addition to direct patient care, Methodist Hospital conducts research and edu-

cation programs. The education programs include medical training for interns, residents, nursing students, medical technicians, X-ray technicians, and inhalation therapists.

Conditions Which Prompted the Study

The present materials management department head was appointed to the position in January, 1969. He replaced an individual who had held the position for the past twenty years. Upon his appointment, the materials manager was advised by the hospital administrator to make maximum use of competitive bidding in the procurement of general storage inventory replacement items. In order to implement this policy, it was decided that a review of the present inventory-management system was necessary because the system in use was based on the former manager's intuition and experience rather than scientific methods. In addition to this, one other operational consideration prompted review of the present inventory-management system. In February, 1969, data processing changed the program and format of the daily inventory status report. The new program replaced a five-year-old program with one that was supposed to keep a perpetual inventory and automatically signal when reorder was necessary. It was readily apparent to the material manager that though the program and report format were good, the inventory data contained in the report was inaccurate and the reorder points unreliable. The hospital administrator's recognition of the

situation prompted his request that the study be made.

Statement of the Problem

The problem is to determine the best method of general stores inventory management for Methodist Hospital, Memphis, Tennessee.

Definitions

ABC analysis or stratification is the listing of inventory line item usage for a period of time in rank order. Usage is expressed in terms of the total dollar value of each line item issued from inventory during the analysis time period. The dollar values are listed in descending order and the percentage of the total value for each listed item is determined. The list enables one to stratify inventory items into categories of high medium and low dollar value in relationship to total inventory value.

Average inventory is one-half of reorder quantity.

Carrying costs are all of the expenses which are assigned to the maintenance of one lot of material in inventory for one year. It is expressed as a percentage of the total value of average inventory.

A demand is a request for one or more units of an inventory item.

General stores consist of all expendable inventory items which are not pharmaceuticals, not foodstuff and not repair parts.

The distribution of inventory value is a graphical representation of the relationship between an inventory item's percentage of the total inventory value and percentage of the total number of inventory items. Value percentages are plotted on the vertical axis and percentages of total items on the horizontal axis.

The economical ordering quantity (E.O.Q.) is a mathematically derived reorder quantity which minimizes order costs and carrying costs.

Exponential smoothing is a statistical technique used to predict requirements based on historical data.

The reorder costs includes all of the administrative and material costs assigned to the purchase of one lot of material.

A reorder point is an established in-stock quantity of an inventory item indicating the necessity for the start of the review and reorder cycle.

The reorder quantity is the number of units of an inventory item purchased from a vendor to replenish inventory stores.

The ratio of order cost to average inventory value is the ratio obtained by dividing the total annual order costs for an item by that item's average annual inventory value.

The safety stock consists of reserve material held to protect the hospital from having a stock-out condition.

This material is not considered as part of average inventory. It is not considered in determining reorder points.

Scientific inventory management is a mathematically based scheme to aid managers in making controlled inventory decisions.

Stock-out occurs when an item is not physically present to satisfy a requisition.

The stock-record card has recorded on it descriptive data, sources of supply, historical use data, and any other pertinent data about an inventory item.

The store catalogue is a list of inventory items which gives the stock number, item description, unit of issue, price, and other appropriate information.

The vendor library is a collection of information about sources of supply, vendor reliability, vendor discount policy, and other pertinent market research information.

Objectives of the Study

The objectives of the study are: (1) to analyze the current inventory-management system at Methodist Hospital; (2) to study and evaluate the basic components of the current inventory-management system; (3) to discuss the basic components of inventory-management practices generally accepted by business today as being the scientific method for inventory management; (4) to consider scientific inventory management as it applies to the particular circumstances of Methodist

Hospital; and (5) to recommend changes which would best improve the inventory-management system of Methodist Hospital.

Criteria

Criteria for the study are established as follows:

1. The system recommended must incorporate the principles set forth in current literature on inventory management.

2. It must keep inventory investment and inventory losses at a minimum.

3. It must support the hospital operation with a continuous supply of quality general stores material.

4. It must keep inventory acquisition and possession cost at a minimum.

5. It must be able to accurately forecast inventory requirements.

6. It must provide data to enable the material manager to make use of competitive bidding methods.

Limitations

Three limitations are imposed on the study:

1. Inventory management is limited to the control of general stores. Drugs, pharmaceuticals, and food stuffs are excluded.

2. No additional personnel requirement is authorized for the purchasing department by the administrator.

3. Historical inventory demand data prior to January 1, 1969, erased from computer memory tapes during conversion to a new inventory report format, cannot be reconstructed.

Factors Bearing on the Problem

Factors having a direct bearing on the problem are:

1. Requisition procedure from inventory by operating departments is satisfactory.

2. Methodist Hospital has personnel on its staff trained to use mathematical prediction techniques.

3. The daily inventory report format and the computer program in current use are acceptable for continued use.

Assumptions

The following assumptions have been made for the study:

1. The hospital will not increase the present bed capacity within the next eight to ten-year time frame.

2. Additional money will be provided for new administrative supplies if required.

3. Items in inventory which are obsolete or for which there is no foreseeable demand will be removed from inventory and disposed of.

Footnotes

[1]American Hospital Association, Statement on the Financial Requirements of Health Care Institutions and Ser-

vices (Chicago: American Hospital Association, February 12, 1969), p. iii.

[2]Ibid.

[3]Raymond C. Salling, "Can Your Inventory Control be Scientific?" Modern Hospital, CIII (October, 1964), 34.

[4]Walter M. Schulz, "Inventory Management in the Hospital," Financial Management, XXIII (March, 1969), 11.

[5]George W. Aljian, ed., Purchasing Handbook (2nd ed.; New York: McGraw-Hill Book Co., Inc., 1966), pp.13-15.

[6]Salling, p. 44.

[7]Glen A. Welsch, Budgeting--Profit Planning and Control (2nd ed.; Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1964), p. 114.

CHAPTER II

RESEARCH METHODOLOGY

A preliminary survey of hospital and business literature was made in order to gain background information in the general problem area. A one-week visit was made to the Methodist Hospital for the purpose of identifying and narrowing the problem. Following this, an extended literature review was conducted. Bibliographies and published materials about accepted inventory-management practices were obtained from the American Hospital Association, The National Association of Purchasing Management, Inc., The Hospital Financial Management Association, and the National Association of Hospital Purchasing Agents. A second visit to Methodist Hospital was made for the purpose of conducting on-site research.

On-site Research

During the second visit to Methodist Hospital, data were gathered from unstructured personal interviews, hospital records, and the physical inspection of inventory stores. Interviews were used to provide information about current inventory-management practice and to obtain an overview of the current system. Particular emphasis was placed on questions about how reorder quantities, average inventory quantities,

and reorder points were determined.

The inventory report was examined to discover how accurate the report was in reporting actual inventory status. Store room records were used to determine if the data needed to predict future requirements and to evaluate the performance of inventory-management function was recorded in a usable form.

A physical inspection of selected inventory items was conducted to compare the actual quantities with the quantity reported on the daily inventory report. The inventory bins were examined to determine the conditions of shelf items in regard to cleanliness, exterior package condition, deterioration, and the amount of space occupied by items not demanded for the past six months.

Literature Review

A review of business, mathematic, and hospital literature was made to gain knowledge about accepted inventory-management practice. The study revealed that there is a mathematically based, scientific inventory-management technique which can be used to manage any type of inventory.[1] Scientific inventory management had a beginning in the mid-1920's when mathematical formulas were devised to determine the economic order quantity (E.O.Q.) from calculations that considered all relevant costs.[2] Through the years, statistical techniques were incorporated with the original method

to increase the validity of the basic calculation. Businessmen and mathematicians have tried and tested the scientific inventory-management method in large and small businesses and have found that it was an acceptable method by which to decide how much to order and when to order inventory replacement items. It must be pointed out that the mathematical formulas do not replace the manager's responsibility to apply his attention to inventory management; rather, they replace intuition with a firm information base on which to make management decisions.[3]

Though most of the literature discusses scientific inventory management as used in a profit-making enterprise, it has been pointed out that hospitals have the same requirement to use scientific inventory-management techniques as business even though they do not have a profit motive.[4] Hospitals and business enterprises share a common requirement to optimize the use of financial resources allocated to inventory by using the best methods available.

It has been mentioned that inventory-management decisions concern how much to order and when to order. The scientific inventory-management method provides answers to these questions through the use of a three-level program. These levels are: (1) ABC stratification, (2) determination of E.-O.Q., and (3) determination of reorder points and safety stocks.[5]

ABC stratification is a management tool which provides

the material manager with the information needed to determine how much attention each item of inventory should receive. It is a means of selective management so that items which account for a high percentage of the dollar resources can be identified and then given more attention than items which account for only a small percentage of inventory value. One author's experience is that hospitals typically have from 1,000 to 3,000 general stores items and that 300 of these items account for approximately 80 per cent of the inventory's value.[6] Economies realized on these 300 items through skillful management will produce more of a pay-off than equal management effort placed on the remaining items which account for only 20 per cent of the inventory resources.

E.O.Q. determination by use of a mathematical model provides an item order quantity which minimizes the procurement and holding cost of that item. The use of E.O.Q. is not recommended for all items, but mainly for those in the B classification.[7] The A items are so important that they must be managed individually. Based on their small amount of dollar resources, the C items are least important, and should be managed by maintaining adequate stock in conjunction with automatic reorder procedure.[8]

The determination of reorder points and safety stocks takes into consideration ABC stratification and the E.O.Q. as well as the demand frequency, the lead time, and the cost of being out of an item.[9] The material manager has to have a

thorough knowledge of the usage rate of the materials and the sources of supply to establish reorder points and safety stocks.

The three-level approach to inventory-management is the method of making the reorder time and quantity decision; however there are two additional requirements for an inventory control system. There is a requirement for the administrator to establish control policies for the inventory manager and the requirement to establish performance factors for evaluating the effectiveness of the system.[10] There are several performance factors in common use in business as indicators of inventory-management effectiveness.

Footnotes

[1]Richard I. Levin and C. A. Kirkpatrick, Quantitative Approaches to Management (New York: McGraw-Hill Book Co., Inc., 1965), pp. 114-36; George Hadley and T. M. Whitin, Analysis of Inventory Systems (Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1963), pp. v-vii; Programmed Instruction in Inventory Management (2nd printing; Newburgport, Mass.: Entelek, Inc., 1964), pp. ii-iii.

[2]Ibid., p. ii.

[3]Homer L. Monk, "A Critical Analysis of Inventory Control Systems and Techniques," Purchaser, November, 1967, p. 13.

[4]Schulz, p. 11.

[5]Salling, p. 34.

[6]Ibid.

[7]Aljian, p. 13-11.

[8]Ibid., p. 13-12.

[9]Schulz, p. 13.

[10]Welsch, p. 114.

CHAPTER III

DISCUSSION

The Current System

Inventory management is one of the responsibilities of the material management department. Inventory is composed of approximately 2,000 items of general stores. Pharmacy and dietary department inventories are physically separate from general stores and managed by their separate departments. The materials management department is staffed by seven employees and the department head (see Appendix B). No item identification stock record card file is maintained for stocked items. Data processing produces a daily computer listing of the current status of the general stores inventory which serves as a catalogue of the stores items and the only source of stores data. The organization, inventory report, and operation of the system is discussed below.

Materials Management Organization

The materials management department operates without written policy guidance from the administrator. This department is responsible for general stores purchasing, inventory management, processing stores requisitions, and delivery of requisitioned supplies to the operating departments of the

hospital.

The materials manager personally makes the decisions and takes all of the action necessary to maintain the inventory. Included in this function are the decisions about when to order, how much to order, and source of supply. After making these decisions, he manually prepares the purchase orders to buy the supplies. Currently the materials manager writes approximately thirty purchase orders per day.

Because there are no individual item stock record cards maintained, the materials manager must rely on memory, a small vendor library, the daily inventory status report, and direct contact with vendors to make the purchase decisions.

The stock room supervisor oversees the operation of inventory stores. His job includes reviewing filled requisitions and the daily inventory status report, preparing a daily supply reorder list, and supervising stock room and delivery personnel.

Stock room personnel verify incoming shipments, stock shelves, and fill requisitions. Delivery personnel fill requisitions and make delivery to the requesting departments.

The invoice clerks collate copies of purchase orders, receiving reports, and billing invoices from vendors. Invoices and matching purchase orders are delivered to the finance office for action. Duplicates of purchase orders and invoices are filed by the clerks in vendor file jackets.

Since billing invoices are processed by the same personnel who process purchase orders and receiving reports there is a lack of internal control. This violation of accounting practice is a weakness in the present system.

The primary weaknesses of this organization are that only one individual has the responsibility to be familiar with the source, price, and quantity determinations for 2,000 inventory items. In addition, this same individual manually prepares the purchase orders for inventory replenishment rather than devoting his management ability to more important responsibilities.

The Daily Inventory Status Report

This report is the only source for general stores item information. The report serves as a store catalogue, a control report, and a source of item demand data.

The current status report format became effective February 1, 1969, when a new computer program was put into service. Data which was in the computer memory bank as a source for the previous report was used as input data for the current report. The input data consisted of item identification numbers, item description, current price, average price, on-hand quantity, and reorder points. Reorder points had been established three or four years ago but the method used to establish them is not known. In converting from the old format to the new, all the historical item-demand data prior to February 1, 1969, was lost. Thus the current

report lists only average monthly usage since the starting date. In addition to the average monthly usage, there is a column reporting the current months to date item issues. At the end of the month, this is averaged in with the average monthly usage to determine the new average.

The inventory status report is updated daily from copies of daily inventory transactions submitted to data processing by the materials management department. An important element of the report program is a perpetual inventory feature. Daily issues are subtracted from the on-hand quantities, and the current on-hand status of each item is reported. When on-hand quantities reach the programmed reorder point, an asterisk prints opposite the item to indicate reorder action should be considered by the materials manager.

This report is a very effective control device; however, there are some problems with it. The on-hand quantities which were carried over from the previous report were not verified by a physical inventory count. As a result, negative quantities and unrealistically large quantities appear on the report. The reorder points carried over have not been verified for several years and are not reliable. Some reorder points were observed to be very high for low-demand items and low for high-demand items. One further weakness of the report is that the report has no provision for accumulating several months of demand history which could be used to predict trends. The average monthly usage

now reported does not give the inventory manager an overall picture of trends or seasonal fluctuations.

The Current System--When to Buy

Operating departments submit requisitions at scheduled times for general stores items. The requisitions are preprinted with only the items a particular department is authorized to requisition from inventory. Storeroom personnel fill the requisitions and indicate on the requisition the number of items issued. If there is a stock-out condition of an item, the condition is apparent because the number issued will be less than the number ordered. When a disparity is noted by the stock room supervisor during the audit of filled requisitions, the item is recorded on a summary list of items that should be ordered. This is one way inventory reorder action is noted. It is based on a stock-out condition being present.

The other way reorder action is indicated is when the stock room supervisor notes an asterisk on the daily inventory status report. The asterisked item noted is recorded on the summary reorder list.

After the summary reorder list is completed by the stock room supervisor, it is given to the materials manager for action. In these two ways, a stock-out condition or computer signal causes the materials manager to become aware of the need to order.

This method has two shortcomings. The first is that

reorders based on a stock-out condition involve some risk and an increase in cost. Being out of required medical material is unacceptable. Being out of other than medical material is inconvenient. An extra cost is added to inventory when supplies are purchased on an emergency basis, even if the supplies can be delivered within one working day. The emergency action does not allow enough time to find the best source of supply and this may require payment of a premium price for small quantities or special transportation.

The second shortcoming is that reorder signals are based on questionable reorder points. The perpetual inventory and reorder signal is an excellent idea but until critical reorder points are established by a mathematical predictive technique, reliance on questionable values can result in replenishing too soon or not soon enough.

The Current System--How Much to Buy

The determination of what quantity of a general stores item to order for inventory is a mixture of two methods. Some items are ordered based on quantities which have traditionally been ordered. The origin of how these quantities were established is not known by the materials management operating personnel. The other method used is to issue a blanket purchase order for one year's estimated quantity, with the provision that the vendors deliver partial

quantities of the items on demand with each partial shipment being deducted from the total estimated quantity. An annual usage rate estimate used in the blanket purchase order was arrived at by the material manager based on experience and intuition. The only statistical technique in use for quantity determination is a simple average monthly usage which was mentioned in the discussion of the inventory status report. No mathematical techniques are being used either by the computer or by manual calculation to forecast annual requirements of general stores items based on past usage rates. Lack of any forecast technique is a weakness of the present system.

Choice of vendor

The selection of the vendor is made exclusively by the materials manager. The choice of the vendor is based on price, quality, and service. No record of vendor performance has been kept prior to January, 1969. The present material manager, who was appointed in January, 1969 is developing a vendor information file to aid him in making vendor selection decisions. A lack of this file makes it difficult to select the best source of supply for stores items.

Inventory control and evaluation

There is no procedure used to classify general stores inventory according to the per cent of annual inventory cost attributable to each item. The only way the manager has to

judge how much managerial attention an item should be given is experience and intuition. A Standardization Committee was established in March, 1969, at the request of the material manager for the purpose of evaluating general stores items. The committee will recommend items to be included in inventory and determine which items should be deleted. There is no policy or procedure established which provides for the disposal of obsolete or deleted stores.

The administrator of the hospital uses two indicators to evaluate the performance of the present system. One indicator is a comparison of the value of the current month's inventory with the value of the inventory at the beginning of the fiscal year. The other indicator is feed-back from the hospital staff about material availability.

Proposed Inventory-Management System

An effective inventory-management system should have a scientific basis for making the "when to buy" and the "what quantity to buy" decision.[1] The time and quantity determinations require that the inventory manager have extensive knowledge about such factors as prices, material sources, order and shipment time, and the quality of the items that comprise the inventory. There are acccpted principles of inventory-management that take all of these factors into consideration to obtain the overall objective of the optimum use of financial resources.[2] The proposed system was devel-

oped from these principles.

Preliminary considerations

Operating considerations of an inventory-management system must be preceded by a policy formulation step.[3] Policies delineating the administrator's expectations of the inventory-management function, establishing the scope of the materials manager's responsibility, and providing a means of evaluating his performance should be made by top management. Policies should also be established at the operating level by the materials manager to cover the function of his department. It is preferred that policies be in written mode rather than oral.[4] For the purpose of this paper it is sufficient to point out the necessity of formal policy as a basis to a sound inventory-management system.

The collection and recording of information about inventory items is necessary for a scientific inventory-management system.[5] The basic inventory record is an item-identification record card. This card should contain descriptive data about the item and selected historical use data. In addition, current source data, prices, and vendor performance information should be recorded for ready reference. The relative percentage of inventory value each item represents will indicate how much market research should be done to insure the best price for the quality of material desired. Suggested methods for preparing this record and gathering of data are readily available in current materials management

literature.[6]

It should be pointed out that the inventory control system proposed is amenable to either a manual or computer-based system. The computations required can certainly be accomplished more quickly and updated more frequently by computer but the use of a computer is not a prerequisite.

The last point to be made before approaching the actual system is the requirement to verify the physical inventory of the on-going system against the inventory status report; this is necessary because this report will be the source of input data for the new system. For example, a random sample of items listed on the inventory status report of Methodist Hospital revealed discrepancies between the reported on-hand quantity and the actual on-hand quantity. This incorrect information has caused false reorder signals and negative quantities to appear on the report. The on-hand quantities should be reconciled with the inventory status report to insure the materials manager that data input to the new system is accurate and reliable. A physical count of inventory performed for the reconciliation should also disclose the presence of deteriorated and obsolete stock items which can then be acted upon.

Organization

A minor modification of the present organization will accommodate the proposed system. At the present time the

department head is personally managing all 2,000 stores items and manually preparing purchase orders.

There are two changes which will give the materials manager more time to devote to important management decisions. The first is the assignment of the clerical task of purchase order preparation to one of the invoice clerks and transfer responsibility for receipt of vendor invoices to business office. The department head will of course retain the authority to authenticate the purchase order instrument.

The second change is to divide the management of inventory items between the materials manager and the storeroom supervisor. The most important items are to be managed by the department head and the remainder by the storeroom supervisor. ABC stratification, which is to be discussed next, will provide a convenient means of determining the division. Dividing the responsibility for managing inventory items will enable the materials manager to do a thorough market research on these inventory items which account for most of the financial resources devoted to inventory. The remaining items, though their management will be less critical under the proposed system, will receive more control. This additional control will improve the overall efficiency of the inventory-management system. The division of responsibility for controlling inventory items is compatible with current business practice.[7]

ABC Analysis

The first step of the proposed inventory-management system is to determine, based on the contribution each item makes to the total value of inventory, the importance of each item. How much managerial attention each item should receive is predicated on its ranking. It is generally known that most inventories have a typical distribution.[8] A relatively small number of inventory items account for a relatively large per cent of the total inventory value. Typically, approximately 10 per cent of the items account for 70 per cent of the inventory value. These are classified as "high value" or "A" items. The next grouping of the distribution is comprised of approximately 40 per cent of the items which account for 20 per cent of the value. These are the medium value or "B" items. The last grouping, the "C" items, of the distribution consists of the remaining 50 per cent of the items and accounts for only 10 per cent of the inventory value.

Segregating the inventory into A, B, and C categories can be accomplished from the data contained in historical records of stores issues over an established period of time. The average unit price for each item is multiplied by the total issues of that item for the established period of time. Each of these values are then ranked and numbered consecutively from the highest to the lowest value. After ranking, the percentage value of each item relative to the total value of all the items is determined. Each rank number is divided by the highest rank number to determine each item's

per cent of the total number of items. The per cent of the total value and the per cent of the total number of items are plotted on a graph with the per cent of value on the vertical axis and the per cent of items on the horizontal axis to describe the distribution curve. A typical distribution curve is illustrated in Figure 1.

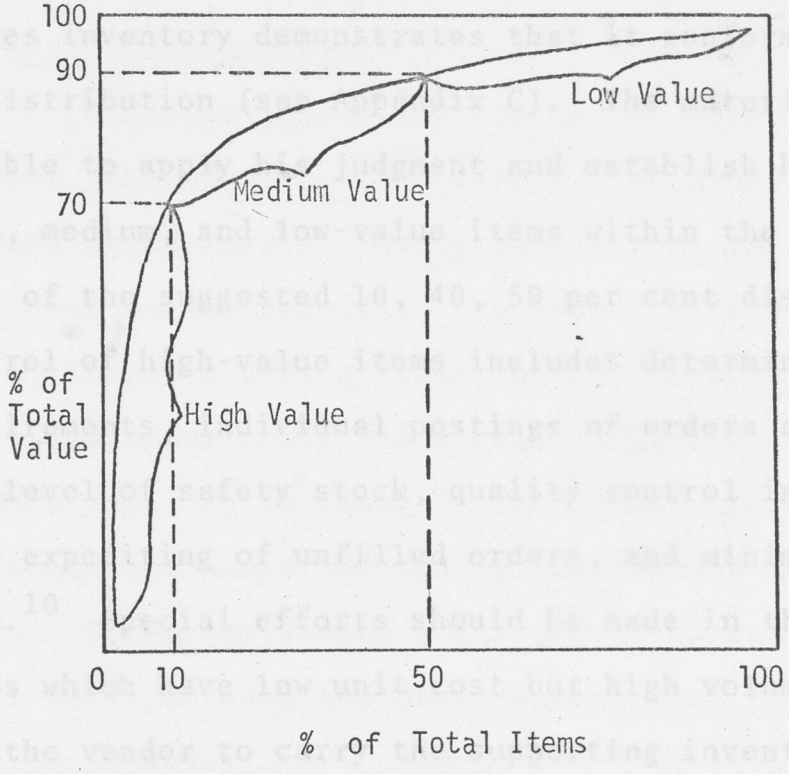


Fig. 1.--Distribution of Inventory Value

Source: Aljian, George W., Ed., Purchasing Handbook (2nd. ed.; New York: McGraw-Hill Book Co., Inc., 1966), fig. 13-2, p. 13-11.

As mentioned previously, ABC classification provides the inventory manager with the information needed to determine where he should place the most managerial attention. It is recommended that "A" items (high value) need constant review and critical analysis; "B" items (medium value) are best suited to the use of an economical ordering quantity (E.O.Q.) model; and "C" items (low value) should be managed as inexpensively as possible.[9]

ABC stratification of Methodist Hospital general stores inventory demonstrates that it conforms to the expected distribution (see Appendix C). The materials manager will be able to apply his judgment and establish his own limits of high, medium, and low-value items within the general framework of the suggested 10, 40, 50 per cent distribution. Close control of high-value items includes determination of exact requirements, individual postings of orders and receipts, a low level of safety stock, quality control inspections, regular expediting of unfilled orders, and minimum active inventory.[10] Special efforts should be made in the case of "A" items which have low unit cost but high volume use to encourage the vendor to carry the supporting inventory.[11] Items in the high-value category usually are those which are subject to obsolescence and rapid deterioration so the close scrutiny given them by the inventory manager will help prevent loss of this type.

The low-value items should receive the least attention. It is recommended that an automatic reorder system be used, based on ordering a three-month supply automatic-

ally when a set order point is reached.[12] The reorder point should be established high enough to prevent a stock-out condition during the reorder and item receipt time. The reorder point is established based on a forecast of the usage rate for this time period.

Medium-value items are controlled by procedures less strict than those used for high-value items but not as automatic as those used for the low-value items. The method of choice is the use of the calculated E.O.Q.[13]

Economic Order Quantity

There is a cost for placing an order to purchase inventory general stores and also a cost associated with maintaining an inventory. Every time an order is placed, there is a cost to the hospital; the more orders placed, the more cost. There is also a relationship between the size of an order and order cost. If a certain number of units are needed each year, an increase in the number ordered at one time decreases the number of orders and thereby decreases order costs. Conversely, many small orders to satisfy yearly demands will increase the total annual cost for keeping the item in inventory.

Offsetting the savings that can be realized by simply increasing order size and decreasing the frequency of ordering is the cost of carrying inventory. If the hospital has a large inventory tying up a considerable amount of capital that would otherwise be invested, it causes the hospital to lose this return on invested capital. In addition, inven-

tory stores will deteriorate and become obsolete if held too long, thus causing a loss to the hospital. Both of these factors are the principal determinants for carrying costs. The E.O.Q. mathematical model is a formulation which can be used to determine an order quantity for part of a yearly requirement that minimizes the sum of order costs and carrying costs.[14] Before using the mathematical model for quantity determination of "B" items, the material manager should assure himself that there is a fairly constant annual usage of the item and that the item will continue to be used during the forecast period.

The E.O.Q. model expressed in mathematical form is as follows: $E.O.Q. = \sqrt{\frac{2AS}{IC}}$ where "A" represents the annual usage in appropriate units, "S" represents the order cost, "C" represents the unit cost, and "I" represents carrying cost expressed as a per cent of average inventory value. There are many purchasing texts which explain how ordering costs and carrying costs are developed.[15] Since these costs have been developed by Methodist Hospital, the derivation of order and carrying costs will not be discussed in this paper. Methodist Hospital order cost, "C" is $7 per purchase order and carrying cost, "I" is 10 per cent.

To illustrate the use of E.O.Q., a comparison of historical data with E.O.Q. calculated quantities has been made. Ten general stores items in the B strata were selected at random and the annual usage, the unit cost, and the number of orders placed in the past calendar year were determined. This data was used to compute the average inventory

value, the annual order cost and the ratio of the order cost to the average inventory value (see Appendix D).

E.O.Q. computations were made for the same items to determine optimum purchase lot size (see Appendix E). E.O.Q. purchase lot size was then used to determine the number of orders, the annual order cost, and the ratio of order cost to the average inventory value (see Appendix F). The desired ratio of an item's order cost to its average inventory value should be equal to or less than the carrying cost.[16] In the case of Methodist Hospital carrying cost was determined to be 10 per cent. It is easy to see that if the ratio of order cost to average inventory value exceeds the carrying cost percentage, then more money is being spent to put an item into inventory than would be spent to carry a larger amount of that item in inventory. Table 1 (see below) is a comparison of the historical ratios order cost to average inventory value compared to the same ratios based on E.O.Q. calculations.

Table 1 illustrates that the ideal ratio of order cost to inventory value is achieved when the E.O.Q. model is used. The two outstanding examples are items 2 and 6. Current procurement quantities cost two dollars to purchase one dollar's worth of inventory. Using E.O.Q., it costs approximately twelve cents to purchase one dollar of inventory. The proposed system recommends the use of E.O.Q. calculation to determine reorder quantities for items in B strata and others as desired by the manager.

TABLE 1

COMPARISON OF HISTORICAL AND E.O.Q. BASED RATIO OF ORDER COST TO AVERAGE INVENTORY VALUE EXPRESSED IN PERCENTAGE.

Item No.	1	2	3	4	5	6	7	8	9	10
Historical	27	229	60	102	28	240	24	22	31	185
E.O.Q. Based	10.3	12.7	9.4	10	9.9	12	11	10	10.6	10

(See Appendixes D, E, and F)

Reorder Points and Safety Stocks

ABC stratification provides the inventory manager with information that enables him to give attention where it is needed most. The E.O.Q. calculation provides him with an order quantity under conditions of minimum order and possession cost. Both of these steps are based on objective methods. The question of when to buy is still largely based on a subjective decision of the manager. Because this decision is largely subjective, the best information available should be used to establish reorder points that are valid indicators of when to order and safety stock levels that insure an uninterrupted flow of material.

All reorder decisions are cyclic in nature.[17] The cycle can be an established time frame which calls for review and reorder at stated intervals of time, for example, weekly or monthly. The cylce can also be initiated by a set reorder point or the presence of a stock-out condition. At a point in time during each cycle dependent on its type, a review of the status of each item is made. How detailed or complete

the review is depends on the ABC classification of the item in question.[18] For example, the A items require a very complete review, while the C items require only a cursory one unless high usage causes a change from C classification to a higher classification.

The following facts about each item are determined or verified at review time:

1. Forecasted requirements.
2. Acquisition lead time.
3. Quantity on hand.
4. Quantity on order.[19]

Forecasted requirements are an important part of the when-to-buy decision. If the demand is going to diminish, the reorder time can be postponed; otherwise, inventory will build up. If the demand is going to increase, the reorder time should come sooner than scheduled; otherwise, a stock-out condition will occur. Historical data is the basis of forecasting requirements and some adjustment action of this data must take place for future requirements to be accurately predicted. It has been found that the exponential smoothing technique is the best method for forecasting hospital inventory requirements.[20] This technique can easily be introduced into the inventory-management system of Methodist Hospital because the computer equipment and the trained personnel are available.

Acquisition lead time has to be determined and considered when establishing a reorder point and determining

the amount of safety stock needed to prevent a stock-out condition. Maintenance of a library of current item and vendor data serves as a source for determining lead time.

The quantity on hand is readily available from the inventory status report. It must be stressed again that reported quantities must reflect the actual quantity on hand. The quantity on order is also available from the inventory status report and should be considered before additional inventory stores are ordered.

Safety stock policies are generally determined by top administration because the reserve material requires the use of operating funds which are essentially nonproductive. The location of Methodist Hospital in a medical center area of the city with a high density of medical supply houses makes it possible for the hospital to operate with a minimum number of items protected by reserve stock. A good knowledge of the vendor's ability to supply hospital requirements along with accurate reorder points minimize the requirement for safety stock. The perpetual inventory capability of the present system makes it possible for the inventory manager to make use of the reorder signal to initiate his review process. The reorder point should be set high enough to prevent stock-out prior to the receipt of the new material, but not high enough to cause a build-up of inventory which increases the possession cost of the material. As mentioned before, a thorough knowledge of the order and shipping time for a particular item and an accurate forecast of usage rates will

enable the materials manager to set accurate reorder points and take advantage of the reorder signal feature of the daily inventory status report.

Inventory Control

An important function of management is evaluating the effectiveness and controlling the operational aspect of the inventory system. The operational aspects of the proposed system are based on the consensus of information on the subject as modified by the particular set of circumstances of this hospital. Accepted criteria are also the basis for establishing evaluation and control procedures of the inventory-management system.[21]

The inventory turnover rate is an indicator that relates average inventory value to the annual value of inventory stores issues. To find the turnover rate divide the annual value of inventory issues by the average inventory value. Some consider that a turnover rate of six to eight times a year is a good rate for a hospital.[22] A turnover rate within this range indicates that a minimum amount of operating capital is tied up in current inventory stocks.

The ratio between acquisitions and requisition issues is a good indicator of the efficiency of inventory control. One should strive for the ideal of a one to one ratio. The attainment of a one to one ratio of active inventory stores items requires accurate forecasting of material usage. If acquisitions and requisitions are unbalanced on either side

of the ratio, one might anticipate conditions of excesses or shortages of material.

The number of times per control period that a requisition cannot be filled from inventory is an indicator of the effectiveness of the inventory management system. A stock-out condition of a medical item is unacceptable and demands emergency procurement action to fill the requisition. This emergency procurement adds to the cost of operation. Stock-out condition for other than medical items is an inconvenience that hinders the hospital operation somewhat. The number of stock-outs and the identification of the stock-out item helps focus managerial attention where it is needed.

One other standard for evaluating the efficiency of the inventory-management function is the establishing of a planned average inventory balance, in terms of quantity or cost, to be achieved at the end of a control period.

The establishment of a percent of requisitions filled standard and setting a dollar amount of inventory balance is a policy decision for the administrator of Methodist Hospital to make. The author was unable to find any standards, applicable to the hospitals, in the literature.

Summary

The requirement that hospital administrators make wise use of financial resources is of major importance today. Government, people involved in nongovernment third-party programs, and private citizens are voicing concern about the

rising costs of hospital care and insisting that the costs be justified. One aspect of the hospital that contributes to cost and which requires a high level of managerial control in the use of financial resources is inventory management. This study described the present inventory-management system and described a new system which is based on accepted principles of scientific inventory-management practice. The principles assist the inventory manager in making the "how much to buy" and "when to buy" decisions in a controlled manner. In developing a scientific inventory control program, the consensus is to approach the problem in three ways. The first way is an ABC stratification of general stores inventory. The second is a determination of ordering quantities by use of the E.O.Q. model. The third, is the determination of reorder points and safety stocks as objectively as possible. One then adds policy for control and performance factors for evaluating effectiveness to complete the inventory-management system.

The advantages of using a scientific management system are that it provides the manager with control techniques and insures continuity of material along with the most effective use of resources.

The disadvantages of this method are that the E.O.Q. equation assumes that many of the variables in the model are constants and depends on cost figures for carrying charges and order costs that are nothing more than considered estimates. Despite these disadvantages, the system does replace intuition with objective methods that yield constant results.

The scientific method does not replace the requirement for managerial ability; rather, it supplements it.

Footnotes

[1]Howard L. Timms, Inventory Management of Purchased Materials (3rd printing; New York: National Association of Purchasing Agents, 1962), p. 8.

[2]Ibid.

[3]Aljian, pp. 3-5.

[4]Harold Koontz and Cyril O'Donnell, Principles of Management (3rd ed.; New York: McGraw-Hill Book Co., Inc., 1964), p. 174.

[5]Timms, p. 22.

[6]Aljian, pp. 25-1 - 25-30; Stuart F. Heinritz and Paul V. Farrell, Purchasing Principles and Applications (4th ed.; Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1965), pp. 136-38.

[7]Lammar Lee, Jr., and Donald W. Dobler, Purchasing and Materials Management (New York: McGraw-Hill Book Co., Inc., 1965), pp. 452-58.

[8]Timms, p. 25.

[9]Schulz, p. 12.

[10]Salling, p. 36.

[11]Timms, p. 28.

[12]Ibid.

[13]Salling, p. 36.

[14]Levin and Kirkpatrick, p. 119.

[15]Ibid , pp. 115, 118; and Timms, pp. 52-58.

[16]Salling, p. 44.

[17]Timms, p. 20.

[18]Ibid., pp. 27-30.

[19]Ibid., p. 20.

[20]Harold E. Smalley, et al., "Hospital Supply Decisions: Inventory Policies," Hospital Management, XCVII (March, 1964), 92.

[21]Homer A. Black, John E. Champion, and R. Gene Brown, Accounting in Business Decisions (2nd ed.; Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1967), pp. 468-84.

[22]George Mathews and Robert C. Harrison, "Computing Economical Ordering Quantities," Hospitals, XXXVII (February, 1963), 82.

CHAPTER IV

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

It is concluded that:

1. The best method of general stores inventory management for Methodist Hospital, Memphis, Tennessee, is the scientific inventory-management method. This consists of ABC stratification, use of E.O.Q., determination or reorder points and safety stocks, a statement of policy and establishment of performance factors.

2. The scientific inventory-management method can be expected to provide administration with the means to evaluate the effectiveness of the inventory-management function.

3. The scientific inventory-management method will provide the hospital with general stores inventory that minimizes average inventory value, provides a constant supply of material, and minimizes losses due to obsolescence and deterioration.

4. The proposed method will indicate which items should be procured using the competitive bidding procedure.

Recommendations

It is recommended that:

1. Methodist Hospital adopt the scientific inventory management system which consists of:

   a. ABC Stratification

   b. Use of E.O.Q. calculations

   c. Determination of reorder points and safety stocks

   d. Statement of policy and establishment of performance factors.

2. Data processing department develop and implement programs to support the adoption of the scientific inventory management system.

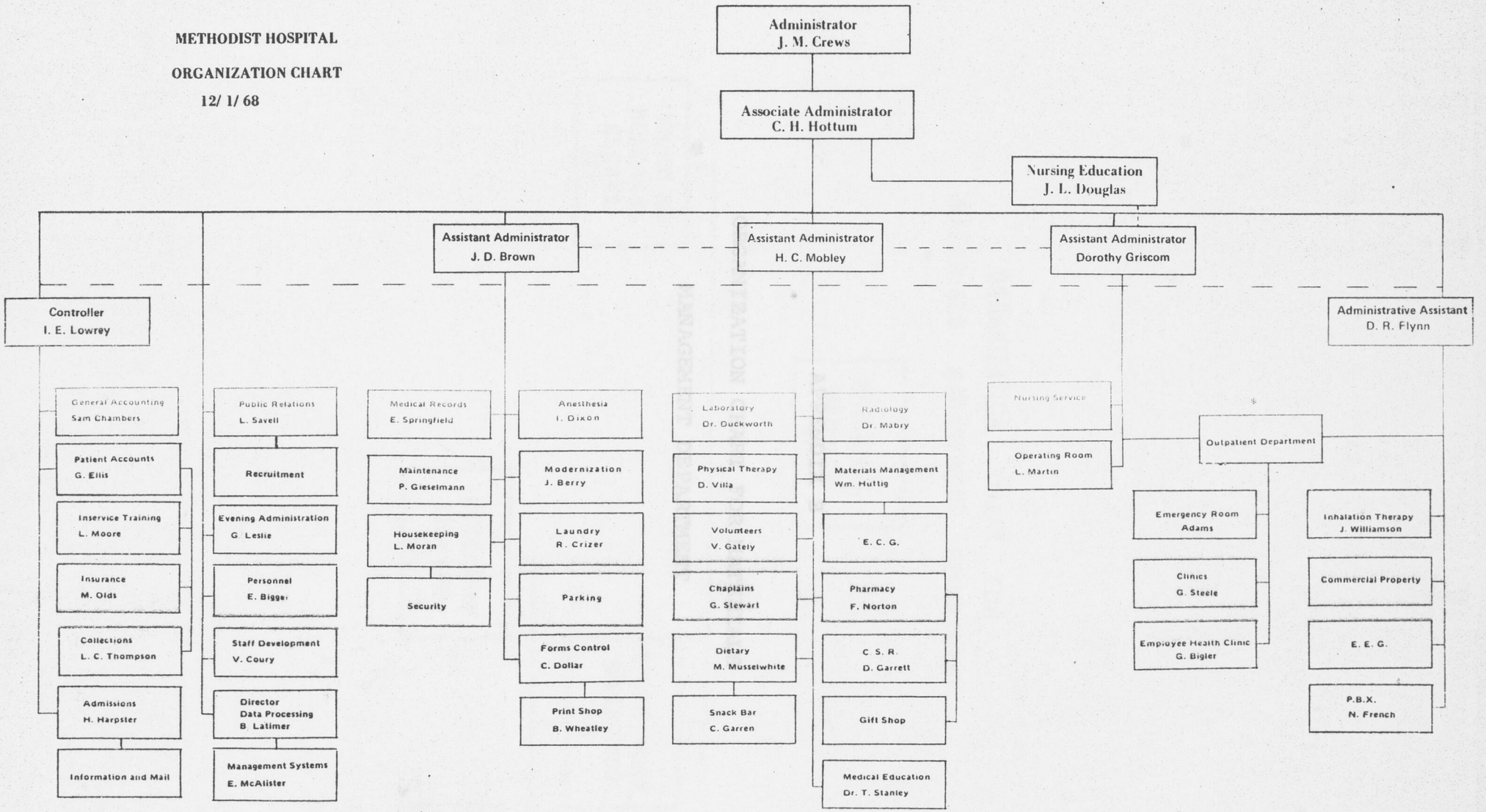
APPENDIX A

METHODIST HOSPITAL, ORGANIZATION CHART

METHODIST HOSPITAL

ORGANIZATION CHART

12/ 1/ 68

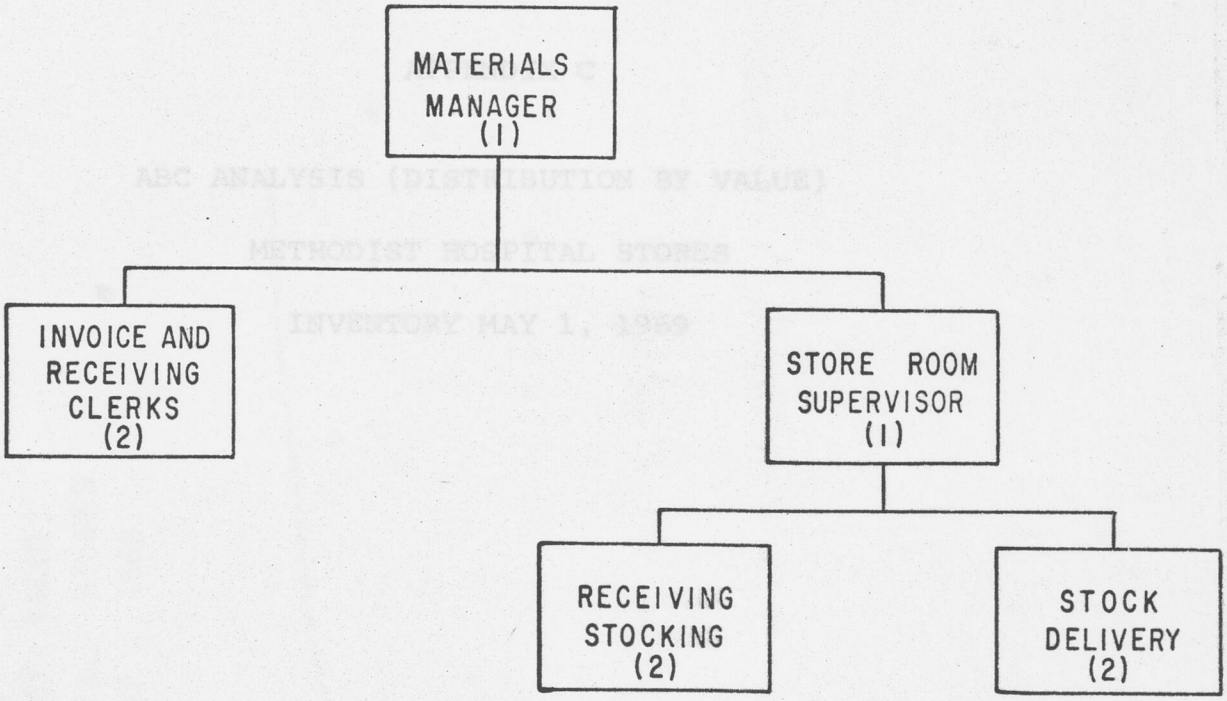


* Professional and Administrative division of authority and responsibility.

APPENDIX B

ORGANIZATION CHART FOR MATERIALS MANAGEMENT DEPARTMENT

ORGANIZATION CHART FOR
MATERIALS MANAGEMENT DEPARTMENT



APPENDIX C

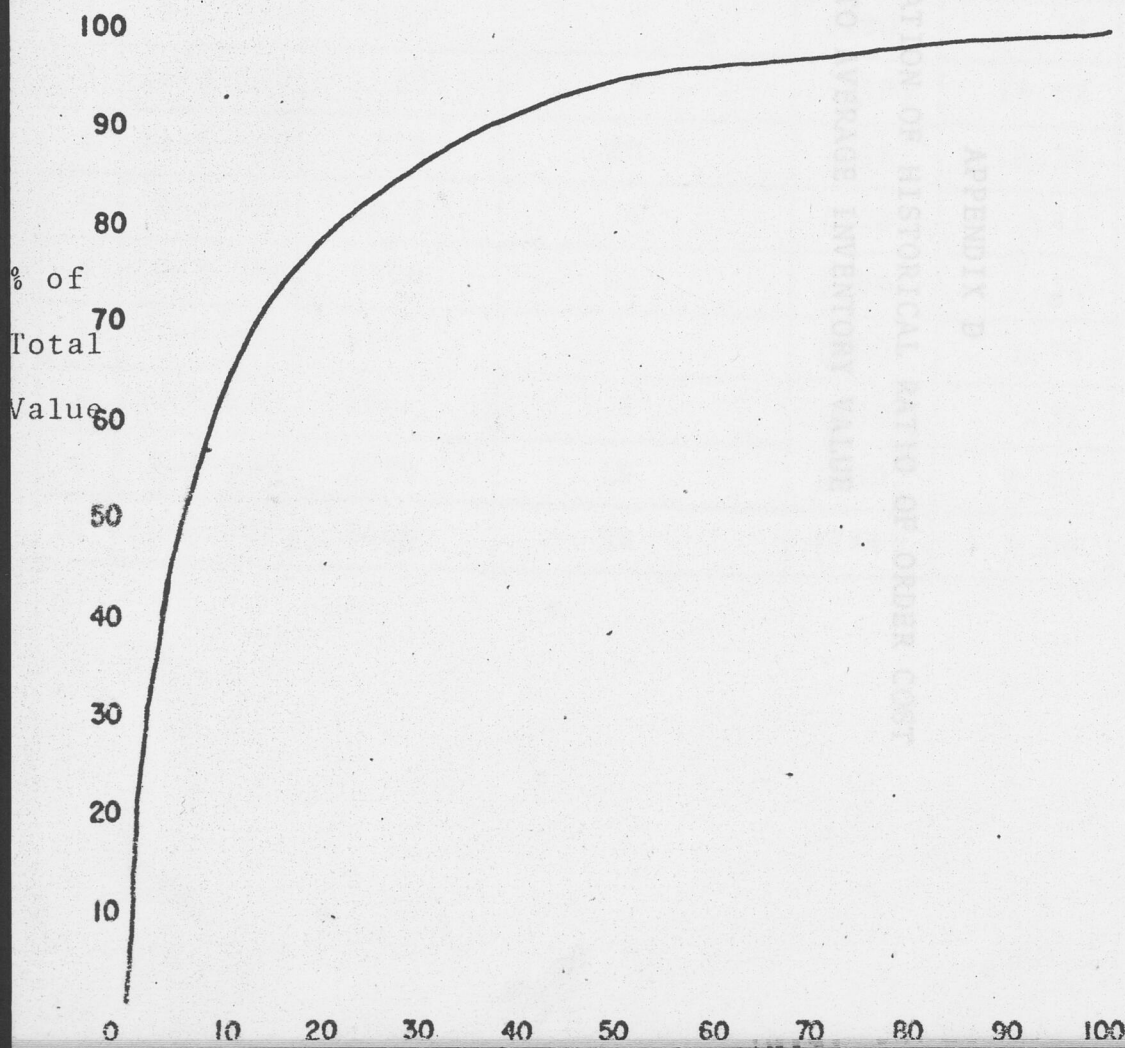
ABC ANALYSIS (DISTRIBUTION BY VALUE)

METHODIST HOSPITAL STORES

INVENTORY MAY 1, 1969

Fig. 2

ABC ANALYSIS
(DISTRIBUTION BY VALUE)
METHODIST HOSPITAL STORES
INVENTORY MAY 1, 1969



COORDINATES

% OF VALUE	% OF ITEMS	% VALUE	% ITEMS
7	.1	87.4	31
21.1	1	88.5	33
29.9	2	89.5	35
37.2	3	90.4	37
43.5	4	91.2	39
48.5	5	91.9	41
52.6	6	92.6	43
56.5	7	93.2	45
59.5	8	93.7	47
62.4	9	94.2	49
64.8	10	94.4	50
67	11	96.3	60
68.9	12	97.4	70
70.6	13	98.8	80
72	14	99.5	90
73.5	15	100.	100
74.7	16		
76	17		
77	18		
78.2	19		
79.2	20		
80.2	21		
81	22		
81.8	23		
83.4	25		
84.8	27		
86.2	29		

APPENDIX D

SAMPLE CALCULATION OF HISTORICAL RATIO OF ORDER COST TO AVERAGE INVENTORY VALUE

SAMPLE CALCULATION OF HISTORICAL RATIO OF ORDER COST TO AVERAGE INVENTORY VALUE

	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
ITEM #	STOCK NUMBER	ANNUAL USAGE (A)	NO. OF ANNUAL ORDERS	ORDER SIZE	UNIT COST (C)	ANNUAL ($7.00 ea.) ORDER COST	AVERAGE INVENTORY VALUE (d/2) X (e)	RATIO OF ORDER COST TO INVENTORY VALUE (f/g)X100
1	1-6-314	2736	5	(600)	$ .43	$ 35.00	$ 129.00	27%
2	9-3-310	3672	7	(280)	.21	77.00	33.60	229%
3	14-8-120	72	8	(10)	18.52	56.00	92.60	60%
4	14-8-610	372	20	(15)	18.30	140.00	137.25	102%
5	9-3-350	3072	5	(600)	.41	35.00	123.00	28%
6	9-3-380	2500	12	(200)	.35	84.00	35.00	240%
7	1-6-302	1008	6	(200)	1.75	42.00	175.00	24%
8	24-8-501	6864	6	(1250)	.31	42.00	193.75	22%
9	9-8-585	1756	19	(100)	8.45	133.00	422.50	31%
10	10-3-070	5400	38	(144)	2.00	266.00	144.00	185%

APPENDIX E

E.O.Q. CALCULATIONS

E.O.Q. CALCULATIONS

E.O.Q. MATHEMATICAL MODEL = $\sqrt{\frac{2AS}{IC}}$

Order cost (S) = \$7 Carrying cost (I) 10 per cent

1. Item No. 1-6-314 Annual usage (A) 2736.

Unit cost (c) .43

$$E.O.Q. = \sqrt{\frac{2 \times 2736 \times 7}{.10 \times .43}} = 944$$

2. Item No. 9-3-310 Annual usage (A) 3672

Unit cost (c) .21

$$E.O.Q. = \sqrt{\frac{2 \times 3672 \times 7}{.10 \times .21}} = 1,564$$

3. Item No. 14-8-120 Annual usage (A) 72

Unit cost (c) \$18.52

$$E.O.Q. = \sqrt{\frac{2 \times 72 \times 7}{.10 \times 18.52}} = 24$$

4. Item No. 14-8-610 Annual usage (A) 372

Unit cost (c) \$18.30

$$E.O.Q. = \sqrt{\frac{2 \times 372 \times 7}{.10 \times 18.30}} = 54$$

5. Item No. 9-3-350 Annual usage (A) 3072

Unit cost (c) \$.41

$$E.O.Q. = \sqrt{\frac{2 \times 3072 \times 7}{.10 \times .41}} = 1024$$

6. Item No. 9-3-380 Annual usage (A) 2500

Unit cost (c) $.35

$$E.O.Q. = \sqrt{\frac{2 \times 2500 \times 7}{.10 \times .35}} = 1,000$$

7. Item No. 1-6-302 Annual usage (A) 1008

Unit cost (c) $1.75

$$E.O.Q. = \sqrt{\frac{2 \times 1008 \times 7}{.10 \times 1.75}} = 284$$

8. Item No. 24-8-501 Annual usage (A) 6864

Unit cost (c) $.31

$$E.O.Q. = \sqrt{\frac{2 \times 6864 \times 7}{.10 \times .31}} = 1,760$$

9. Item No. 9-8-585 Annual usage (A) 1756

Unit cost (c) $8.45

$$E.O.Q. = \sqrt{\frac{2 \times 1756 \times 7}{.10 \times 8.45}} = 170$$

10. Item No. 10-3-070 Annual usage (A) 5400

Unit cost (c) $2.00

$$E.O.Q. = \sqrt{\frac{2 \times 5400 \times 7}{.10 \times 2.00}} = 615$$

APPENDIX F

SAMPLE CALCULATION OF E.O.Q. BASED RATIO OF ORDER COST TO AVERAGE INVENTORY VALUE

SAMPLE CALCULATION OF E.O.Q. BASED RATIO OF ORDER COST TO INVENTORY VALUE

	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
ITEM #	STOCK NUMBER	ANNUAL USAGE (A)	NO. OF ORDERS PER E.O.Q.	E.O.Q. ORDER	UNIT COST	ANNUAL ORDER COST	AVERAGE INVENTORY VALUE (d/2) X (e)	RATIO ORDER COST TO INVENTORY VALUE (f/g)x100
1	1-6-314	2736	3	(944)	$ .43	$ 21.00	202.96	10.3%
2	9-3-310	3672	3	(1564)	.21	21.00	164.22	12.7%
3	14-8-120	72	3	(24)	18.52	21.00	222.24	9.4%
4	14-8-610	372	7	(54)	18.30	49.00	494.10	10.0%
5	9-3-350	3072	3	(1024)	.41	21.00	210.33	9.9%
6	9-3-380	2500	3	(1000)	.35	21.00	175.00	12.0%
7	1-6-302	1008	4	(284)	1.75	28.00	248.50	11.0%
8	24-8-501	6864	4	(1760)	.31	28.00	272.80	10.0%
9	9-8-585	1756	11	(170)	8.45	77.00	718.25	10.6%
10	10-3-070	5400	9	(615)	2.00	63.00	615.00	10.0%

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ABSTRACT

A STUDY OF GENERAL STORES INVENTORY MANAGEMENT AT METHODIST HOSPITAL, MEMPHIS, TENNESSEE

A Problem Solving Project Report Submitted to the Faculty of Baylor University in Partial Fulfillment of the Requirements for the Degree of Master of Hospital Administration

By Major Joseph A. Donato, MSC

August, 1970 60 Pages

A copy of this document may be obtained on loan from the United States Army Medical Field Service School, Brooke Army Medical Center, Fort Sam Houston, Texas

The purpose of this report was to determine the best method of general stores inventory management for Methodist Hospital, Memphis, Tennessee.

The methodology used to solve this problem consisted of on-site observation of the hospital's inventory-management system which prompted the study to be undertaken. Material for this report was obtained through personal interviews with people who used the system, review of inventory and purchasing records and a review of the literature to determine what was currently accepted inventory-management practice in business enterprises and in other hospitals.

The report concluded that the inventory-management practice of Methodist Hospital was unable to satisfy the expectations of an inventory-management system as established by the administrator. It was also the conclusion of this report that scientific inventory-management techniques would satisfy these expectations by increasing control over the inventory and by producing monetary savings.

It was the recommendation of this report that Methodist Hospital make use of scientific inventory-management techniques in its management of general stores inventory.