

## CHAPTER 2

### LITERATURE REVIEW

#### Inventory Definitions

- **Inventory** is defined as a stock of goods. More generally, inventory can be regarded as an idle resource that has economic value. An inventory is made up of one or more items where each item is a unique supply item, raw material, purchased or manufactured part, assembly, or final product.
- **A stock point** is a location at which an item can be stored. Generally, a warehouse will have many stock points, one for each item.
- **A stock-keeping unit (SKU)** is an item held at a particular stock point. So three items, for example, each stocked in three warehouses would result in nine SKUs.
- **An allocation** is a quantity on a requisition sent to the stockroom but not yet filled.
- **Net inventory** is on-hand inventory less back orders and allocations.
- **Inventory position** is on-hand plus on-order inventory less back orders and allocations.

#### Functions of Inventory

The principal role of inventory is to serve as a buffer, decoupling successive stages of production and distribution to achieve greater efficiency. A secondary role is to provide a hedge against price increases and fluctuations in demand.

More specifically, inventories can be categorized by the functions they serve, as follows:

Safety stocks - Inventory control is subject to many uncertainties. Customer demand must usually be forecast with the potential for forecast errors. Lead times may be longer than expected. The quantity rejected at inspection can only be estimated in advanced. Even the size of the inventory being replenished is subject to

counting error. Safety stocks protect against failure to fill customer orders or satisfy the needs of manufacturing on time due to these uncertainties.

Excess inventory - Where the continued stocking of inventories can no longer be justified for such reasons as obsolescence or physical deterioration, the inventories are in excess. Possible recourses include sale for scrap or reworking to the specifications of some active item.

### **Inventory Costs**

Three principal costs of operating inventory systems are ordering, holding and shortage costs.

Ordering costs are the costs that increase with the number of orders placed. Ordering costs for purchased items includes the costs of some or all of the following:

- Preparation of purchase requisition
- Preparation of purchase order
- Mail
- Expediting, including telephone and telegraph
- Transportation
- Receiving
- Inspection
- Put away
- Updating inventory records
- Paying invoice

Holding costs are those costs that increase with the size of the inventory. Usually most of this cost is a function of the value of the inventory. If the item in inventory is purchased, it will be valued at its purchase price. Holding costs are calculated, in baht per unit per unit time, by the product of the holding costs fraction and the unit costs.

Shortage costs result when demand exceeds the supply of inventory on hand. The costs can include the opportunity cost of not making a sale, loss of customer goodwill, lateness charges, and similar costs.

## Independent and Dependent Demand Inventory Systems

Independent demand for an item is demand which is unrelated to the demand for other items. Examples include demand for finished goods and for service parts. Independent demand typically is uniform, resulting in gradual inventory depletion. Also the demand usually must be forecast. Inventory models used in managing independent demand items generally involve economic order quantities or order levels, order points, and safety stocks.

Dependent demand for an item is demand which is related to or derived from demand for other items. For example, demand for a component is derived from the demand for its parent. Dependent demand for items is often lumpy and discrete. This results from the lot sizing of the higher level components, assemblies, or products in which they are used. Also these demands are determined from the production schedules for these higher level items and therefore are calculated rather than forecast.

## The Economic Order Quantity

The purpose of the EOQ formula is to determine the order quantity that will minimize the sum of ordering and inventory carrying costs per unit time.

### EOQ Assumptions

1. Demand is deterministic at a constant rate,  $r$ .
2. No shortages are allowed.
3. Order size is a constant,  $q$ , in continuous units.
4. The replenishment is instantaneous, that is, the replenishment rate,  $p$ ,  $= \infty$ .
5. Lead time,  $L$ ,  $= 0$

## Orders Points and Safety Stocks

One of the assumptions in the basic EOQ model was that the lead time,  $L$ , was zero. Therefore, there was no need to carry safety stock to protect against shortages because as soon as the inventory was depleted a new lot could be brought in immediately. Even with positive lead time, there is still no need for safety stock if both lead time and demand are known with certainty in advance.

The order point can be expressed mathematically as

$$s = m + Ks_L$$

where  $m$  = expected demand during lead time

$K$  = safety factor

$s_L$  = standard deviation of demand during lead time

$Ks_L$  = safety stock

$K$  is a decision variable which can be selected to achieve desired results in terms of frequency of stockouts or customer service level. Table provides data that can be used in choosing values for  $K$  that meet these objectives. The table is based on the common assumption that forecasting errors are normally distributed.  $F'(K)$  is the probability that demand will be less than or equal to the order point.  $F'(K)$  is equal to  $1 - F(K)$  and is the probability that demand during lead time will be equal to or greater than the order point.

**TABLE 2.1** safety Factors, Demand Probabilities

SAFETY FACTOR , $K$	PROBABILITY , $F(K)$	PROBABILITY , $F'(K)$
0.0	0.5000	0.5000
0.1	0.5398	0.4602
0.2	0.5793	0.4207
0.3	0.6179	0.3821
0.4	0.6554	0.3446
0.5	0.6915	0.3085
0.6	0.7257	0.2743
0.7	0.7580	0.2420
0.8	0.7881	0.2119
0.9	0.8159	0.1841
1.0	0.8413	0.1587
1.1	0.8643	0.1357
1.2	0.8849	0.1151
1.3	0.9032	0.0968
1.4	0.9192	0.0808
1.5	0.9332	0.0668
1.6	0.9453	0.0548
1.7	0.9554	0.0446

1.8	0.9641	0.0359
1.9	0.9713	0.0287
2.0	0.9772	0.0228
2.1	0.9821	0.0179
2.2	0.9861	0.0139
2.3	0.9893	0.0107
2.4	0.9918	0.0082
2.5	0.9938	0.0062
2.6	0.9953	0.0047
2.7	0.0065	0.0035
2.8	0.9974	0.0026
2.9	0.9981	0.0019
3.0	0.9984	0.0016

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