**Inventory Management**

**Chapter Outline**

* Introduction
* ABC Analysis
* Physical Inventory and Cycle Counting
* Inventory Control
* Economic Order Quantity
* Continuous Review System
* Periodic Review System
* Single-Period Inventory Decision

**Introduction**

**Inventory** is a stock of any item or resource used in an organization. Inventories can be classified into raw materials, semi-finished goods, and finished goods. Any raw materials or semi-finished goods that have been released into production but not yet finished can be classified into work-in-process.

The **purposes of carrying inventory** are as follows.

* To meet demands immediately from stock.
* To smooth production requirements. We can produce more than needed during the time of low demand, put them in stock, and use them later at the time of high demand.
* To protect against stockouts. Stockouts can occur due to uncertainty in demand and supply. We may want to keep some extra units to avoid stockouts.
* To take advantage of economic lot size. For a production item, since it takes time to set up the production, we may want to produce more than needed so that we can spread out the production setup costs over more units and reduce average cost per unit. For a purchase item, we might get some quantity discounts from the supplier if we order a large quantity. In that case, we may want to purchase more than needed at a discounted price and keep them in stock for later use.
* To protect loss from price increases. If a price increase is anticipated, we may want to purchase more than needed and keep them in stock for later use.

**Inventory-related costs** include acquisition costs, inventory-holding costs, ordering costs, and shortage costs. These costs should be taken into account in inventory decisions.

* Acquisition costs are purchase costs for a purchase item and variable production costs, including materials costs and direct labor costs, for a production item.
* Inventory-holding (or -carrying) costs include the costs of capital for the money tied up with the inventory. Inventory also requires storage space and material handlings, so we incur physical storage costs.
* Ordering costs are the costs of placing and receiving orders. They also include the costs of setting up production tool and equipment if the item is a production item. Since these costs are not affected by order quantity, they are called fixed costs.
* Shortage costs include lost profit and loss of goodwill. If we have stockouts, we may lose potential profits as well as customer loyalty.

Before we proceed, let us define some important terminologies used in inventory management.

* On-hand inventory refers to physical inventory held in stock.
* Inventory level is on-hand inventory minus backorders, where backorders are customer orders that have been received but not yet shipped because of stockouts.
* Inventory position is inventory level plus scheduled receipts, where scheduled receipts are purchase or production orders that have been placed but not yet received.
* Stock keeping unit (SKU) refers to any individual inventory item that has an identifying code.
* Cycle-service level is the probability of not running out of stock in any one ordering cycle, where an ordering cycle begins at the time an order is received and ends right before the next order is received.
* Safety stock is the inventory held in excess of expected demand. Safety stock inventory can be held to protect against stockouts due to uncertainty in demand and supply.
* Lot size (or order quantity) is the quantity ordered or produced.
* Cycle inventory is the portion of total inventory that varies directly with lot size.

**ABC Analysis**

**ABC analysis** is the process of dividing SKUs into three classes according to their *dollar usage*, so that we can focus on items that have the highest dollar usages. This approach is based on the observation that in many cases about 20% of the inventory items explain 80% of the total dollar usage. In ABC analysis we list up all the inventory items according to their dollar usages and classify roughly top 20% of the items into “A” class, the next 30% into “B” class, and the remaining into “C” class.

After classification of the inventory items, we can use different inventory control methods for items in different classes. For example, for “A” class items we may review their inventory continuously and places orders frequently, whereas for “C” class items we may review their inventory periodically and place orders infrequently. The ABC classifications of the inventory items can be also used for cycle counting (see below for more details).

**Example of ABC Classification**

Suppose we have 10 items whose unit costs and monthly sales are as follows:

 Monthly

 Unit Cost Sales

 Inventory Item ($) (units)

 Cameras 200 40

 CDs 10 400

 Computers 2500 30

 Displays 250 40

 Home Theater 5000 30

 Refrigerators 1000 15

 Software 50 100

 Speakers 150 60

 Television Sets 400 60

 Thumb Drives 5 1000

For ABC classification, we first need to calculate the monthly dollar usage of each item. For example, the monthly dollar usage of cameras is $200$×$40 = $8,000. And then we list up all the items according to their dollar usages. We can classify top 2 items (i.e., 20% of 10 items) into “A” class, the next 3 items (i.e., 30% of 10 items) into “B” class, and the remaining items into “C” class.

 Monthly Dollar Usage

 Unit Cost Sales per Month

 Inventory Item ($) (units) ($) Class

 Cameras 200 40 150,000 A

 CDs 10 400 75,000

 Computers 2500 30 24,000

 Displays 250 40 15,000 B

 Home Theater 5000 30 10,000

 Refrigerators 1000 15 9,000

 Software 50 100 8,000

 Speakers 150 60 5,000 C

 Television Sets 400 60 5,000

 Thumb Drives 5 1000 4,000

**Physical Inventory and Cycle Counting**

In inventory management it is important to maintain a high level of inventory accuracy, where inventory accuracy refers to how well the inventory records in the system agrees with physical inventories.

Traditionally, all inventory items were counted once or twice a year (typically at the end of the fiscal year because general accounting requires asset valuation for the balance sheet). But this traditional method can create many problems due to human errors and other inaccuracies. It can be also expensive and time consuming, often requiring a shutdown or work stoppage.

**Cycle counting**, on the other hand, is a physical inventory-counting technique in which inventories are counted on a *frequent* basis rather than once or twice a year. In cycle counting, we set the rules for choosing items to be counted, run the cycle counting program to get the list of items to be counted, count inventory for the items in the list, and update their inventory records. For example, we can set the rules such that “A” class items are counted every two months, “B” class items every four months, and “C” class items every six months. Other examples of setting the rules are choosing items whose inventory level is low or items that show a positive inventory level but also have backorders.

**Inventory Control**

**Inventory control** involves monitoring the inventory and placing orders if needed. Three important questions for inventory control are:

1. How often to review the inventory status? The inventory status can be reviewed periodically (e.g., every Monday) or continuously on a real time basis.
2. When to order? We may place orders periodically. Or, we may place an order whenever the amount of inventory drops to a certain level.
3. How much to order? Each time we place an order, we need to decide how much to order.

The remaining of this chapter will be devoted to:

* Economic order quantity (EOQ) model, which is a well-known and widely-used model for determining order quantity
* Two inventory control systems: continuous review system and periodic review system
* Single-period inventory model, which can be used for determining order quantity when a single selling period or season is involved (e.g., newsvendor)

**Economic Order Quantity**

**Continuous Review System**

**Periodic Review System**

**Single-Period Inventory Decision**