Supply Chain Management

Part 8

Inventory Management in a Supply Chain

Why do we need inventory

- Improve customer service.
- Safe-guard to hazards in demand, supply, and delivery that might cause stock-out.
- Take advantage of economies of scale, & reducing ordering costs, stock-out costs and fixed costs.
- Contribute to the efficient and effective operation of the production system, e.g.,
  - Reduces the number of costly setups and re-schedulings
  - Smoothing and stabilizing resource utilization

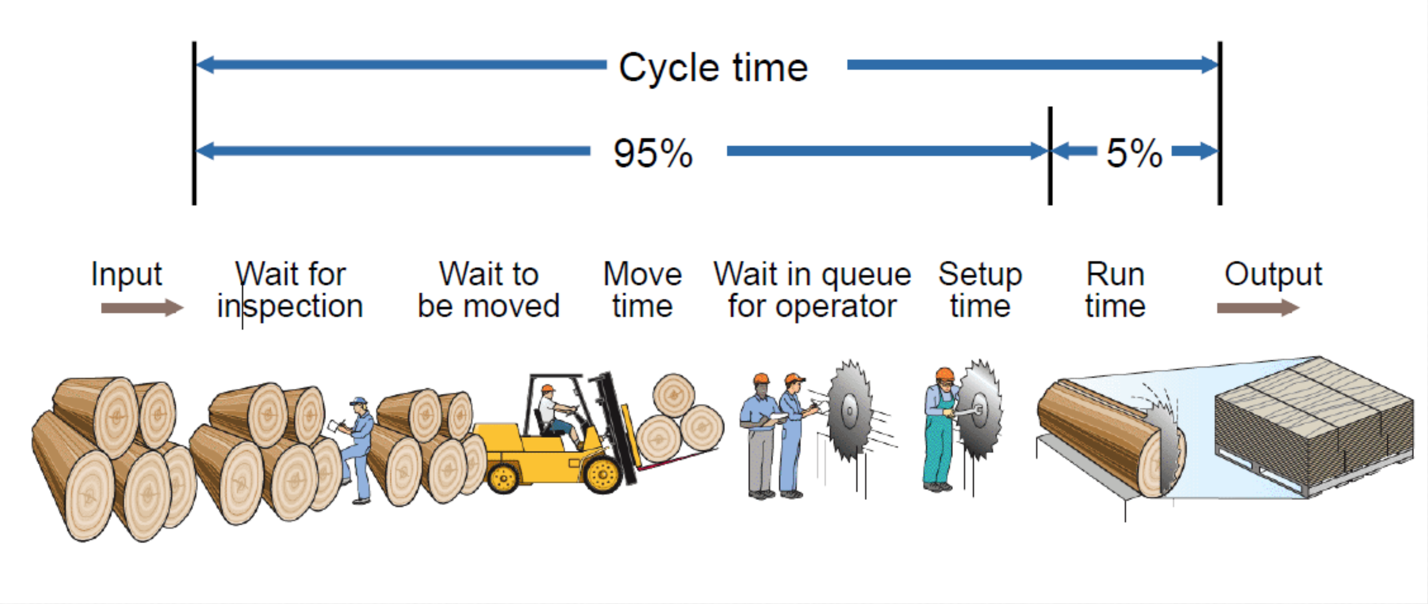
Why we do not want inventory

- Certain costs increase such as
  - Storage costs
  - insurance costs
  - outdate costs
  - cost of production problems
- Ties capital for which the company pays interest
- Risk of getting stuck with unsalable goods

Types of inventory

- **Raw material**
  - Purchased but not processed
- **Work-in-process (WIP)**
  - Undergone some change but not completed
- **Maintenance/repair/operating (MRO)**
  - Necessary to keep machinery and processes productive
- **Finished goods**
  - Completed product awaiting shipment

Material flow cycle



Inventory-related costs

- Ordering costs (Unit ordering cost (C) + fixed ordering cost (S))
  - costs of replenishing inventory, placing orders, receiving goods
- Inventory holding costs (H)
  - cost of holding an item in inventory over time,

  Note: It may also be obtained as a fraction, h, of the unit cost of the product. Given a unit cost of C, the holding cost H is given by

  $H = hC$
- Shortage or Stock-out / penalty costs
  - Lost sales vs. backlogging
- Outdate costs (for perishable products)

Holding costs

Determining Inventory Holding Costs

CATEGORY	COST (AND RANGE) AS A PERCENT OF INVENTORY VALUE
Housing costs (building rent or depreciation, operating costs, taxes, insurance)	6% (3 - 10%)
Material handling costs (equipment lease or depreciation, power, operating cost)	3% (1 - 3.5%)
Labor cost (receiving, warehousing, security)	3% (3 - 5%)
Investment costs (borrowing costs, taxes, and insurance on inventory)	11% (6 - 24%)
Pilferage, space, and obsolescence (much higher in industries undergoing rapid change like PCs and cell phones)	3% (2 - 5%)
Overall carrying cost	26%

ABC Analysis

- All items do not deserve the same attention in terms of inventory management.
- Focus on items that have the highest monetary value
- Divides inventory into three classes based on annual dollar volume:
  - Class A - high annual dollar volume
  - Class B - medium annual dollar volume
  - Class C - low annual dollar volume
- Used to establish policies that focus on the few critical parts and not the many trivial ones

ABC Analysis

Steps of ABC analysis:

- First, multiply the annual number of products with each item's cost and find the annual usage value.
- Make a category of every product in the descending order based on its usage value.
- Add the usage value of the products, including the total number of items.
- Find out the cumulative percentages of items sold and annual consumption value.
- Now, it's time to divide your data into three categories, finally, in an approximate ratio of 80:15:5.

ABC Analysis

Example. Using ABC analysis categorize the products.

Product	Annual number of sold items	Cost per unit ($)
Beds	5000	80
Chairs	1500	20
Coffee Tables	700	40
Desks	600	40
Ottomans	500	30
Dining Tables	700	50
Book Cases	600	15
Office Chairs	10000	20
Wardrobes	600	40
Computer Cabinet	700	30

ABC Analysis

Step 1- Multiply the total number of items by the cost of each unit to find the annual usage value.

Product	Annual number of sold items	Cost per unit ($)	Annual usage value ($)
Beds	5000	80	400000
Chairs	1500	20	30000
Coffee Tables	700	40	28000
Desks	600	40	24000
Ottomans	500	30	15000
Dining Tables	700	50	35000
Book Cases	600	15	9000
Office Chairs	10000	20	200000
Wardrobes	600	40	24000
Computer Cabinet	700	30	21000

ABC Analysis

Step 2- After noting all the products of the inventory, it's time to list them in the descending order based on annual consumption value.

Product	Annual number of sold items	Cost per unit ($)	Annual usage value ($)
Beds	5000	80	400000
Office Chairs	10000	20	200000
Dining Tables	700	50	35000
Chairs	1500	20	30000
Coffee Tables	700	40	28000
Desks	600	40	24000
Wardrobes	600	40	24000
Computer Cabinet	700	30	21000
Ottomans	500	30	15000
Book Cases	600	15	9000

ABC Analysis

Step 3- Sum up and add the total number of units sold and the annual consumption value.

Product	Annual number of sold items	Cost per unit ($)	Annual usage value ($)
Beds	5000	80	400000
Office Chairs	10000	20	200000
Dining Tables	700	50	35000
Chairs	1500	20	30000
Coffee Tables	700	40	28000
Desks	600	40	24000
Wardrobes	600	40	24000
Computer Cabinet	700	30	21000
Ottomans	500	30	15000
Book Cases	600	15	9000
Total	20900		786000

ABC Analysis

Step 4- Find out the cumulative percentage of products sold along with the percentage of annual consumption value.

Product	Annual number of sold items	Cost per unit ($)	Annual usage value ($)	Percentage of annual units sold	Percentage of annual consumption value
Beds	5000	80	400000	23.92%	50.89%
Office Chairs	10000	20	200000	47.85%	25.45%
Dining Tables	700	50	35000	3.35%	4.45%
Chairs	1500	20	30000	7.18%	3.82%
Coffee Tables	700	40	28000	3.35%	3.56%
Desks	600	40	24000	2.87%	3.05%
Wardrobes	600	40	24000	2.87%	3.05%
Computer Cabinet	700	30	21000	3.35%	2.67%
Ottomans	500	30	15000	2.39%	1.91%
Book Cases	600	15	9000	2.87%	1.15%
Total	20900		786000		

ABC Analysis

Step 5- In the last step, split the data and numbers into the three A, B, and C categories. Remember, it's essential to set the data in the ratio of 80:15:5.

Product	Annual number of sold items	Cost per unit ($)	Annual usage value ($)	Percentage of annual units sold	Percentage of annual consumption value	
Beds	5000	80	400000	23.92%	50.89%	76.34%
Office Chairs	10000	20	200000	47.85%	25.45%	
Dining Tables	700	50	35000	3.35%	4.45%	14.89%
Chairs	1500	20	30000	7.18%	3.82%	
Coffee Tables	700	40	28000	3.35%	3.56%	
Desks	600	40	24000	2.87%	3.05%	
Wardrobes	600	40	24000	2.87%	3.05%	5.73%
Computer Cabinet	700	30	21000	3.35%	2.67%	
Ottomans	500	30	15000	2.39%	1.91%	
Book Cases	600	15	9000	2.87%	1.15%	

ABC Analysis

Policies employed may include:

1. More emphasis on supplier development for A items

2. Tighter physical inventory control for A items

3. More care in forecasting A items

EOQ Model

As Best Buy sells its current inventory of HP computers, the purchasing manager places a replenishment order for a new lot of Q computers. Including the cost of transportation, Best Buy incurs a fixed cost of $S per order. The purchasing manager must decide on the number of computers to order from HP in a lot. For this decision, we assume the following inputs:

D = Annual demand of the product

S = Fixed cost incurred per order

C = Cost per unit of product

h = Holding cost per year as a fraction of product cost

EOQ Model

The model is developed using the following basic assumptions:

1. Demand is steady at D units per unit time.

2. No shortages are allowed—that is, all demand must be supplied from stock.

3. Replenishment lead time is zero.

Aim: is to makes the lot-sizing decision to minimize the total cost for the store.

EOQ Model

- 1- ***Annual material cost = CD***

2- ***Annual ordering cost***

The number of orders must suffice to meet the annual demand D. Given a lot size of Q, we thus have

Number of orders per year = $\frac{D}{Q}$

Because an order cost of S is incurred for each order placed, we infer that

Annual ordering cost $= (\frac{D}{Q})S$

EOQ Model

3- ***Annual holding cost***

Given a lot size of Q, we have an average inventory of Q/2. The annual holding cost is thus the cost of holding Q/2 units in inventory for one year and is given as

Annual holding cost = $\left(\frac{Q}{2}\right) hc$

$$\textit{Total annual cost, } TC = CD + \left(\frac{D}{Q}\right)S + \left(\frac{Q}{2}\right) hc$$

EOQ Model

- $$\frac{\partial TC}{\partial Q} = 0 \rightarrow 0 - \frac{DS}{Q^2} + \frac{hc}{2} = 0$$

The optimal lot size is referred to as the *economic order quantity* (EOQ). It is denoted by Q^* and is given by the following equation:

$$Q^* = \sqrt{\frac{2DS}{hc}}$$

The optimal ordering frequency is given by n^*, where

$$n^* = \frac{D}{Q^*} = \sqrt{\frac{Dhc}{2S}}$$

For this formula, it is important to use the same time units for the holding cost rate h and the demand D.

EOQ Model

Example. A museum of natural history opened a gift shop which operates 52 weeks per year. Managing inventories has become a problem. Top-selling SKU is a bird feeder. Sales are 18 units per week, the supplier charges $60 per unit. Ordering cost is $45. Annual holding cost is 25 percent of a feeder's value. Management chose a 390-unit lot size.

1- What is the annual cycle-inventory cost of the current policy of using a 390-unit lot size?

2- Would a lot size of 468 be better?

3- Calculate the EOQ and its total annual cycle-inventory cost.

4- How frequently will orders be placed if the EOQ is used?

EOQ Model

- D = (18 units/week) (52 weeks/year) = 936 units

1- Total cycle-inventory for the current policy is

$TC_1 = (D/Q)S + (Q/2)hC = (936/390)*45 + (390/2)*0.25*60 = \$3033$

2- Total cycle-inventory for the alternative lot size is

$TC_2 = (936/468)*45 + (468/2)*0.25*60 = \$3600$

3- Optimal order size = $Q^* = \sqrt{\frac{2*936*45}{0.25*60}} = 74.94 \text{ or } 75 \text{ units}$

4- n* = number of order per year = D/Q*= 936/75= 12.48