**Topic 12: Managing Inventory**

Overview

Operations managers are responsible for operations cost control. One critical cost of operations is investment in raw materials, supplies, work-in-progress and finished products not yet shipped. If the investment becomes excessive, the results are high capital costs, high operating costs and decreased production efficiency when too much space is used for inventory. Operations managers develop plans to control the desired levels for materials and organise jobs to carry out their plans. Because of environmental influences, actual performance generally ldoes not conform to planned performance, and managers must exercise material (inventory) control. They must monitor output, compare actual with planned output, and take corrective actions through feedback mechanisms.

Learning Outcomes

By the end of this topic, you will be able to:

1. realise that inventory can hold up 50% of the total invested capital in the firm and that good management of inventory is crucial for the success of the firm.
2. acknowledge the importance of inventory control through proper maintenance of records of the inventory and constant reconciliation of inventory with the inventory records.
3. explain the ordering model (EOQ) for ordering the supply of raw materials to minimise the total costs of holding the inventory.

Introduction

12.1 The importance of inventory for production purpose and for the success of an

 organisation

12.2 Managing inventory in terms of types and keeping of records

12.3 Control of service inventories where extensive inventory may be held e.g. the food

 service business.

12.4 Inventory models - the basic economic order quantity (EOQ) model.and its influence on

 minimising total holding costs.

**Lecture Notes**

**12. Managing Inventory**

Production/operations managers are responsible for operations cost control. One critical cost of operations is investment in raw materials, supplies, work-in-progress and finished products not yet shipped. If the investment becomes excessive, the results are high capital costs, high operating costs and decreased production efficiency when too much space is used for inventory.

As a consequence operations managers develop a plan specifying desired levels for materials and organise jobs to carry out this plan.

Because of environmental influences, actual performance generally does not conform to planned performance, and managers must exercise material (inventory) control. They must monitor output, compare actual with planned output, and take corrective action through feedback mechanisms.

**Importance of Inventory**

Inventory is one of the most expensive assets of many companies representing as much a 50% of total invested capital. Therefore good management of inventory is crucial for the success of the organisation.

The objective of inventory management is to strike a balance between inventory investment and customer service. The quantity of inventory available in the firm must be at the optimal level to enable the quantity of products to be produced to meet the demand of the customers.

The firm must determine whether to produce goods or to purchase them. Once the decision has been made the next step is to forecast demand. Then the operations managers determine the inventory necessary to service the demand.

*Functions of Inventory*

1. To decouple or separate various parts of the production process. (To separate the production process from the suppliers.)
2. To decouple the firm from fluctuations in demand and provide a stock of goods that will provide a selection for customers. Such inventories are typical in retail establishment.
3. To take advantage of quantity discounts, because purchases in larger quantities may reduce the cost of goods or their delivery.
4. To hedge against inflation and upward price changes.

*Types of inventory*

* raw material
* work-in-progress
* Inventories for maintenance/repair/operating supplies (MROs)
* Finished goods

**Managing Inventory**

Operations managers establish systems for managing inventory. Two aspects are examined:

1. How inventory items can be classified (called ABC analysis).

 The available inventory is divided into three classifications on the basis of annual dollar

 volume basing on the Pareto principle.

 The annual dollar volume = annual demand of each inventory item x cost per unit.

 (1) Class A items are those on which the annual dollar demand is high (high cost) in the

 order of 70% to 80% usage.

 (2) Class B items are those inventory items of medium annual dollar volume and may

 represent about 30% of inventory items and of 15% to 25% of total value.

 (3) Class C items are those inventory items of 5% of the annual dollar volume but about

 55%of the total inventory items.

2. How accurate inventory records can be maintained.

 Good inventory policies are necessary in order to know what inventory is on hand.

 Accuracy of records is a critical ingredient in production and inventory systems. They are

 needed for ordering, scheduling and shipping. Incoming and outgoing record keeping must

 be good. A good stockroom is needed to hold the inventory as well as security.

Cycle Counting - it is a continuing reconciliation of inventory with inventory records. It involves shutting down the facility and do a physical count on the stock items. This is to check whether the existing stocks tally with the records.

Advantages of cycle counting

1. Eliminates the shutdown and interruption of production necessary for annual physical inventories.
2. Eliminates annual inventory adjustments.
3. Trained personnel audit the accuracy of inventory.
4. Allows the cause of the errors to be identified and remedial action to be taken.
5. Maintains accurate inventory records.

Control of Service Inventories

In the service industry, there are inventory too. For instance, extensive inventory is held in wholesale and retail businesses. In the food-service business the control of inventory can make a difference between success and failure. Inventory that is in transit or held in the warehouse is considered lost because of perishability. In retailing, inventory that is unaccounted for between receipt and time of sale is known as ***shrinkage***. Loss of inventory due to theft is known as ***pilferage***. Because the losses suffered can be substantial, and the impact on profitability inventory accuracy and control are critical. Applicable techniques include the following:

1. Good personnel selection, training and discipline.

2. Tight control of incoming shipments.

3. Effective control of all goods leaving the facility.

Successful retain operations require very good store-level control with accurate inventory in its proper location. Research has found that major retailer lose 10% to 25% of the overall profits due to poor or inaccurate inventory records.

Inventory Models

1. Independent verses Dependent Demand

Inventory control models assume that demand for an item is either independent of or dependent on the demand for other items. This focus here is on the demand is being independent.

2. Holding, Ordering and Setup Costs

Holding costs –the costs associated with holding or carrying inventory over time. They include insurance, extra staffing and interest payments.

Ordering costs – include costs of supplies, forms, order processing, purchasing, clerical support and so forth.

Setup costs – for preparing a machine or process for manufacturing an order. Include time and labour to clean and change tools or holders. Setup cost is highly correlated with setup time.

**Inventory Models for Independent Demand**

Three independent demand models for inventory are available to address two important questions: where to order and how much to order:

1. Basic economic order quantity (EOQ) model
2. Production order quantity model
3. Quantity discount model

The Basic Economic Order Quantity (EOQ) Model

This model is commonly used to control inventory. It is based on certain assumptions:

1. Demand for an item is known, reasonably constant, and independent of decisions of other items.
2. Lead time i.e. the time between placement and receipt of the order, is known and consistent.
3. Receipt of inventory is instantaneous and complete. I.e. the inventory from an order arrives on one batch at one time.
4. Quantity discounts are not possible.
5. The only variable costs are the cost of setting up or placing an order (setup or ordering cost).
6. Stockouts (shortages) can be completely avoided if orders are placed at the right time.

With the above assumptions the graph of inventory usage over time has a sawtooth shape.

Q, represents the quantity ordered. If this quantity is 500 pineapples, then all of them arrive at one time (when the order is received). Thus the inventory level jumps from 0 to 500 pineapples. In general, an inventory level increases from 0 to Q units when an order arrives. Because demand is constant over time, inventory drops at a uniform rate over time. Each time the inventory level reaches 0, the new order is placed and received and the inventory level again jumps to Q units (represented by the vertical lines). This process continues indefinitely over time.

Inventory Usage Over Time

 Total order received

 Usage rate

 Order quantity =Q

 (Maximum inventory

 level) Average inventory

 on hand (Q/2)

**Inventory**

 **level**

 Minimum inventory 0

  **Time**

Minimizing Costs

With the assumptions given, significant costs are setup (or ordering) cost and holding (or carrying) cost.

All other costs, such as the cost of the inventory itself, are constant.

Therefore if the sum of setup and holding costs are minimized then the total cost is minimized.

The setup cost declines as the quantity (order size) increases as shown in graph A.

The holding cost increases as the quantity (inventory) increases as shown in graph B.

Combining graph A and graph B, the total cost declines as shown in graph C and this is possible when there is a reduction in either holding or setup cost. A reduction in the setup cost curve also reduces the optimal order quantity (i.e. the lot size). Furthermore smaller lot sizes have a positive impact on quality and production flexibility.

 Annual Total cost for holding

 Cost and setup (order)

 C

 Minimum B

 total cost Holding cost

 Setup (order) cost

 A

 Optimal order Order quantity

 quantity (Q\*)

The optimal order size Q\* will be the quantity that minimises the total costs. This occurs at the point when the ordering-cost curve and the carrying-cost curve intersect.

The EOQ model helps the operations managers to determine the quantity of inventory to be ordered where the total cost is the minimum. The optimal order quantity will occur at the point where the total setup cost is equal to the total holding cost.

The equation is:

Optimal order quantity occurs when:

 Annual setup cost = Annual holding cost

 Annual demand

 (Setup or order = (Average inventory level) x (Holding cost per unit

 Number of units in each order cost per order) per year)

 D Q

 S = H

 Q 2

 To solve the Q\*, simply cross-multiply terms and isolate Q on the left of the equal sign:

 2DS = Q2H

 Q2 = 2DS/H

 Q = 2DS/H

The robustness of the EOQ model

The benefit of the EOQ model is that it is robust i.e. it gives satisfactory answers even with substantial variation in its parameters. The determination of accurate ordering costs and holding costs for inventory is often difficult. The EOQ model allows the variations and for this the model is said to be advantageous. This is because the total cost of the EOQ changes little in the neighbourhood of the minimum. The curve is very shallow. This implies that the variations in setup costs, holding costs, demand or even EOQ make relatively modest differences in total cost.

Reorder Points

Having known hold much to order is one thing. The next issue is to know when to place the order.

The time between the placing of an order and the receipt of the order is known as the lead time or delivery time. It can be a few days or a few months. Therefore the when to order decision is usually expressed in terms of a recorder point (ROP) - the inventory level at which an order should be placed.

The recorder point (ROP) is given as:

 ROP = (Demand per day) x (Lead time for a new order in days)

 = d x L

 where

 d = annual demand, D divided by the number of working days in a year.

 = D/ No. of working days in a year.]

 Therefore,

 ROP = D/no. of working days in a year x L

 Q\*

 Resupply takes place as

 order arrives

 Inventory

 level Slope = units/day = d

 (units)

 ROP

 (units)

 Lead time

An Apple distributor has a demand for 8,000 iPods per year. The firm operates a 250-day working year. On average delivery of an order takes 3 working days. It wants to calculate the reorder point.

 d = D/No. of working days per year = 8,000/250

 = 32 units

 ROP = d x L = 32 x 3 days = 96 units

Note:

Therefore when the inventory drops to 96 units, an order should be placed. The order will arrive 3 days later just as the distributor stock is depleted.

Other models

There are models for other situations regarding of inventory orderings such receiving inventory over a period of time, for quantity discount or problematic situation and safety stock, and single-period or fixed-period systems.