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Dynamics of Inventory Cost Optimization – A Review of Theory and Evidence

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Abstract
The inventory control models as an estimation tool for optimizing inventory cost and management of inventory is discussed in this paper. Various methods of estimating the Economic Order Quantity (EOQ), Safety Stocks under deterministic and stochastic situations are reviewed. Traditional methods of managing inventory such as accounting ratios analysis, two bin systems, perpetual inventory system and some others form part of this paper. Ratings of inventory or its classification in order of priority by unit and consumption value are also reviewed in the paper. Empirical evidence reviewed in this work tends to support the opinion that modern method of inventory control is far more effective and efficient than the traditional methods of control.
Keywords: Inventory Control Models, Inventory Ratios, Economic Order Quantity.

1. Introduction

Inventory is an idle resource which is usable and has value. It may be men, money, materials, plant acquisition, spares and other stocked to meet future demand. But Hillier and Lieberman (1995) define inventory as stocks of goods being held for future use or sale. We accept the latter as a formal definition of inventory as it best suits our contextual understanding. Inventory control is necessary to ensure uninterrupted supply of materials and sustenance of optimal stock. (Not too much, not too little). Different types of organizations have different inventory requirements. These organizations include manufacturers, hospitals, finance institutions, universities and a host of others. Their inventory is purchased in form of raw materials and or finished goods.

There are a number of control methods used over time to ensure adequate controls over materials un-used or used. These control measures for rating the value of consumption and units of stock include - ABC analysis (Always Better Control), VED analysis (Vital Essential Desirable), FSN analysis (Fast, Slow Moving and Non-Moving), SDE analysis (Scarce, Difficult, Easy) and HML analysis (High, Medium, Low).

The principal goal of inventory management involves having to balance the conflicting economics of not wanting to hold too much stock. Thereby having to tie up capital, and incur costs such as storage, spoilage, pilferage and obsolescence. The desire to make items or goods available when and where required (quality and quantity wise) becomes paramount so as to avert the cost of not meeting such requirement. Adeyemi and Salami (2010).

The role of inventory as a buffer against uncertainty has been established for a long time. However, more recently, the disadvantages of holding inventory have been increasingly recognized, particularly with regard to the adverse impact that this may have on supply chain responsiveness. Also, increasing globalization has tended to lead to longer supply lead-times, which, by conventional inventory control theory, result in greater levels of inventory to provide the same service levels (Waters, 2002)

In lean supply chain thinking, inventory is regarded as one of the seven "wastes" and, therefore, it is considered as something to be reduced as much as possible (Womack and Jones, 1996) Similarly, in agile supply chains, inventory is held at few echelons, with goods passing through supply chains quickly so that companies can respond rapidly to exploit changes in market demand (Christopher and Towill, 2001) There have been various supply chain taxonomies based on these concepts and most stress the need for inventory reduction within each of the classifications.

In addressing the issue of cost which, is central to inventory management, there are two major cost associated with inventory. Procurement cost and carrying cost. Annual procurement cost varies with the numbers of orders. This implies that the procurement cost will be high, if the item is procured frequently in small lots. The annual procurement cost is directly proportional to the quantity in stock. The inventory carrying cost decreases, if the quantity ordered per order is small. The two costs are diametrically opposite to each other. The right quantity to be ordered is one that strikes a balance between the two opposition costs. This quantity is referred to as "Economic Order Quantity" (EOQ).

If an organization does not have a good inventory system, it will not be able to forecast demands with any kind of accuracy. And this might result in them running out of stock every so often (Levinson, 2005). The rest of the paper is as follows; part two is on inventory models (modern and traditional) and techniques of inventory control and ratings Part three discusses empirical evidence and part four concludes the paper.

2. Inventory Control Models and Selective Ratings

Inventories pervade the business world. Maintaining inventories is necessary for any company dealing with physical products, including manufacturers, wholesalers, and retailers. "Sorry, we're out of that item or stock" How often have we heard that during shopping trips? In many of these cases, what you have encountered are stores that aren't doing a very good job of managing their *inventories* (stocks of goods being held for future use or sale). They aren't placing orders to replenish inventories soon enough to avoid shortages. Inventory control is necessary to achieve the following; uninterrupted supply of materials, optimal stock (not too much and not too little) and adequate controls over stock of materials. The mathematical inventory models used for stock control analysis can be divided into two broad categories—deterministic models and stochastic models.

The choice of a firm would depend on the predictability of demand involved. The demand for a product in inventory is the number of units that will need to be withdrawn from inventory for some use (e.g., sales) during a specific period. If the demand in future periods can be forecast with considerable precision, it is reasonable to use an inventory policy that assumes that all forecasts will always be completely accurate. This is the case of *known demand* where a *deterministic* inventory model would be used. However, when demand cannot be predicted very well, it becomes necessary to use a *stochastic* inventory model where the demand in any period is a random variable rather than a known constant.

2.1 Deterministic continuous Inventory Model

The assumptions of the Basic EOQ Model are:

- A known constant demand rate of a unit per unit time. Units of the product under consideration are assumed to be withdrawn from inventory continuously at a *known constant rate,* denoted by a; that is, the demand is a units per unit time.
- The order quantity (Q) to replenish inventory arrives all at once just when desired, namely, when the inventory level drops to 0.
- Planned shortages are not allowed.

In regard to assumption 2 in 2.1 there is usually a lag between when an order is placed and when it arrives in inventory. The amount of time between the placement of an order and its receipt is referred to as the *lead time.* The inventory level at which the order is placed is called the reorder point. To satisfy assumption 2, these re-order point needs to be set at the product of the demand rate and the lead time. Thus, assumption 2 is implicitly assuming a constant lead time.

Figure 1 is an illustration of the deterministic continuous model when re-order is placed at the point where the stock drops at 0. And the inventory is replaced to reach level Q each time stock is ordered. The size of the inventory order any time an order is placed is OQ.

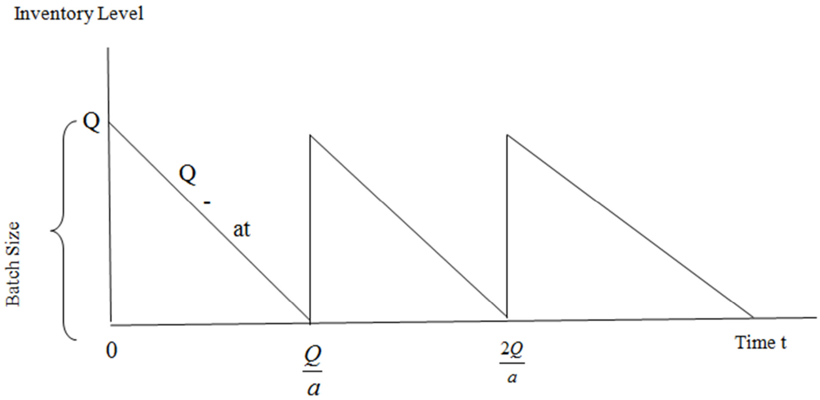

Figure 1 Graphical Illustration of Inventory: if it drops to 0

Inventory policies affect profitability; hence the choice of a company policy among others depends upon their relative profitability. For inventory control management, some of the costs that determine this profitability are (1) the ordering costs, (2) holding costs, and (3) shortage costs. Other relevant factors include (4) revenues, (5) salvage costs, and (6) discount rates. But in the basic EOQ model the only costs to be considered are:

K = set up cost for ordering one batch,

c = unit cost for producing or purchasing each unit,

h = holding cost per unit of time held in inventory.

The objective is to determine when and by how much to replenish inventory so as to minimize the sum of these costs per unit time.

The time between consecutive replenishments of inventory is referred to as a *cycle.* In general, the cycle length is $\boldsymbol{Q/a}$ (see figure1). It is defined as the order quantity **Q** divided by constant demand rate **a**.

Cycle length = Q/a ….. (1)

Production or ordering cost per cycle = K + cQ (2)

The average inventory level during a cycle is (Q +0)/2 = Q/2 units, and the corresponding cost is hQ/2 per unit time. The cycle length is Q/a, from equation 1. Consequently holding cost per cycle hQ/2 x Q/a,

Holding cost per cycle = $\frac{hQ^2}{2a}$ (3)

Therefore, summing up equations 2 and 3, we have

Total cost per cycle = K + cQ + $\frac{hQ^2}{2a}$ (4)

Total cost per unit time is. T= $\frac{K + cQ + hQ^2/2a}{Q/a} = \frac{ak}{Q} + ac + \frac{hQ}{2}$ …(5)

The value of Q, say Q^*, that minimizes T is found by setting the first derivative to zero

$$T = \frac{dT}{dQ} = \frac{aK}{Q^2} + \frac{h}{2} = 0 \quad (5)$$

If we make Q^* the subject of the equation 6 we have

$$Q^* = \sqrt{\frac{2aK}{h}} \quad (6)$$

Equation 7 is the well-known economic order Formula (*EOQ).* (It also is sometimes referred to as the square root formula.

The corresponding *cycle time,* say t^*, is

$$t^* = \frac{Q^*}{a} = \sqrt{\frac{2K}{ah}} \quad (7)$$

The basic EOQ model presented above satisfies the common desire of managers to avoid shortages as much as possible. Nevertheless, unplanned shortages can still occur if the demand rate and deliveries do not stay on schedule. This equilibrium point is demonstrated in figure 2. The point of intersection q represents the quantity to be ordered at a particular cost.

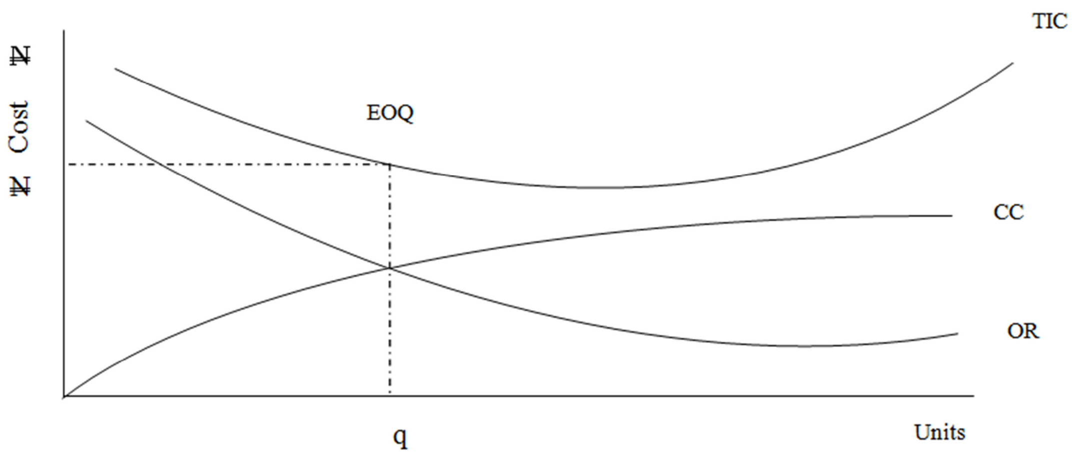

Figure 2 Graphical Illustration of EOQ Model

2.2 The EOQ Model with Planned Shortages

In cases of an inventory shortage sometimes referred to as a stock out—demand would not be met at the current time because the inventory is depleted. By assuming that planned shortages are not allowed, the basic EOQ model presented above satisfies the common desire of managers to avoid shortages as much as possible. The basic EOQ model with planned shortages addresses this kind of situation by replacing only the third assumption of the EOQ model with following new assumption. Planned shortages are now allowed. And when a shortage occurs, the affected customers will wait for the product to become available again. Their backorders are filled immediately when the order quantity arrives to replenish inventory.

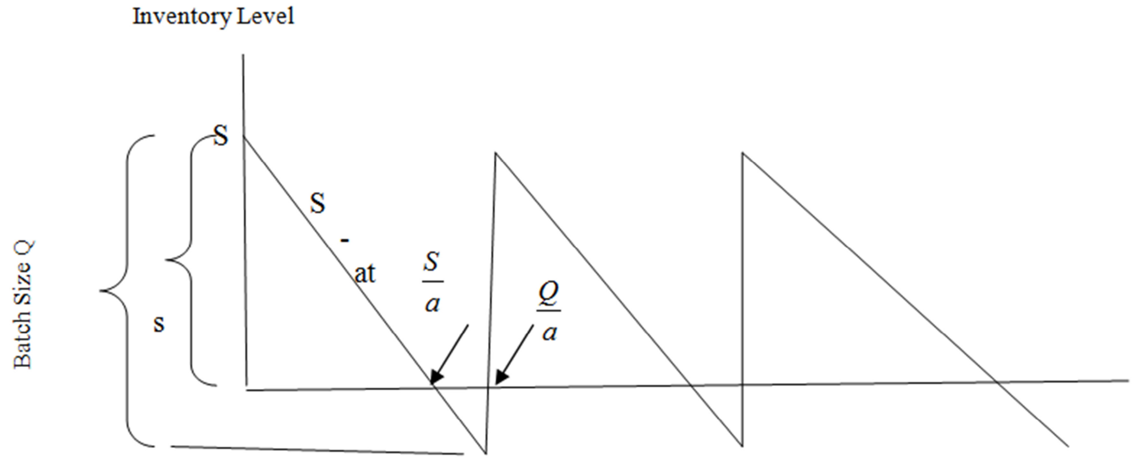

Table 3 Graphical Illustration of EOQ Model with Planned Shortages

To estimate the EOQ under planned shortages the model is developed as follows;
Let:
P = shortage cost per unit short per unit of time short,
S = inventory level just after a batch of *Q* units is added to inventory,
Q - *S* = shortage in inventory just before a batch of *Q* units is added.
The total inventory cost for planned shortages can be estimated from the following components. From equation 2
Production or ordering cost per cycle = K + cQ
During each cycle, the inventory level is positive for a time *S*/*a*. The average inventory level during this time is (*S*+0)/2 = *S*/2 units, and the corresponding cost is h*S*/2 per unit of time. Similarly, shortages occur for a time (*Q* - *S*)/*a*. The average amount of shortages *during this time* is (0 + *Q* - *S*)/2 = (*Q* - *S*)/2 units, and the corresponding cost is P(*Q* - *S*)/2 per unit of time.
Therefore,

$$\text{Holding cost per cycle} = \frac{hS}{2}\frac{S}{a} = \frac{hS^2}{2a} \qquad (8)$$

$$\text{Shortage cost per cycle} = \frac{P(Q-S)}{2}\frac{Q-S}{a} = \frac{P(Q-S)^2}{2a} \qquad (9)$$

Summing equations 2, 8 and 9 to estimate total cost per unit of time.
Hence

$$\text{Total cost per cycle} = K + cQ + \frac{hS^2}{2a} + \frac{P(Q-S)^2}{2a} \qquad (10)$$

Total Cost per unit of time T

$$T = \frac{aK}{Q} + ac + \frac{hS^2}{2Q} + \frac{P(Q-S)^2}{2Q} \qquad (11)$$

From equation 11, the two decision variables are Q and S so the optimal values of S* and Q* are found by setting the partial derivatives of dT/dS and dT/dQ equal to zero.
Thus,

$$\frac{dT}{dS} = \frac{hS}{Q} - \frac{P(Q-S)}{Q} = 0 \qquad (12)$$

$$\frac{dT}{dQ} = -\frac{aK}{Q^2} - \frac{hS^2}{2Q^2} + \frac{P(Q-S)}{Q} - \frac{P(Q-S)^2}{2Q^2} = 0 \qquad (13)$$

Solving equations 12 and 13 simultaneously, we have

$$S^* = \sqrt{\frac{2aK}{h}}\sqrt{\frac{p}{p+h}} \tag{14}$$

$$Q^* = \sqrt{\frac{2aK}{h}}\sqrt{\frac{p+h}{p}} \tag{15}$$

The optimal cycle length t^* is given by

$$t^* = \sqrt{\frac{Q^*}{a}} = \sqrt{\frac{2K}{ah}}\sqrt{\frac{p+h}{p}} \tag{16}$$

The maximum shortage is equation 15 minus equation 14

$$Q^* - S^* = \sqrt{\frac{2aK}{p}}\sqrt{\frac{h}{p+h}} \tag{17}$$

The fraction of time that no shortage exists is given by

$$\text{Fraction of no time shortage} = \frac{S^*/a}{Q^*/a} = \frac{p}{p+h} \tag{18}$$

Equation 18 is independent of K.

2.3 A Stochastic Continuous Model

The stochastic inventory models are designed for analyzing inventory systems where there is considerable uncertainty about future demands. Thus, the inventory level is being monitored on a continuous basis so that a new order can be placed as soon as the inventory level drops to the reorder point.

The traditional method of implementing a *continuous-review* inventory system was to use a two-bin system. All the units for a particular product would be held in two bins. The capacity of one bin would equal the reorder point. The units would first be withdrawn from the other bin. Therefore, the emptying of this second bin would trigger placing a new order.

In recent period of computer age, the two-bin systems have been largely replaced by computerized inventory systems. Each addition to inventory and each sale causing a withdrawal are recorded electronically, so that the current inventory level always is in the computer. Therefore, the computer will trigger a new order as soon as the inventory level has dropped to the reorder point.

A continuous-review inventory system for a particular product normally will be based on two critical numbers:

R = reorder point.

Q = order quantity.

Assumptions of Stochastic Continuous Model

- Each application involves a single product.
- The inventory level is under *continuous review,* so its current value always is known.
- An (*R*, *Q*) policy is to be used, so the only decisions to be made are to choose *R* and *Q*.
- There is a *lead time* between when the order is placed and when the order quantity is received. This lead time can be either fixed or variable.
- The *demand* for withdrawing units from inventory to sell them (or for any other purpose) during this lead time is uncertain. However, the probability distribution of demand is known (or at least estimated).
- If a stock out occurs before the order is received, the excess demand is *backlogged,* so that the backorders are filled once the order arrives.
- A fixed *setup cost* (denoted by *K*) is incurred each time an order is placed.
- Except for this setup cost, the cost of the order is proportional to the order quantity *Q*.
- A certain holding cost (denoted by *h*) is incurred for each unit in inventory per unit time.
- When a stockout occurs, a certain shortage cost (denoted by *p*) is incurred for each unit backordered per unit time until the backorder is filled.

2.3.1Order Quantity

In determining the order quantity **Q** for the stochastic continuous model, we adapt the formula in equation 15 (with slight modification) for the EOQ model with planned shortages.

Let;

$$Q = \sqrt{\frac{2AK}{h}}\sqrt{\frac{p+h}{p}} \qquad (19)$$

Where;

A = average demand per unit time and k, h, and p are as previously defined.

Equation 20 is an approximation of the optimal order quantity for the Stochastic Continuous Model. However, no formula is available for the exact value of the optimal order quantity, so an approximation is needed. Fortunately, the approximation given in equation 19 is a fairly good one (Axsäter 1996; Zheng, 1992).

2.3.2 Reorder point

In determining the reorder point R for the stochastic continuous model, a common approach to choosing the reorder point *R* is to base it on management's desired level of service to customers which is any of the under listed options.

(a) The probability that a stock out will not occur between the time an order is placed and the order quantity is received.
(b) The average number of stock outs per year.
(c) The average percentage of annual demand that can be satisfied immediately (no stock out).
(d) The average delay in filling backorders when a stock out occurs.
(e) The overall average delay in filling orders (where the delay without a stock out is 0).

A managerial decision needs to be made on the desired value of at least one of these measures of service level. For example if alternative (a) is chosen, we denote the desired level of service under this measure with L.

where;

L = management's desired probability that a stock out will not occur between the time an order quantity is placed and the order quantity is received.

The mean of the distribution D between the time an order quantity is placed a and the time the order quantity is received b. Also if the probability of distribution D is a uniform distribution in the interval.

Then;

$$\text{Mean of this distribution } E(D) = \frac{a+b}{2} \qquad (20)$$

$$\text{Reorder point } R = a + L(b-a) \qquad (21)$$

$$\text{Safety Stock} = R - E(D) = a + L(b-a) - \frac{a+b}{2}$$

$$= \left(L - \frac{1}{2}\right)(b-a) \qquad (22)$$

The safety stock is the expected inventory level just before the order quantity is received. Under the desired level of service (Option a) above, the procedure for choosing R are choose L and solve for the estimate value of R as defined in equation 21.

2.4 Inventory Control Ratios

The modern inventory control models signifies a planned approach of ascertaining when to buy, how much to buy and how much to stock so that costs involving buying and storing are optimally minimum, without interrupting production or affecting sales.

Unlike these models, the traditional inventory control ratios/index is used for monitoring the effectiveness of inventory management ex post. Some of the accounting ratios/index is estimated below.

$$\text{Overall inventory Turnover Ratio} = \frac{\cos tofgoodssold}{averagetotalinventoriesat \cos t}$$

$$\text{Raw Material Inventory Turnover Ratio} = \frac{annualconsumptionofrawmaterials}{Averagerawmaterialinventory}$$

$$\text{Work-in-process Inventory Turnover Ratio} = \frac{CostofManufacture}{Averageworkinproces \sin ventoryat \cos t}$$

Finished Goods inventory Turnover Ratio = $\dfrac{CostofGoodssold}{AverageinventoryofFinishedGoodsatCost}$

Average age of Raw Materials in Inventory = $\dfrac{AverageRawMaterialsInventoryatCoat}{AverageDailyPurchaseofRawMaterials}$

Average Age of Finished Goods Inventory = $\dfrac{AveragefinishedGoodsInventoryatCost}{AverageCostofGoodsmanufactureddaily}$

Out of Stock index = $\dfrac{NumberofTimesoutofStock}{NumberofTimes\,\mathrm{Re}\,quisitioned}$

Spares Parts Index = $\dfrac{ValueofSparesPartsInventory}{ValueofCapitalEquipment}$

2.5 Other Traditional Inventory Control Methods.

2.5.1 Two Bin System

Under this system all inventory items are stored in two separate bins (two bins for each type of inventory items). In the first bin, a sufficient supply of inventory is stored which is going to be used over a designated period of time. In the second bin a safety stock is maintained which is going to be used during lead times. As soon as material in the first bin is consumed an order for further stock is placed and in the meantime inventory from the second bin is used. On receipt of new order, second bin is restored and the balance is put in the first bin. In this system depletion of inventory in the first bin automatically generates a signal to re-order that particular inventory.

2.5.2 Perpetual Inventory System

In this type of system store balances are computed and recorded after each and every issue and receipt. The main focus of this system is to make available details about the quantity and value of stock at all points of time. If the balance of any item of inventory falls below a particular pre-determined level the order is placed for a further quantity of inventory. In this system physical verification is done after every issue and receipt as a result of which this system is costly, but at the same time materials statement, monitoring and follow up action can be smoothly carried out.

2.5.3 Periodic Inventory System

Under this system all stock levels are reviewed after a fixed time interval, depending upon the importance of the item. Imported items may require a shorter review cycle, whereas slow moving items may require a longer review cycle. In practice the review of stock items takes place at the end of the accounting period. At the time of review, orders are placed for further stocking up to a pre-determined level. Under this system the order point is not actually determined but the time of review itself is an indication to place further orders.

2.6 Selective Inventory Control and Ratings.

Inventory optimization is critical in order to keep costs under control within the supply chain. Yet, in order to get the most from management efforts, it is efficient to focus on items that cost most to the business. There are various methods of inventory control classifications used in minimizing cost of managing inventory in firms. These include; ABC analysis (Always Better Control) HML analysis (High, Medium, Low). VED analysis (Vital Essential Desirable) SDE analysis (Scarce, Difficult, Easy) FSN analysis (Fast, Slow Moving and Non-Moving).

2.6.1 ABC Classification

The ABC approach states that, when reviewing inventory, a company should rate items from A to C, basing its ratings on the importance of the material, to provide overall protection against stock outs. Splitting items in A, B and C classes are relatively arbitrary. This grouping only represents a rather straightforward interpretation of the Pareto principle. In practice, sales volume is not the only yardstick that weighs the importance of an item. Margin of return and the impact of a stock-out on the business should also influence the inventory strategy. The analysis prepared should be checked regularly (weekly or monthly) depending on the level of operations of the firm.

A-items are goods in which annual consumption value is the highest. The top 70-80% of the annual consumption value of the company typically accounts for only 10-20% of total inventory items. A-items should have tight inventory control, more secured storage areas and better sales forecasts. Reorders should be frequent, with weekly or even daily reorder. Avoiding stock-outs on A-items is a priority.

C-items are, on the contrary, items with the lowest consumption value. The lower 5% of the annual consumption value typically accounts for 50% of total inventory items. Reordering C-items is made less frequently. A typically inventory policy for C-items consist of having only 1 unit on hand, and of reordering only when an actual purchase is made. This approach leads to stock-out situation after each purchase which can be an acceptable situation, as the C-items present both low demand and higher risk of excessive inventory costs. For C-items, the question is not so much how many units do we store? but rather do we even keep this item in store?

B-items are the interclass items, with a medium consumption value. That is 15-25% of annual consumption value typically accounts for 30% of total inventory items.B-items benefit from an intermediate status between A and C. An important aspect of class B is the monitoring of potential evolution toward class A or, in the contrary, toward the class C.

2.6.2 HML Classification

The High, medium and Low (HML) classification follows the same procedure as is adopted in ABC classification. Only difference is that in HML, the classification unit value is the criterion and not the annual consumption value. The items of inventory should be listed in the descending order of unit value and it is up to the management to fix limits for three categories. For examples, the management may decide that all units with unit value of # 2500 and above will be H items, # 1500 to 2500 M items and less than # 1500 L items. The HML analysis is useful for keeping control over consumption at departmental levels, for deciding the frequency of physical verification, and for controlling purchases.

2.6.3 VED Classification

While in ABC, classification inventories are classified on the basis of their consumption value and in HML analysis the unit value is the basis, criticality of inventories is the basis for vital, essential and desirable categorization. The VED analysis is done to determine the criticality of an item and its effect on production and other services. It is specially used for classification of spare parts. If a part is vital it is given V classification, if it is essential, then it is given E classification and if it is not so essential, the part is given D classification. For V items, a large stock of inventory is generally maintained, while for D items, minimum stock is enough.

2.6.4 SDE Classification

The SDE analysis is based upon the availability of items and is very useful in the context of scarcity of supply. In this analysis, S refers to scarce items, generally imported, and those which are in short supply. D refers to difficult items which are available indigenously but are difficult items to procure. Items which have to come from distant places or for which reliable suppliers are difficult to come by fall into D category. E refers to items which are easy to acquire and which are available in the local markets. The SDE classification, based on problems faced in procurement, is vital to the lead time analysis and in deciding on purchasing strategies.

2.6.5 FSN Classification

FSN stands for fast moving slow moving and non-moving. Here, classification is based on the pattern of issues from stores and is useful in controlling obsolescence. To carry out an FSN analysis, the date of receipt or the last date of issue, whichever is later, is taken to determine the number of months, which have lapsed since the last transaction. The items are usually grouped in periods of 12 months. FSN analysis is helpful in identifying active items which need to be reviewed regularly and surplus items which have to be examined further. Non-moving items may be examined further and their disposal can be considered.

3.0 Empirical Evidence

The importance of inventory management and control and its effects on firm income is so enormous to justify continuous research on this subject area so as to improve on the ways and means of managing these very important current assets so as to enhance it optimal level. We review some of the studies conducted in this area. A study on inventory management and a tool of optimizing resources in a manufacturing company (case study of Coca-Cola Bottling Company Ilorin Plant) was conducted by Adeyemi and Salami (2010). The major finding using the EOQ model was that the company through a well-built policy is able to handle its idle stock without incurring unnecessary costs

Soni (2012) conducted a study on the inventory of engineering goods industry in Pujab India using the traditional method of inventory control analysis (inventory control ratios) and found that half of the gross working capital is being used for meeting out inventory requirements. And such a huge investment in the inventory has resulted into overstocking of inventory due to low velocity/circulation of inventory and high holding period, particularly of finished goods and raw material.

Liyanage (2010) conducted a study on Inventory Management Practices of Processed Food Supply Chain in Sri Lanka.The study was based on primary data collected from the selected organization with in depth interviews with senior managers, lower level managers and operational workers, structured and non-structured questionnaires and site-observations. Lead times of the raw material purchased from Sri Lankan suppliers are based on the experience of the store manager. Minimum, maximum and reorder levels of raw materials, packing materials in the inventory are decided by the production requirement for last 6 months usage based on the experience and intuition of the store managers.

The findings of this case study reveals that the inventory management practices of the selected organization is not up to the standards and this affects the performance of entire supply chain. In selected organization, it is evident that informal inventory management practices are prevailing to a greater extent. No attention has been paid to application of sophisticated inventory theories available in literature due to the reasons such as non-availability of resource persons and application of many theories need to take in to consideration the organization specific contingency factors..

Scott (2007) examines inventory management and the role it plays in improving customer satisfaction in Argosy Atlanta USA. He study's how food companies have been under pressure to streamline their inventory systems, and the consequences of such actions. It also examines how many retailers are trying to implement a "perfect order" system and how suppliers are constantly under pressure to meet the demands of these retailers. The study observed a distributor who hitherto was using a manual inventory "system" and working from "experience." He found out that although he thought he was doing well, his clients (the retailers) were not very satisfied with his performance because within the last 12-month period, he had ran short of supplies on 20 different occasions. After implementing an inventory management system and using it for a 6-month period, the distributor was able to accurately predict demand and therefore stocked the required amount of goods at the right time. During that period, he experienced no shortage. His customers, too, (the retailers) were happy with him. Even more important for him was that he found no need to increase storage space – a thing he was planning to do – because he knew what to order and when. The retailers too, who were stocking their grocery based on simple "past experience" also implemented an inventory management systems. After using it for a similar 6-month period, each of them realized that they could easily identify products that were in high demand, those that were going out of stock, and also of importance, items that were hardly being demanded. Each of the two "mom-and-pop" retailers were able to avoid loses from over stocking of perishable items soon after the system went into operation. Not only were they able to reduce loses, they were able to satisfy their customers better.

TomJose et al (2013) In a study on Comparison of Inventory Control Techniques in Kochi India found that there is a variation in the use of EOQ models amongst firms and the inventory management is not satisfactory. Many firms use ABC and FSN classifications. And from such classifications, A class is that whose unit value are more than Rs.100 and constitute 45% of total components. B class is that whose unit value is between Rs.25-100 constitutes 35% of total components and C class is that whose unit value is less than Rs.25 constitutes 30% of total components. In respect of FSN classification, F items are those which moves fastly and constitutes 43% of total components. S items are those which moves slowly constitute 57% of total components and N items are those which don't move (Non-moving items). According to data given, there are no Non-moving items. It is not good as the company maintains low percentage in fast moving items in compared to slow moving inventories based on movements using controlling techniques.

Imelda and Rhessy (2012) Conducted a study on ABC-VED Analysis and Economic Order Interval(EOI)-Multiple Items for Medicines Inventory Control in some government Hospitals in Indonesia. The analytical method was based on a matrix that coupled ABC analysis (based on cost criteria) and VED analysis (based on criticality) was formulated for prioritization. Then, Economic Order Interval (EOI)-multiple items model was proposed to determine 'when' and 'how much' the order should be placed. It was observed that 40 medicines (11.90%) were classified into category 1(AV+BV+CV+AE+AD) for stringent control. Application of EOI-multiple items also allow effective control of annual total expenditure.

Manhas et al (2012) carried out analysis of Inventory of Drug and Pharmacy Department of a Tertiary care Hospital in Srinagar India. It was a retrospective study carried out for a period of one year from 1-4-2005 to 31-3-2006. The study revealed that 156 items in total were stored during the study period. The value of annual consumption of the inventory was worked out to be Rs.9303507.Out of these drugs, 15.38% consumed 70% of annual drug expenditure comprising group 'A' items. 22.43% consumed 20% of annual drug expenditure forming group 'B' items. Rest 62.17% items consumed only 10% of total budget, classified as group 'C' items. VED classification of the inventory revealed that out of 156 items stored, 19.23% were considered 'Vital' by the constituted medical panel; 39.10% were 'Essential' and the rest, 41.66% were considered 'Desirable'. The results of the study are expected to guide the management to delegate the responsibility to different officers and apply the "Principle of Management by Exception". Moreover it will facilitate the management in controlling the cost and ensure the availability of vital and essential items in the hospital which will be in the interest of patients and the administration.

4.0 Conclusion

This paper reviews the inventory control models under deterministic and stochastic models. And some traditional methods of inventory control methods. The traditional methods of inventory control tends to support loss of resources either through shortages of orders resulting into sales loss or over stocking resulting into loss of goods through obsolescence.

On the contrary, the modern methods of inventory control tend to provide analytical framework which, reduces the costs of surplus or shortage inventory after demands are realized. Emphasis should also be placed on the economic order quantity model because it was seen to be in the best interest of firms to maintain an optimal level of materials in store.

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