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Optimization of Stock Levels Using Inventory Models

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For a successful conduct of a day to day operation, manufacturers and sellers of goods must obtain a variety of goods. This paper looked at inventory control system which protect the assets of companies and at the same time, maintain an optimal level of inventory investment. A practical illustration was used to show how the models worked, which will ensure effective and efficient handling of stocks.

Keywords: Inventory, Optimization, Stock Levels, Inventory Models

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INTRODUCTION

The optimization of stock levels is clearly a very important component of the management function. Modern business, whether manufacturing firms, wholesalers or retailers, must obtain variety of stocks, for the successful conduct of their day-to-day operations.

In general, the manufacturing firms will have three categories of stocks:

> Raw materials: Work-in-process or semi-finished goods and indirect items, such as consumable stores and tools which will depend upon the nature of production.

Wholesalers and retailers on the other hand, concentrate upon finished goods and these will obviously be dependent on demand.

The objective of this paper is to:

> Determine the inventory control systems which protect the asset from loss due to deterioration, pilferage, etc.
> Identify and maintain an optimum level of inventory investment.

METHODOLOGY

Model one: Instantaneous Receipt

This model assumes that, there is a constant consumption and a zero delivery time for items of stock. The objectives of the model is to minimize the total cost of acquiring and holding stock and so to decide the most economical quantity that should be ordered and the optimum number of orders that should be placed in any given time period. We would expect that ordering and stock-out cost will tend to increase the more frequently orders are made while on the other hand, holding cost will tends to fall. Thus, we seek the optimum trade-off between these costs and benefits.

Let
D = Annual Demand for the item
Q = Size of the batch quantity
P = Cost price per item
H = Holding cost
K = Ordering cost

$$\text{Number of order per Annum} = \frac{\text{Annual Demand}}{\text{Batch Quantity}} = \frac{D}{Q}$$

$$\text{The Annual Ordering Cost} = \frac{KD}{Q}$$

$$\text{The Annual Carrying Cost} = h\frac{Q}{2}$$

Therefore, the Total Inventory Cost (Tc) is sum of the ordering and carrying cost, that is, $Tc = \frac{KD}{Q} + h\frac{Q}{2}$

Thus, the optimal value of Q can be determine by differentiating the total cost (Tc) function, which is given as

$$\frac{dTc}{dQ} = KDQ^{-1} + h\frac{Q}{2}$$

$$= -KDQ^{-2} + \frac{h}{2} = 0$$

$$= \frac{KD}{Q^2} + \frac{h}{2} = 0$$

$$= 2KD = hQ^2$$

$$= \frac{2KD}{h} = Q^2$$

$$Q^2 = \frac{2KD}{h}$$

$$Q = \sqrt{\frac{2KD}{h}}$$

The total minimum cost is obtained by substituting the value for the optimal order size (Q) in the total cost (Tc) equation above.

Model two: Non-Instantaneous Receipt

Most stock control problems are caused by the combination of a varying usage rate and a reorder period which is not instantaneous. Most firms in such circumstances will hold a buffer or safety stock in order to avoid possible interruptions to production or distribution. In this case, we have a trade-off between losses caused by shortage of stocks and the extra holding cost of the extra items stocked.
Let,

P = Daily rate at which the order is received over-time also known as the production rate.
D = The daily rate at which inventory is demanded
The maximum inventory level is given by

$$Q - \frac{Qd}{P} = Q\left(1 - \frac{d}{P}\right)$$

The average inventory level

$$\frac{1}{2}\left[Q\left(1 - \frac{d}{P}\right)\right] = \frac{Q}{2}\left[1 - \frac{d}{P}\right]$$

$$\text{The total carrying cost is} = h\frac{Q}{2}\left[1 - \frac{d}{P}\right]$$

Therefore, the total annual inventory cost is given as

$$Tc = \frac{KD}{Q} + h\frac{Q}{2}\left[1 - \frac{d}{P}\right]$$

Thus, to find the optimal order quantity, we equate total carrying cost with total ordering cost.

$$= h\frac{Q}{2}\left[1 - \frac{d}{P}\right] = \frac{KD}{Q}$$

$$= hQ^2\left[1 - \frac{d}{P}\right] = 2KD$$

$$Q^2 = \frac{2KD}{h\left[1 - \frac{d}{P}\right]}$$

$$Q = \sqrt{\frac{2KD}{h\left[1 - \frac{d}{P}\right]}}$$

DATA ANALYSIS

Model one

Divine trading company has a monthly demand for a certain fast food of 5000 packages. The cost of placing an order is ₦200 while the monthly cost of maintaining a package in store is ₦50. What should be his optimum order quantity and how often should it be placed and the total cost?

The optimum order quantity (Q),

$$Q=\sqrt{\frac{2\text{KD}}{h}}$$

$$= \sqrt{\frac{(200)(5000)}{50}} = 141\text{packages}$$

$$\text{How often to place order} = \frac{\text{D}}{\text{Q}} = \frac{500}{141} = 35$$

Total cost (Tc),

$$\text{Tc} = \frac{\text{KD}}{\text{Q}} + \text{h}\frac{\text{Q}}{2}$$

$$\text{Tc} = \frac{(200)(500)}{141} + 50\frac{141}{2}$$

$$\text{Tc} = 7092.20 + 3532$$

$$\text{Tc} = 7092.20 + 3532$$

$$\text{Tc} = \text{N}10,617.20$$

MODEL TWO

Divine company has its own manufacturing facility in which it produces cloth. The annual carrying cost of ₦0.90 per yard and ordering cost of ₦200 and an estimated annual demand of 20000 yards. The manufacturing facility operates for 311 days and produces 250 yards of cloths per day.
Compute the optimal order size, total inventory cost and the number of orders per years.

The optimum order quantity (q) is given as

$$Q=\sqrt{\frac{2\text{KD}}{h\left[1-\frac{d}{P}\right]}}$$

Where,

$$\text{d} = \frac{20000}{311} = 64.31$$

$$\text{and P} = 250 \text{ yards per day}$$

Therefore,

$$Q=\sqrt{\frac{2(200)(20000)}{0.90\left[1-\frac{64.31}{250}\right]}}$$

$$Q=\sqrt{\frac{8,000,000}{0.90[0.74276]}} = 3459.39\,yards$$

Total annual inventory cost (Tc)

$$\text{Tc} = \frac{\text{KD}}{\text{Q}} + h\frac{Q}{2}\left[1-\frac{d}{P}\right]$$

$$\text{Tc} = 200\frac{(20000)}{3459.39} + 0.90\left[\frac{3459.39}{2}\right]\left[1-\frac{64.31}{250}\right]$$

$$\text{Tc} = 1156.27 + 1156.28 = \text{N}2312.55$$

$$\text{Number of production runs} = \frac{\text{D}}{\text{Q}}$$

$$\frac{20000}{3459.39} = 5.78\,runs$$

DISCUSSION OF RESULTS

From the analysis on the Instantaneous Receipt, for company to be in business and maintain profit, should have an Economic Order Quantity (Qptimum Order Quantity) of 141 packages on a monthly basis, place order 35 times and make a budget of ₦10, 617.20

On Non-instantaneous Receipt, the company has its own manufacturing facility should be able to produce 3459.37 yards annually at a total cost of ₦2312.55 with the number of production runs as 5.78.

FINDINGS

(1) From the analysis with model one instantaneous receipt, the optimum order quantity is 141 packages
(2) The number of times to place order is 35
(3) The total cost of placing order is ₦10, 617.20
(4) For non-instantaneous receipt, the optimum production quantity is 3459.37 yards
(5) The number of production runs is 5.78
(6) The total annual inventory is ₦2312.55

CONCLUSION

A good system of inventory management includes a determination of economic order quantity, the total cost and number of order in order to avoid stockout. Stockout cost is in reality not one cost, but a group of costs which are the result of being out of stock in a given inventory item. A practical approach to inventory control should take the nature of stock out into consideration and thereby get more accurate estimate of economic order quantity. In a manufacturing situation, a shortage of one unit of raw material might cause disruption in production, resulting in down-time and the costs of starting production up again. In the same company, the shortages of several hundred units would result in the same down-time and related costs, as well as possibly an increase in the loss of sales and bad customer relations which would impact on the future sales. The use of economic order quantity model may prove to be a more practical and useful tool for estimating relevant inventory costs for many companies.

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