POST GRADUATE DIPLOMA IN MANAGEMENT

MP-09

Logistics & Supply Chain Management

Block

4

SUPPLY CHAIN INVENTORIES & WAREHOUSING

Unit-1

Supply Chain Inventories

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Warehousing

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Unit- 1:

Supply Chain Inventories

Learning Objectives

After completion of the unit, you should be able to learn:

- What is inventory and types
- What are the tools of Inventory Management
- Inventory costs and Turnover Ratio
- Inventory audit and
- Operational challenges in inventory management

Structure

1.1 INTRODUCTION

In any business or organization, all functions are interlinked and connected to each other and are often overlapping. Some key aspects like supply chain management, logistics and inventory form the backbone of the business delivery function. Therefore these functions are extremely important to marketing managers as well as finance controllers.

Inventory management is a very important function that determines the health of the supply chain as well as the impacts the financial health of the balance sheet. Every organization constantly strives to maintain optimum inventory to be able to meet its requirements and avoid over or under inventory that can impact the financial figures.

Inventory is always dynamic. Inventory management requires constant and careful evaluation of external and internal factors and control through planning and review. Most of the organizations have a separate department or job function called inventory planners who continuously monitor, control and review inventory and interface with production, procurement and finance departments.

There are instances where efficiency in supply chain can be ensured by efficiencies in inventory, to be more precise, by maintaining efficiency in inventory reductions. Though inventory is considered a liability to efficient supply chain management, supply chain managers acknowledge the need of inventory. However, the unwritten rule is to keep inventory at a bare minimum.

Many strategies are developed with the objective of streamlining inventories beyond the supply chain and holding the inventory investment as low as possible. The supply chain managers tend to maintain the inventories as low as possible because of inventory investment. The cost or investment related with owning inventories can be high. These costs comprise the cash outlay that is

necessary for purchasing the inventory, the costs of acquiring the inventories (the cost of having invested in inventories rather than investing in something else) and the costs related with managing the inventory.

1.2 What is Inventory?

Inventory is an idle stock of physical goods that contain economic value, and are held in various forms by an organization in its custody awaiting packing, processing, transformation, use or sale in a future point of time.

Any organization which is into production, trading, sale and service of a product will necessarily hold stock of various physical resources to aid in future consumption and sale. While inventory is a necessary evil of any such business, it may be noted that the organizations hold inventories for various reasons, which include speculative purposes, functional purposes, physical necessities etc.

From the above definition the following points stand out with reference to inventory:

- All organizations engaged in production or sale of products hold inventory in one form or other.
- Inventory can be in complete state or incomplete state.
- Inventory is held to facilitate future consumption, sale or further processing/value addition.
- All inventoried resources have economic value and can be considered as assets of the organization.

Current manufacturing paradigm demands high productivity and the company's ability to respond to unstable market settings. For most of the industries, high competition led ways to optimize the manufacturing processes and structure their own inventory management plans accordingly. Inventory management is

managing the parts or stocks of materials in any form inside the plant and stabilizing the flow of materials considering the variability in demand. It is very important that the inventory plans are structured in such a way that they accommodate variability in demand especially when the company deals with multiple products. Inventory management starts from procurement of materials for manufacturing or processing until it reaches the customer as a finished product. Even stocked up finished goods are to be managed inside the facility along with the unprocessed materials. So it becomes important to frame an overall plan that considers all materials to be stocked up inside the facility.

Inventory management plans will lead to categorizing parts that comprise to a complete product and helps in deciding the amount of inventory for each part that is stocked at any given time. Inventory management also facilitates a plant to decide the release and order intake dates of raw materials and finished parts considering the demand of the product and allotment of space for stocking materials inside the available facility.

1.3 Why do Companies hold Inventories?

Inventory is a necessary evil that every organization would have to maintain for various purposes. Optimum inventory management is the goal of every inventory planner. Over inventory or under inventory both cause financial impact and health of the business as well as effect business opportunities.

Inventory holding is resorted to by organizations as hedge against various external and internal factors, as precaution, as opportunity, as a need and for speculative purposes.

Reasons why organizations maintain Raw Material Inventory

Most of the organizations have raw material inventory warehouses attached to the production facilities where raw materials, consumables and packing materials

are stored and issue for production on JIT basis. The reasons for holding inventories can vary from case to case basis.

1. Meet variation in Production Demand

   Production plan changes in response to the sales, estimates, orders and stocking patterns. Accordingly the demand for raw material supply for production varies with the product plan in terms of specific SKU as well as batch quantities.

   Holding inventories at a nearby warehouse helps issue the required quantity and item to production just in time.

2. Cater to Cyclical and Seasonal Demand

   Market demand and supplies are seasonal depending upon various factors like seasons; festivals etc. and past sales data help companies to anticipate a huge surge of demand in the market well in advance. Accordingly they stock up raw materials and hold inventories to be able to increase production and rush supplies to the market to meet the increased demand.

3. Economies of Scale in Procurement

   Buying raw materials in larger lot and holding inventory is found to be cheaper for the company than buying frequent small lots. In such cases one buys in bulk and holds inventories at the plant warehouse.

4. Take advantage of Price Increase and Quantity Discounts

   If there is a price increase expected few months down the line due to changes in demand and supply in the national or international market, impact of taxes and budgets etc., the company’s tend to buy raw materials in advance and hold stocks as a hedge against increased costs.

   Companies resort to buying in bulk and holding raw material inventories to take advantage of the quantity discounts offered by the supplier. In such cases the

savings on account of the discount enjoyed would be substantially higher that of inventory carrying cost.

5. Reduce Transit Cost and Transit Times

   In case of raw materials being imported from a foreign country or from a faraway vendor within the country, one can save a lot in terms of transportation cost buy buying in bulk and transporting as a container load or a full truck load. Part shipments can be costlier.

   In terms of transit time too, transit time for full container shipment or a full truck load is direct and faster unlike part shipment load where the freight forwarder waits for other loads to fill the container which can take several weeks.

   There could be a lot of factors resulting in shipping delays and transportation too, which can hamper the supply chain forcing companies to hold safety stock of raw material inventories.

6. Long Lead and High demand items need to be held in Inventory

   Often raw material supplies from vendors have long lead running into several months. Coupled with this if the particular item is in high demand and short supply one can expect disruption of supplies. In such cases it is safer to hold inventories and have control.

   Holding inventories help the companies remain independent and free from vendor dependencies.

1.4 Types of Inventory

There are three main types of inventories and are raw materials, work-in-progress, & finished Goods.

Raw Materials:

Raw Materials is an unprocessed natural substance, semi processed or product used in Manufacturing Process and that are converted by a manufacturer into a finished product. There are the goods which have not yet been committed to production in a manufacturing Firm. They may consist of raw materials or finished components. They are the resources purchased as inputs to the transformation process that have not yet been transformed. Materials suitable for manufacture or use or finishing is raw material. Raw material is the original material as taken from its source, usually the ground.

Work-in-Progress:

Work-in progress, also called stock-in-progress, refers to goods in the intermediate stages of production. This includes those materials which have not yet been completed. It refers to the raw materials engaged in various phases of production schedule. The degree of completion may be varying for units. Some units might have been just introduced and some others may be 40% complete or others may be 90% complete. The work-in-progress refers to partially produced goods.

The value of work-in-progress refers to raw materials costs, direct wages, and expenses already incurred and the overhead if any. So work-in-progress inventory contains partially produced/completed goods. The purpose of work-in-progress inventory is to uncouple the various operations in the production process so that machine failures and stoppages in one operation will not affect other operations.

Finished Goods:

Inventory that is in a saleable or shippable form based upon its location within the supply chain. Finished goods are completed products awaiting sale. They are the final output of the production process in a manufacturing firm. An item considered a finished good in a supplying plant might be considered a component or raw material in a receiving plant. Commodities that will not undergo further processing and ready for sale to the final demand user, either an

individual consumer or business firm. In case of wholesalers and retailers, they are generally referred to as merchandise inventory. This includes durable goods such as automobiles, household furniture and appliances, And Nondurable goods such as apparel and home heating oil.

High & low level of Inventory:

Inventory control involves a tight rope walk between two conflicting goals- not to have too high an inventory level, & not to have too low as well. The relative benefits arising out of keeping high & low levels of inventories are briefly presented in the following table:

ITEMS	HIGH	LOW
1. Raw Materials	a. Protection against lack of supply b. Bulk discount from Supplier's cost per unit c. Better utilization of Import License and using quotas allotted by canalizing agencies viz. STC, CIL, etc. d. Lower transportation and other ordering costs	a. Reduce inventory carrying costs. b. Less risks of deterioration. c. Less handling and insurance costs d. Reduced storage space
2. Work in progress	a. Safeguard against machine breakdown b. Longer and economic production runs c. Lower machine setting costs	a. Reduce inventory carrying costs b. More elbow room in factory premises
3. Component parts	Smooth and uninterrupted and production runs	Reducing carrying costs
4. Consumable stores	Proper machine fed production runs	Reduced carrying costs
5. Finished goods	a. Better customer satisfaction b. A clear incentive to sales department	a. Reduced inventory b. Less risks of deterioration or obsolescence.
6. Packing materials	Protection against deterioration	Reduced carrying costs

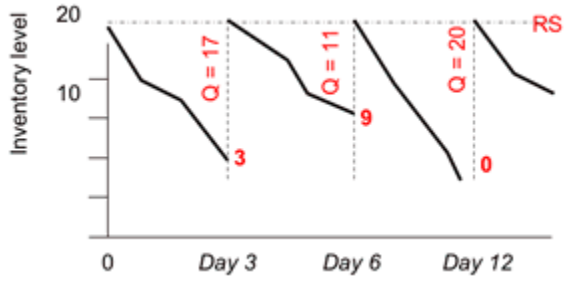
Periodic review system:

In this system of inventory, the stock position is reviewed once in a fixed period and an order is placed depending on the stock position, unlike a fixed quantity in the Q system of inventory. The review period is approximately equal to EOPQ/D.

The Desired Maximum Inventory Level is fixed as the sum of the average demand during average lead time plus review period, variation in demand during average lead time plus review period, and the average demand during delays in supply. A schematic representation of this model is shown in figure.

EXAMPLE 1

- A retailer reviews the inventory for a certain product every **3 days**. The restocking level is **20**.
- If the inventory level is low, new items are available in the storeroom and are immediately brought out:



Determining the restocking level

$$RS = D_{RP+L} + SS$$

Where:

D_{RP+L} = Average demand during the reorder period plus thereplenishment lead time (if there is a delay getting new products in).

SS = Safety stock. This is a “cushion” of inventory held to mitigate the uncertainties of forecasts and lead times.
Higher safety stock levels increase the likelihood that goods are available, but also drive up inventory levels and costs

EXAMPLE 2

- A pharmacy sells an over-the-counter drug, Digene syrup.
- Every 10 days, the vendor comes by to check the inventory levels and order more of the drug.
- It takes about 3 more days to get the new order in.
- Demand per day is about 20 bottles, but can vary.
- The pharmacy would like to keep a safety stock of about 40 bottles to protect against stockouts, just in case demand levels or lead times are greater than expected.

Solution

D_{RP+L} =13 days * (20 bottles) = 260 bottles

SS =40 bottles

$RS = D_{RP+L} + SS$ =260 + 40

=300 bottles

Maximum Inventory Level during lead time and review period Units
Reserve stock during delivery
Safety stock during lead time and review period

1.5 Tools of Inventory management:

Effective inventory management requires control over inventories. Inventory control refers to a system which ensures supply of required quantity and quality of inventories at the required time and at the same time prevents unnecessary investment in inventories. The tools of inventory control / inventory management are as follows:

(I) ABC analysis:

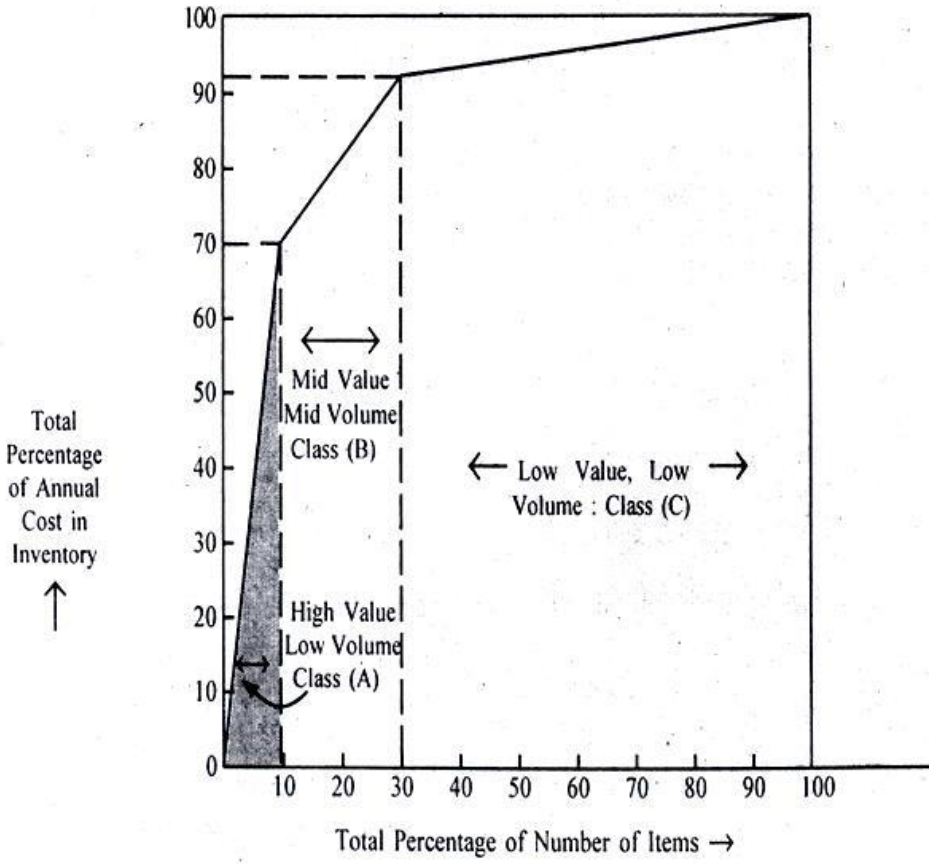
The ABC method is an analytical method of stock control which aims at concentrating efforts on those items where attention is needed most. It is based on the premise that a small number of the items in inventory may typically represent the built money value of the total materials used in production process, while a relatively large number of items may represent a small portion of the money value of stores used and that small number of items should be subject to the greater degree of continuous control.

Under this system, the materials stocked may be classified into a number of categories according to their importance, i.e., their value and frequency or replenishment during a period. The first category, we may call if the group of 'A items may consists of only a small percentage of total items handled but its combined value may be large portion of the total stock value. The second category, naming it as group of B items may be relatively less important. In this third category, consisting of C items, all the remaining items of stock may be included which are quite large in number but their value is not high.

Type of control that is required on different types of items:

NATURE	CLASS-A ITEMS HAVING HIGH CONSUMPTION VALUE	CLASS-B ITEMS HAVING MODERATE CONSUMPTION VALUE	CLASS-C ITEMS HAVING LOW CONSUMPTION VALUE
1. Value (Monetary)	High consumption	Moderate consumption	Low consumption
2. Extent of control	Very strict control	Moderate control	Low control
3. Lead time	Maximum efforts to	Moderate efforts to	Minimum efforts to
4. Sources of supply	As many sources as possible	Three or more reliable	Three reliable sources
5. Value analysis	Rigorous	Moderate	Minimum

Cumulative curve of ABC analysis



Application of ABC analysis:

This approach helps the materials manager to exercise selective control and focus his/her attention only on a few itemswhen he/she is confronted with thousands of stores items. Any stock control system should ensure that every item gets itsdue attention at the right time. ABC analysis makes it possible with considerable less effort by its selective approach. Thefollowing are the applications of ABC analysis.

(II)Economic order quantity:

A decision about how much to order has great significance in inventory management. The quantity to be purchased should neither be small nor big because costs of buying and carrying materials are very high. Economic order

quantity is the size of the lot to be purchased which is economically viable. This is the quantity of materials which can be purchased at minimum costs. Generally, economic order quantity is the point at which inventory carrying costs are equal to order costs. In determining economic order quantity it is assumed that cost of a managing inventory is made of solely of two parts i.e. ordering costs and carrying costs.

(A) Ordering Costs: These are costs that are associated with the purchasing or ordering of materials. These costs include:

(1) Inspection costs of incoming materials.

(2) Cost of stationery, typing, postage, telephone charges etc.

(3) Expenses incurred on transportation of goods purchased.

These costs are also known as buying costs and will arise only when some purchases are made.

(B) Carrying Costs: These are costs for holding the inventories. These costs will not be incurred if inventories are not carried. These costs include:

(1) The cost of capital invested in inventories. An interest will be paid on the amount of capital locked up in inventories.

(2) Cost of storage which could have been used for other purposes.

(3) Insurance Cost

(4) Cost of spoilage in handling of materials

Assumptions of EOQ: While calculating EOQ the following assumptions are made.

1. The supply of goods is satisfactory. The goods can be purchased whenever these are needed.

2. The quality to be purchased by the concern is certain.

3. The prices of goods are stable. It results to stabilize carrying costs.

Economic order quantity can be calculated with the help of the following formula:

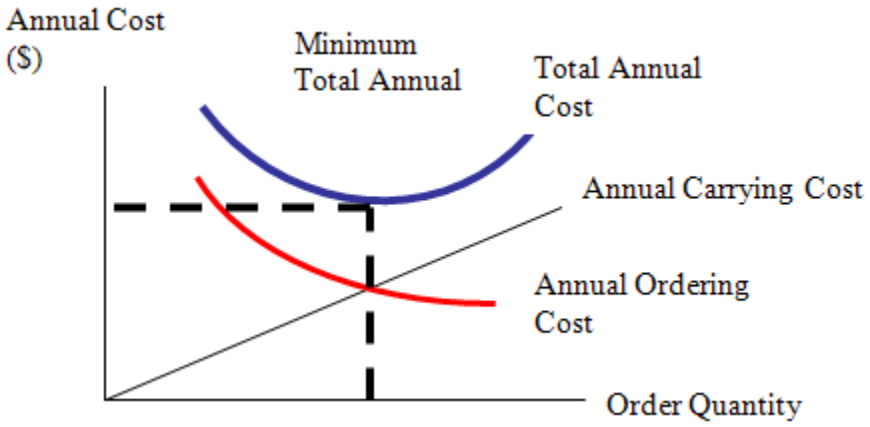
$$EOQ = \sqrt{2DS / C}$$

Where, D = Annual consumption in rupees.

S = Cost of placing an order.

C = Inventory carrying costs of one unit.

Graphical representation of EOQ



Example 1: Biotech. Co produces chemicals to sell to wholesalers. One of the raw material it buys is sodium nitrate which is purchased at the rate of $22.50 per ton. Biotech's forecasts show an estimated requirement of 575,000 tons of sodium nitrate for the coming year. The annual total carrying cost for this material is 40% of acquisition cost and the ordering cost is $595. What is the Most Economical Order Quantity?

$$EOQ = \sqrt{2DS / C}$$

D = Annual Demand

C = Carrying Cost

S = Ordering Cost

D = 5,75,000 tons

C =0.40(22.50) = $9.00/Ton/Year

S = $595/Order

$$EOQ = \sqrt{2(5,750,000)(595)/9.00}$$

= 27,573.135 tons per Order.

This model pre supposes certain assumptions as under:

- No safety Stocks available in inventory.
- No Shortages allowed in order delivery.
- Demand is at uniform rate and does not fluctuate
- Lead Time for order delivery is constant
- One order = One delivery no shortages allowed.
- This model does not take into account other costs of inventory such as stock out cost, acquisition cost etc. to calculate EOQ.

In this model, the demand increases for production the inventory gets depleted. When the inventory drops to a critical point the re order process gets triggered. New order is always place for fixed quantities. On receipt of the delivery against the order the inventory level goes up.

Using this model, further data extrapolation is possible to determine other factors like how many orders are to be placed in a year and what is the time lapse between orders etc.

Example 2: The finance department of a Corporation provides the following information:

(i) The carrying costs per unit of inventory are Rs. 10

(ii) The fixed costs per order are Rs. 20]

(iii) The number of units required is 30,000 per year.

Determine the economic order quantity (EOQ) total number of orders in a year and the time gap between orders.

Solution: The economic order quantity may be found as follow

A = 30,000

S = Rs.20

I = Rs.10

Now, EOQ = $(2 \times 30{,}000 \times 20) \div 10)^{1/2}$ = 346 units

So, the EOQ is 346 units and the number of orders in a year would be 30,000/346 = 86.7 or 87 orders. The time gap between two orders would be 365/87 = 4.2 or 4 days.

(III) Just in time system:

It refers to the preoccupation of manufactures with inventory. Literally, the term suggests a system in which products are made 'just in case' they are needed. While it is an overstatement; it serves a useful purpose in highlighting the anomalies of traditional western manufacturing methods.

The just-in-time inventory system, while conceptually very appealing, is difficult to implement because it involves a significant change in the total production and management system. It requires inter alia (1) a strong and dependable relationship with suppliers who are geographically not far off from the manufacturing facility, (2) a reliable transport system, and (3) an easy physical access in the form of adequate doors and conveniently located docks and storage areas to dovetail incoming materials to the needs of assembly line.

Under the just-in time inventory systems, a concentrated effort is made to lower the ordering cost and also the safety stock by forging a stronger relationship with the supplier. As a result, both the components decline and this means that the average inventory level is lower. (just-in-time) process in HMIL is followed by 50% basis.

(IV) FSN analysis:

FSN classification takes into account the pattern of issues from stores. The three letters stand for fast-moving, slow movingand non-moving. This classification comes in very handy when we desire to control obsolescence. Items classified as ‘S’and ‘N’ require attention. There may be several reasons why an item has got into ‘N’ category. There may have been achange in technology or change in the specification or a particular spare part. When a FSN classification is made, all suchinformation stands out prominently, enabling managers to act it in the best interests of the organization.

FSN analysis ensures the following:

1. Periodic review of categorization under F.S.N.
2. Take appropriate action to increase number of orders (frequency) or quantity per order against fast moving items.
3. Close watch of slow moving items.
4. Find alternate use (substation) of slow moving items o that their usage rate can be increased.
5. Take appropriate actions, in time, to dispose of dead stock and prevent their stockpiling.

(V) VED Analysis:

VED stands for vital, essential and desirable. This type of classification is applicable mostly in the case of parts.

The peculiarity about parts is that they do not follow the usual methods outline dealer; we might get into difficulties when the demand pattern suddenly changes.

The VED analysis is used generally for spare parts. The requirements and urgency of spare parts is different from that of materials. A-B-C analysis may not be properly used for spare parts. Spare parts are classified as Vital (V), Essential (E) and Desirable (D). The vital spares are a must for running the concern

smoothly and these must be stored adequately. The non-availability of vital spares will cause havoc in the concern. The E type of spares are also necessary but their stocks may be kept at low figures. The stocking of D type of spares may be avoided at times. If the lead time of these spares is less, then stocking of these spares can be avoided.

1.6 Inventory Turnover

Inventory management as well as Supply chain operations are often overlapping and hold the key to the success of sales operations. In all of the businesses be in automobile, manufacturing, pharma or retail industry, status of inventory reflects the health of the business.

Inventory operations have two key elements namely Inventory System and Physical operations. Today inventory systems have replaced the book keeping and financial accounting that was being practiced earlier. Current inventory systems not only do the book keeping but are linked to upstream as well as downstream activities including procurement, sales processing, and financial accounting.

In terms of measuring a sales performance in relation to Inventory, we often use the term Inventory Turnover. Inventory turnover simply refers to the number of times the inventory is sold or used in a period of one year. Inventory turnover is also termed as stock turn, or stock turnover.

Inventory Turnover is calculated by taking the Total Cost of Goods Sold, divided by Average Inventory. Adding together Beginning inventory and ending inventory and dividing the figure by 2 in turn calculate average Inventory.

The inventory turnover as a measure of health of sales and business is used extensively in Retail, textile as well as FMCG segments. A higher inventory turnover does indicate a healthy trend of increased sales and indicates the need to maintain adequate inventory levels to avoid stock outs. In adequate stocks can

result in loss of business opportunities and is something that the management needs to keep watching closely. On the other hand a lower inventory turnover shows that either the sales of the said inventory is slowing down or that the unused inventory is building up clogging the system somewhere. A slow inventory turn can help the inventory manager focus on finding non-moving, obsolete and slow moving inventory items and thereby steps can be taken to deal with them appropriately.

Inventory turnover also reflects the holding cost that is incurred in managing inventory. Increased inventory turns reduce the holding costs. The costs especially fixed costs like rent and cost of operations get distributed over higher inventory throughput and thereby the cost of inventory transactions reduces.

Inventory turnover is also indicative of the health of inventory operations. When the inventory turnover is higher, the inventory operations efficiency will also be high to meet with the increased operational requirements thereby good housekeeping and increased responsiveness to market requirements.

Inventory turn in some cases or some systems is also calculated based on the numbers sold rather than the average value of inventory. In such a system the Inventory turn is calculated by dividing the Number of Units Sold divided by the Average number of Units inventory held in a given period of time.

Over a number of years, each industry has developed methods to check inventory turnover and industry standards have been standardized. So whenever a new business venture is set up, they are able to have the industry standard as benchmark to be achieved and use it as a guide to streamline operations.

1.7 Inventory Costs

Inventory procurement, storage and management is associated with huge costs associated with each these functions.

Inventory costs are basically categorized into three headings:

- Ordering Cost
- Carrying Cost
- Shortage or stock out Cost & Cost of Replenishment

    a) Cost of Loss, pilferage, shrinkage and obsolescence etc.
    b) Cost of Logistics
    c) Sales Discounts, Volume discounts and other related costs.

1. Ordering Cost

   Cost of procurement and inbound logistics costs form a part of Ordering Cost. Ordering Cost is dependent and varies based on two factors - The cost of ordering excess and the Cost of ordering too less.

   Both these factors move in opposite directions to each other. Ordering excess quantity will result in carrying cost of inventory. Whereas ordering less will result in increase of replenishment cost and ordering costs.

   These two above costs together are called Total Stocking Cost. If you plot the order quantity vs. the TSC, you will see the graph declining gradually until a certain point after which with every increase in quantity the TSC will proportionately show an increase.

   This functional analysis and cost implications form the basis of determining the Inventory Procurement decision by answering the two basic fundamental questions - How Much to Order and When to Order.

   How much to order is determined by arriving at the Economic Order Quantity or EOQ.

2. Carrying Cost

   Inventory storage and maintenance involves various types of costs namely:

- Inventory Storage Cost
- Cost of Capital

Inventory carrying involves Inventory storage and management either using in house facilities or external warehouses owned and managed by third party vendors. In both cases, inventory management and process involves extensive use of Building, Material Handling Equipments, IT Software applications and Hardware Equipments coupled managed by Operations and Management Staff resources.

3. Inventory Storage Cost

Inventory storage costs typically include Cost of Building Rental and facility maintenance and related costs. Cost of Material Handling Equipments, IT Hardware and applications, including cost of purchase, depreciation or rental or lease as the case may be. Further costs include operational costs, consumables, communication costs and utilities, besides the cost of human resources employed in operations as well as management.

Cost of Capital

Includes the costs of investments, interest on working capital, taxes on inventory paid, insurance costs and other costs associate with legal liabilities.

The inventory storage costs as well as cost of capital is dependent upon and varies with the decision of the management to manage inventory in house or through outsourced vendors and third party service providers.

Current times, the trend is increasingly in favor of outsourcing the inventory management to third party service provides. For one thing the organizations find that managing inventory operations requires certain core competencies, which may not be in line with their business competencies. They would rather

outsource to a supplier who has the required competency than build them in house.

Secondly in case of large-scale warehouse operations, the scale of investments may be too huge in terms of cost of building and material handling equipments etc. Besides the project may span over a longer period of several years, thus blocking capital of the company, which can be utilized into more important areas such as R & D, Expansion etc. than by staying invested into the project.

4. Cost of shortage or stock out – This is the estimated or imputed opportunity cost incurred if we do not have materials in stock when the demand arises. This depends upon the consequences of such a situation to arise. If we lost a customer, then it will be the opportunity cost of lost sales. If the demand remains backlogged (or back-ordered), then this will be the penalty cost (if any), loss of goodwill, cost of production or project delays, etc. Estimating the shortage cost is relatively more difficult than the carrying cost, but an approximate estimate is better than ignoring such costs altogether.

1.8 Inventory Audits and Cycle Counts

Any inventory of Raw materials, finished goods as well as Intermediate in process inventory has an economic value and is considered an asset in the books of the company. Accordingly any asset needs to be managed to ensure it is maintained properly and is stored in secure environment to avoid pilferage, loss or thefts etc.

Inventory control assumes significance on account of many factors.

First of all inventory of raw materials as well as finished goods can run in thousands of SKU varieties. Secondly inventory can be in one location or spread over many locations. Thirdly inventory may be with the company or may be under the custody of a third party logistics provider. These factors necessitate inventory maintenance mechanisms to be devised to ensure inventory control.

Inventory control is also required as an operational process requirement. Inventory is has two different dimensions to it. On one level it is physical and involves physical transactions and movement of inventory. While on the other hand, inventory is recognizable by the book stock and the system stocks maintained. This necessitates inventory control mechanism to be implemented to ensure the book stocks and the physical stocks match at all times.

Thirdly the inventory always moves through supply chain and goes through various transactions at various places. The number of transactions and handling that it goes through from the point of origin to the point of destination is numerous. Therefore it becomes essential to control inventory and have visibility through the pipeline including transit inventory.

Inventory control is exercised through inventory audits and cycle counts. An inventory audit essentially comprises of auditing the books stocks and transactions and matching physical stocks with the book stock.

Cycle counts: Cycle count refers to the process of counting inventory items available in physical locations. Depending upon the nature of inventory, number of transactions and the value of items, cycle count can be carried on periodically or perpetually.

1. **Daily Cycle Count:** Normally where the number of SKUs is very high coupled with high number of transactions and through put, daily cycle count is initiated, where in a certain percentage of locations or SKUs are counted on daily basis and physical stock is compared with system stock. By the end of the month all of the stocks would have been covered once in cycle count.

   Inventory system throws up a count list based on an analysis of the movements of fast moving SKUs along with other attributes like value etc. In some of the system, inventory controllers can set up the attributes for each cycle count.

2. **Quarterly & Half Yearly Cycle Counts:** End of the sales quarter or end of half yearly sales, finished goods and spare parts are normally covered under inventory audit and a 100% cycle count is carried out.
3. **Wall to Wall Cycle Count:** End of financial year and closing of books entails doing wall to wall cycle count of all stocks lying in all locations and tallying with books of account. This is a mandatory audit requirement and until stock figures are reconciled, certified by auditors and published, New Year books of accounts cannot be started a fresh.

How the audit process works?

Except for daily cycle counts, all other cycle counts entail counting hundred percent of all the stocks by stopping all transactions during the counting period. System transactions are also frozen until the count is completed.

Inventory system throws up count list with SKU number, description and location number. The operator goes to the location, checks the SKU, counts the quantity available and updates the list, which is then fed into the system. The system reconciles the physical quantity with system quantity and throws up discrepancy report, which is further worked upon to tally and adjust inventory.

1.9 Operational Challenges in Inventory Management

The latest trend in all industries has been to outsource inventory management functions to Third Party Service providers. Companies outsource both Raw Material Inventory as well as Finished Goods to the Service Provider.

In case of finished goods inventory, depending upon the supply chain design, there may be multiple stocking points at national, regional and state levels. In such an event each of the warehouse a different service provider may manage operations, as one may not be able to find a supplier having operations all over the country.

Therefore the inventory in such a situation will be managed in the Company's system as well as in the Service provider's system. Inventory management and control becomes a critical function especially in such situations where multi locations and multiple service providers are involved.

To ensure Inventory control is maintained across all locations, following critical points if focused upon will help:

1. Establish and outline Operations Process for Service Providers: Draw up SOP - Standard Operating Procedure detailing warehouse operations process, warehouse inventory system process as well as documentation process.

   Especially in a 3rd Party Service Provider's facility, it is important to have process adherence as well as defined management, authorization and escalation structure for operations failing which inventory operations will not be under control.

2. Establish inventory visibility at each of the location through MIS Reports: Draw up list of reports and MIS data for all locations and ensure they are mailed to a central desk in the inventory team for daily review. The inventory team leader should analyze daily reports of all locations and highlight any non-conformity and resolve them as well as update the management.
3. Initiate Daily Stock count procedure to be carried out at all of the locations and reported back to the inventory desk.

   Daily stock count should be able to reflect location accuracy, stock accuracy as well as transaction summary for the day.

4. Monthly audits and inventory count should be implemented at all locations without fail and insist on one hundred percent adherence.
5. Quarterly inventory - wall-to-wall count or half yearly and annual wall-to-wall count should be implemented depending upon the volume of transactions as well as value of transactions at each location.

6. Central Inventory team to be responsible for ensuring review of all reports and controlling inventories at all locations.
7. Inventory reconciliation - involves reconciling physical inventory at site with the system inventory at 3PL Site and then reconciling 3PL System stocks with company's system stock.
8. Visiting major sites and being present during physical stock audits on quarterly or half yearly basis is very important.
9. Lastly keep reviewing processes and ensure training and re training is carried out regularly and at all times at site so that a process oriented culture is imbibed and all operating staff understand the importance of maintaining processes as well as inventory health.

Inventory is nothing but money to the company. If 3PL vendor is managing the inventory, needless to say you should have your processes in place to be able to control and maintain inventory health.

1.10 Let's sum-up

Inventory includes and refers to raw material, work in progress and finished goods. Inventory management refers to management of level of these components.

The inventory management involves a tradeoff between costs and benefits of inventory. In a systematic approach to inventory management, a financial manager has to identify (i) the items that are more important than others and (ii) the size of each order for different items.

Two important techniques of deal with the inventory management are ABC Analysis and The Economic Order Quantity (EOQ) model.

The EOQ model attempts to find out the number of units to be ordered every time in order to minimize the total cost of ordering and carrying the inventory.

1.11 Key Terms

Periodic Review System: A classic inventory system where the inventory level is reviewed at a regular time intervals (e.g., once a week), whereupon the decision is made as to how much to order to bring the inventory level up to a given amount

ABC Analysis: An analysis of a range of items that have different levels of significance and should be handled or controlled differently. It is a form of Pareto analysis in which the items (such as activities, customers, documents, inventory items, and sales territories) are grouped into three categories (A, B and C) in order of their estimated importance. 'A' items are very important, 'B' items are important, 'C' items are marginally important.

The reorder point (ROP) is the level of inventory which triggers an action to replenish that particular inventory stock. ... It is normally calculated as the forecast usage during the replenishment lead time plus safety stock.

Lead Time (LT): It is the total time taken from the day procurement action has been initiated to the day the stock is replenished. Lead Time has two components viz. Internal Lead time and External Lead time. Internal Lead time is the time taken between raising the materials requisition request and placing the order. External Lead time is the time taken between placements of an order to actual receipt of the item. Thus, Total Lead time (LT) = Internal Lead time + External Lead time.

Reorder Level (ROL): This is the level at which if the stock of an item falls, in course of its consumption, fresh replenishment action is initiated by way of raising the Materials procurement requisition or Indent.

Review Period (RP): This is the time period defined for an item or a group of similar inventory items, during which a review on whether to raise procurement requisition or not is done. Often, it decides the number of procurement requisitions to be raised during the period

Maximum Limit: When devising a suitable Inventory model, the Maximum limit establishes the upper limit to which the stock of an inventory item shall be allowed.

Minimum Limit: It is the lower limit to which the stock can be allowed to fall in course of replenishment of the stock of an item. Normally, this is taken to be the safety stock also.

Safety Stock: This is the stock that is maintained to counter the variation in demand of an item during the replenishment lead time.

Inventory Turnover Ratio: Measures the return obtained from inventory investments and provides an indication of the movement of materials. Usually expressed as the ratio of annual sales to average inventory investment on hand.

1.12 Self-assessment Questions

1. What is inventory turnover ratio? Why it is important for measurement of performance of inventory controller?

2. Define EOQ. Give an example.

3. Define safety stock. Give one example.

4. Define lead time? Is the time between receiving an indent and receiving quotation covered under lead time? Discuss.

1.13 Further Readings

1. Operations Research by V.K.Kapoor, Sultan Chand and Sons
2. Cost and Management Accounting by Jain &Narnag,Kalyani publishers
3. Financial Management by Prasanna Chandra, Tata McGraw Hill

4.Financial Management by P.N. Reddy, H.R.Appanniaiah, G.Sathyaprasad

5. Materials Management- An Integrated Systems Approach by P. Vrat

6. Inventory Control- Theory & Practice by MK Starr & JW Miller

1.14 Model Questions

1. Write short notes on:

(a) ABC Analysis of inventory control

(b) Economic order quantity

2. Define safety stock. How is it determined? What is the role of safety stock in inventory management?

3. What is the need for holding inventory? Why inventory management is important?

4. Explain briefly techniques of inventory management.

5. What is JIT? Is JIT realizable in a chaotic supply environment?

6. What are different kinds of inventories?

7. Inventory is wastage of money and must be avoided. Discuss.

Unit- 2

Material Handling

Learning Objectives

After completion of the unit, you should be able to learn:

- Definition of material handling
- Objectives and principles of material handling
- Functions, costs included and system concept
- Steps in analyzing material handling problems
- Relationship with other departments
- Basic material handling systems and limitations

Structure

2.1 INTRODUCTION

Raw materials form a critical part of manufacturing as well as service organization. In any organization, a considerable amount of material handling is done in one form or the other. This movement is either done manually or through an automated process. Throughout material, handling processes significant safety and health; challenges are presented to workers as well as management. Therefore, manual material handing is of prime concern for health and safety professional, and they must determine practical ways of reducing health risk to the workers.

Material Handling is the movement, protection, storage and control of materials and products throughout manufacturing, warehousing, distribution, consumption and disposal. As a process, material handling incorporates a wide range of manual, semi-automated and automated equipment and systems that supports logistics and make the supply chain work.

Manual material handling ranges from movement of raw material, work in progress, finished goods, rejected, scraps, packing material, etc. These materials are of different shape and sizes as well as weight. Material handling is a systematic and scientific method of moving, packing and storing of material in appropriate and suitable location. The main objectives of material handling are as follows:

- It should be able determine appropriate distance to be covered.
- Facilitate the reduction in material damage as to improve quality.
- Reducing overall manufacturing time by designing efficient material movement
- Improve material flow control
- Creation and encouragement of safe and hazard-free work condition
- Improve productivity and efficiency
- Better utilization of time and equipment

It is critical for manufacturing organization to identify importance of material handling principle as the critical step in promoting the job improvement process. Manual material handling significantly increases health hazard for the workers in from lower back injuries.

In the current competitive and globalized environment, it is important to control cost and reduce time in material handling. An efficient material handling process promotes:

- Design of proper facility layout
- Promotes development of method which improves and simplifies the work process

- It improves overall production activity.
- Efficient material handling reduces total cost of production.

2.2 Objectives of Material Handling

Material handling relates to the loading, unloading and movement of all types of materials. Today, we have numerous ways by which material handling is done and it is generally classified according to the type of equipment used. Material handling may involve as much as 50 percent of the total production cost of a business's goods. Hence, the objectives of material handling become crucial to the organization.

Cost Reduction:

One of the main objectives of material handling is the reduction of production cost. Material handling can constitute as much as 50 percent of total product cost and effective handling of materials can help minimize this cost. When handling costs are reduced the overall unit cost is reduced as a direct result. Sophisticated management theories, including just-in-time production and supply chain management are primarily concerned with materials handling.

Increasing Warehouse Capacity:

When materials are not stored correctly in a warehouse, much of the facility is being wasted. This wastage adds to the cost of the product. Focusing on efficient storage in terms of cubic as well as floor space becomes important. Minimizing aisle space is also necessary with respect to increasing the amount of storage space. In both cases effective use of material handling will help to reduce warehousing cost of materials.

Improving Layout to Reduce Waste:

A complete analysis of the flow of materials between operations, volumes, flow paths and timing is a must for efficient material handling. When space requirements are optimized and travel times reduced through the use of efficient handling systems and equipment, material handling becomes more cost effective. Further, this will lead to enhanced productivity.

Optimal Equipment Utilization:

Expensive equipment often fails to operate at full potential simply because the material handling system does not permit it to. For example, the rate at which materials are supplied or removed could cause a drop in equipment performance by simply leaving it standing idle. With a proper material handling system in place or more efficient control of an existing system, equipment utilization can soon be maximized.

Increasing Safety:

Safety in any organization is a primary concern and an efficient material handling system can make a direct contribution to the safety of workers, materials and associated equipment. With an efficient system in place, accident costs, lost time and damage to materials, among other things, can be reduced.

Improved Customer Service:
Customer’s service will be improved by following proper and improved materials handling system which will enable regular and timely market supply by avoiding disruption in production schedule. These are the main sources of good customer service.

2.3 Principles of Material Handling

Material handling principles are as follows:

- **Orientation Principle:** It encourages study of all available system relationships before moving towards preliminary planning. The study includes looking at existing methods, problems, etc.
- **Planning Principle:** It establishes a plan which includes basic requirements, desirable alternates and planning for contingency.
- **Systems Principle:** It integrates handling and storage activities, which is cost effective into integrated system design.
- **Unit Load Principle:** Handle product in a unit load as large as possible
- **Space Utilization Principle:** Encourage effective utilization of all the space available
- **Standardization Principle:** It encourages standardization of handling methods and equipment.
- **Ergonomic Principle:** It recognizes human capabilities and limitation by design effective handling equipment.
- **Energy Principle:** It considers consumption of energy during material handling.
- **Ecology Principle:** It encourages minimum impact upon the environment during material handling.
- **Mechanization Principle:** It encourages mechanization of handling process wherever possible as to encourage efficiency.
- **Flexibility Principle:** Encourages of methods and equipment which are possible to utilize in all types of condition.
- **Simplification Principle:** Encourage simplification of methods and process by removing unnecessary movements
- **Gravity Principle:** Encourages usage of gravity principle in movement of goods.
- **Safety Principle:** Encourages provision for safe handling equipment according to safety rules and regulation
- **Computerization Principle:** Encourages of computerization of material handling and storage systems
- **System Flow Principle:** Encourages integration of data flow with physical material flow

- **Layout Principle:** Encourages preparation of operational sequence of all systems available
- **Cost Principle:** Encourages cost benefit analysis of all solutions available
- **Maintenance Principle:** Encourages preparation of plan for preventive maintenance and scheduled repairs
- **Obsolescence Principle:** Encourage preparation of equipment policy as to enjoy appropriate economic advantage.

Material handling operations are designed based upon principles as discussed above. Material handling equipment consists of cranes, conveyors and industrial trucks.

2.4 Functions of Materials Handling:

The basic function of material handling-the movement of material- is as old as man, but the need of materials handling developed from the development of factory system, which started from the industrial revolution which took place in late eighteenth and early nineteenth centuries.

The industries, supermarket, offices, construction projects and the banks—all are engaged in moving things. In early days man was physically handling the material, however over a period of years he has started applying mechanical principles like lever, wheel, pulley etc.

The material handling, though does not add value to a product, it generally adds significant element of cost. Material handling generally costs between 20 to 35% of the cost of the product, with certain exceptions. Earlier, it was a general belief that most of this cost is inevitable and cannot be easily avoided, but now-a-days need for reduction in materials handling costs through systems approach is being realised.

Not only cost, majority of production time is also consumed in handling materials before, during and after the manufacture. The materials handling time and cost can be reduced by proper selection, operation, maintenance and layout of these handling devices.

The materials handling problem must be studied at the time of planning of various machines and tools to be required and before the erection of factory building. Materials handling is a prime consideration in designing new plants, and existing plants can also be modify by the application of modern materials handling devices. These devices increase output, improve quality, speed up the deliveries and therefore, reduces the production cost.

2.5 Costs Included in Material Handling:

Materials handling includes following costs:
Materials handling cost = cost of handling + cost of transportation + cost of packaging + cost of space + cost of handling equipment including operation, maintenance and depreciation etc.

In any industry materials handling is of following 3 types:
1. Handling of individual part or unit by men,

2. Handling in room, department, or plant

3. Handling of materials during the entire process of production and distribution, starting from raw material source, going through the factory and distribution network to the ultimate customer and beyond, to waste disposal and recycling.

This can be shown as below:
Raw material → Supplier → Transportation → Receiving → Storing → Issue → Manufacturing or fabrication → Packaging → Shipping → Dealer or Distributors warehouse → Retailers → Customer → Disposal → Recycling.

Since materials handling is concerned with the movement of materials, every movement has following elements:

1. Picking up the load,

2. Transporting the load, and

3. Setting the load down.

2.6 Systems Concept for Materials Handling:

Systems concept for materials handling means, adopting a materials handling system from overall optimization point of view. This means that it is not necessary to buy the latest materials handling equipment, materials handling engineer must put all the elements of the system together to see whether it is profitable for the enterprise.

He must analyze to ensure the objective of least total cost of handling. Materials handling engineer must have basic criteria for selecting a handling system of adequate monetary pay back, if all other things are equal.

Systems approach for materials handling demands that all elements of problem, its cause and effect be analyzed so as to accomplish to desired objectives.

Systematic analysis should lead to solutions which satisfy the following important conditions:

1. There should not be any other problem created by the new system proposed to be implemented.

2. Amount of return on investment must justify the proposed handling system.

3. The system must take care for reasonably long period of time, and that it must permit expansion or modification without much cost and difficulty.

4. The new system must be simple to implement so that it is easily acceptable by management as well as by operators.

In short the new handling system must have technique and method which can easily fit the existing system and has least total cost of the system and meets the ultimate objective of the materials handling.

By following the systems approach, materials handling engineer must achieve the following:

1. Increase the production effectiveness by having right quantity of material, at right places at the right time, by avoiding delays and following the orderly flow of material or item. This helps in improving the productivity.

2. Minimize unnecessary labour and make the enterprise more profitable.

3. Reduce damage due to materials handling and thus saves expenditure due to scrap and rework. This can be achieved only if we have sufficient data related to the damages e.g., identification of product or item, whether in transportation, storing, picking or setting down, packaging material or method, type of container etc.

4. Reduce accident rates.

5. Effective utilization of space by proper layout planning.

2.7 Steps in Analyzing Materials Handling Problems

Following factors should be studied to analyze the materials handling problems:

1. Establish the scope of the study.

2. Pinpoint the areas of plant layout to be covered by the study.

3. Determine volume expected to be handled per unit time by the new system.

4. Nature and type of the materials to be handled.

5. Determine the handling cost of the items being handled by the present system.

6. Determine details of distance to be moved, with details of curves, slopes etc.

7. Determine, how to move the material i.e., in tray, bundles, pallets etc.

8. Determine the details of the equipment used viz., capacity, speed, flexibility etc.

9. Determine the time taken for the movement.

10. A thorough survey should then be made considering the systems approach.

11. Alternative systems should then be evaluated from all angles including financial, physical, safety, acceptance by the management and operators, and its effects on working, safety and overall environment.

2.8 Activity Areas of Materials Handling:

For effective materials handling, materials handling engineer must look after handling work in different areas, some of them are:

1. Packaging and packing of raw material for the industry.

2. Loading and transportation to the plant.

3. Unloading activities.

4. Receiving, storage and issue of material for production.

5. In-process handling.

6. In-process storage.

7. Work-place handling.

8. Infra-departmental handling.

9. Inter-departmental handling.

10. Intra plant handling.

11. Packaging.

12. Warehousing.

13. Packing.

14. Loading and transportation to customers/ distributors/ dealers place.

2.9 Relationship of Materials Handling with Other Departments:

In the past materials handling was neglected and due importance was not given to this function in the industries. This was simply due to lack of awareness on the part of management. But now a day this aspect is being given its due importance and materials handling engineers play a vital role in the industries.

In order to carry out the functions of materials handling, the personnel of this department work in close association with other departments of the enterprise, such as with the following:

1. Purchasing Department:

To facilitate in deciding the size of order, packaging, packing and transportation system from suppliers place to the plant.

2. Stores Department:

Handling and storage of materials and supplies is determined by the characteristics of the items and the nature of storage methods.

3. Production Control Department:

Handling department must cooperate with production control department in following fields:

(a) Directing path of material movement.

(b) Moving material in lots or containers of predetermined sizes.

(c) Making optimum use of mechanical handling in picking, accumulation and loading.

(d) Meeting production requirement with the handling equipment.

(e) Materials handling system itself must incorporate features of production control, inventory control and accounting.

(f) Moving materials as per schedule and to avoid rush deliveries, partial loads or duplicate moves.

4. Industrial Engineering Department:

Since materials handling function is a division of the broad field of industrial engineering, materials handling engineer has to work in close cooperation with other industrial engineers dealing different functions, e.g.;

(a) With the process engineering in designing the manufacturing process to establish line balancing, in-process handling, and storage operations.

(b) With the methods engineering in designing the individual work places, the methods used in performing the operations.

(c) With the work standards personnel in establishing work standards for materials handling operations for using as the basis of incentive schemes for material handlers.

(d) With plant layout personnel in developing the overall flow pattern and the arrangement of the facilities in the plant.

2.10 Basic Materials Handling Systems:

1. Equipment Oriented Systems:
(a) Industrial Truck Systems: Platform trucks and skids, fork trucks and pallets, and tractor-trailers.

(b) Conveyor systems.

(c) Overhead systems: Overhead cranes, and monorails.

2. Material (Load) Oriented Systems:
(a) Unit handling system.

(b) Bulk handling systems: conveyors, power shovels, scoops, cranes, draglines, and construction equipment.

(c) Liquid material handling systems.

3. Method (Production) Oriented Systems:
These are described in terms of the types of production in which they are used:
(a) Manual system.

(b) Mechanized or automated systems,

(c) Mass production handling systems.

(d) Job shop handling systems.

4. Function Oriented Handling Systems:
(a) Transportation systems: For horizontal motion.

(b) Elevating systems: For vertical motion over vertical or steeply inclined routes.

(c) Conveying systems: Horizontal, vertical or combined motions.

(d) Transferring systems: Horizontal, inclined or declined motions through the air.

(e) Self-loading systems: Intermittent motion with machines that pick up, move and set down, i.e., unit load systems.

2.11 Key Benefits of an Integrated Material Handling System

An integrated system connects all material handling equipment and software in order to support all aspects of the production cycle, including receiving, processing, storage, picking and shipping. By connecting all these components, a well-engineered integrated material handling system can help in the following areas:

- Improve customer service
- Reduce inventory excesses
- Shorten delivery times
- Lower overall handling costs in manufacturing, distribution and transportation
- Enhance handling through streamlining and better timing
- Facilitate product control through better monitoring and management

- Improve inventory management and the accuracy of information through real-time monitoring

2.12 Limitations of Material Handling:

While evaluating a material handling system its disadvantages must also be considered.

Some of the disadvantages are:

1. Additional capital investment.

2. Loss of flexibility:
A mechanical system is generally designed for a particular size, shape, volume and for a particular sequence of operation and hence it is difficult to change, and require additional cost for modification for likely range of changes in the product or production techniques.

3. Breakdown:
Being mechanical and electrical system, the handling system may breakdown at times, and may take some time for repairs.

4. Every mechanical handling system requires timely maintenance, which means addition of skilled maintenance manpower, maintenance spares, cost of maintenance time required for servicing and arrangement during this period to continue production.

2.13 Let's sum-up

The material handling is important activity in the logistics system. The speed of the materialflow across the supply chain depends on the type of the material

handling equipment and thesophistication in the system. In the logistics operation the material handling system isdesigned in and around the warehouse. Commonly, the following material handling operationsare performed in the warehouse, unloading the incoming material from transport equipment,moving the unloaded material to the assigned storage place, lift the material from its storageplace during order picking, move the material for inspection and packing, and load thepackages on to the transport vehicle. These operations are performed using manual,mechanized or computerized controlled material handling equipment. The mechanized systemshifts the fatigue to machine and brings effectiveness to human efforts. The selection of theappropriate system depends on the factors such as volumes to be handled, speed in handling,product characteristics (weight, size, shape) and nature of the product (hazardous, perishable,crushable). The prime consideration before going in for mechanized material handling systemsis the layout of the warehouse. The investment in the material handling system will be sheerwaste if it is not compatible to the warehouse layout plan. The layout will create the obstaclesfor the free movement of equipment and the goods. The mechanized equipment requires thespace for the free movement across the warehouse. They should have the accessibility tostorage area for material loading and unloading during storage and retrieval. In themechanized version the variety of equipment are used for the specific application. The rangecovers common types are wheeled trolleys, forklift trucks, conveyors, cranes, towlines andcarousal etc. The more sophisticated systems such as robotics, automatic storage & retrievaland automatic guided vehicles systems are used in semi or fully automatic warehouses forspeedy material movement.

2.14 Key Terms

Drive- Through Racks: Are similar to drive-in racks in that they allow the fork truck and pallet to enter the rack structure and place the pallet on rails. However, the drive through rack is not obstructed at the end by bracing, but gets its rigidity

from its own overhead bracing or by tying into the overhead structure. FIFO movement is possible with drive through racks whereas FILO movement must usually be acceptable with drive through racks.

Hand Pallet Truck: A truck designed to lift loads off the floor high enough to move them from one location to another. Positioning of the truck is by hand. The lifting surface can be a platform or forks. The platform unit is used for handling skids and the fork type unit for handling pallets.

Pull Cord Switch: A switch (or switches in a long conveyor) mounted along a conveyor stringer and manually actuated by a cord running the full length of the conveyor. The switch (or switches) may be actuated from any point along the conveyor length as an emergency stop.

Quite Zone: A clear space, containing no dark marks, that precedes the start character of a bar code symbol and follows the stop characters. Sometimes called the 'clear area'.

Conveyor system: A conveyor system is a common piece of mechanical handling equipment that moves materials from one location to another. Conveyors are especially useful in applications involving the transportation of heavy or bulky materials. Conveyor systems allow quick and efficient transportation for a wide variety of materials, which make them very popular in the material handling and packaging industries. Many kinds of conveying systems are available and are used according to the various needs of different industries. There are chain conveyors (floor and overhead) as well. Chain conveyors consist of enclosed tracks, I-Beam, towline, power & free, and hand pushed trolleys.

Manual handling: Manual handling refers to the use of a worker's hands to move individual containers by lifting, lowering, and filling, emptying, or carrying them. Ergonomic improvements can be used to modify manual handling tasks to reduce injury. These improvements can include reconfiguring the task and using positioning equipment like lift/tilt/turn tables, hoists, balancers, and manipulators to reduce reaching and bending.

Automated handling: Whenever technically and economically feasible, equipment can be used to reduce and sometimes replace the need to manually handle material. Most existing material handling equipment is only *semi-automated* because a human operator is needed for tasks like loading/unloading and driving that are difficult and/or too costly to fully automate, although ongoing advances in sensing, machine intelligence, and robotics have made it possible to fully automate an increasing number of handling tasks.

2.15 Self-assessment Questions

1. Mention three automatic material handling equipments and discuss their uses.

2. Where manual handling is recommended and why?

3. Discuss the role of Purchase department in material handling support.

2.16 Further Readings

1. Supply chain management- Strategy, cases and best practices by DK Agarwal

2. Material Handling Handbook, 2nd Edition by Raymond A Kulwiec

2.17 Model Questions

1. What is meant by material handling? Discuss its objectives in supply chain.

2. Write a note on the various principles of material handling laid down for its design and facility.

3. Discuss the various mechanized material handling equipments with their scopes.

Unit- 3

Warehousing

Learning Objectives

After completion of the unit, you should be able to:

- Understanding Warehousing elements
- Understand the importance of warehousing
- Know the functions of warehousing
- Understand Warehouse layout
- Know the importance of warehousing in Trade & development
- Know Warehouse Management System (WMS)

Structure

3.1 INTRODUCTION

Warehousing is the act of storing goods that will be sold or distributed later. While a small, home-based business might be warehousing products in a spare room, basement, or garage, larger businesses typically own or rent space in a building that is specifically designed for storage.

We might hear “warehouse” and “distribution center” used interchangeably, but technically, a warehouse provides nothing more than storage. A distribution center, on the other hand, stores product but also fulfills orders.

- Warehousing played a role in the storage and exchange of goods for centuries. Long-term storage to provide product for future consumption has been a utility of warehousing both past and present. Transit sheds, warehouses connected to a wharf, have facilitated the movement and storage of goods embarking or disembarking merchant and military vessels supplying domestic and world trade. Rail transportation set in motion the industrial era with the transport of agriculture commodities and livestock; warehousing was leveraged to store such cargo prior to processing and then distribute finished products traveling to the destinations.
- With the proliferation of computers, information exchange in the late 20th century became a game-changer in the way warehouses collected, transmitted, and utilized data and information within facilities and with warehouse customers. Perhaps computers came about in such good time to enable warehouse operators better control over the increasing variety of products demanded by consumers.

3.2 Warehousing Elements

Whether the purpose is strictly storage or storage plus order fulfillment, warehouses use specific elements that help manufacturers, distributors, and retailers monitor inventory and store it safely. An overview of basic elements includes:

- Shelving and rack systems that offer maximum storage capacity and easy product access.

- A climate control system for the product being stored. This is particularly important for frozen products or those requiring refrigeration, including certain pharmaceutical or laboratory products, and others that degrade if exposed to too much heat.
- Inventory control software that tells the product owner – who isn't necessarily the building owner – where all individual units are in the system at all times.
- Equipment that can move products from point A to point B – forklifts, pallet jacks, bins that hold products for orders, and conveyor belts, for example.
- Shipping supplies for order fulfillment.
- People who load products into a warehouse and others ("pickers") who fill orders in a true distribution center, plus those who manage the facility and operation.
- Security to protect stored products.
- Access to cost-effective transportation to bring products in or move them out as orders are fulfilled. That often means easy access to interstates, rail lines, or airports.

3.3 The Importance of Warehousing in a Logistics System

Warehousing and warehouse management are part of a logistics management system, which is itself a component in supply chain management. Although viewed by some as simply a place to store finished goods, inbound functions that prepare items for storage and outbound functions that consolidate, pack and ship orders provide important economic and service benefits to both the business and its customers

Central Location

A warehouse provides a central location for receiving, storing and distributing products. As each inbound shipment arrives, responsibility for the goods transfers to warehouse personnel, products are identified, sorted and dispatched to their temporary storage location. Storage isn't a static "thing" but rather a process that includes security measures and maintaining an environment that preserves the integrity and usefulness of the items. Once it's time to move items,

each order is retrieved, grouped, packaged and checked for completeness before being dispatched to their new destination.

Value-Adding Operation

The objective of a logistics system is to reduce cycle times and overall inventories, lower costs and most importantly, improve customer service. Warehousing increases the utility value of goods by providing a means to have the right products available at the right place in the right time. Operations such as order consolidation, order assembly, product mixing and cross-docking that take place within the warehouse structure also add value to the overall logistics system.

Economic Benefits

Warehouses provide an economies of scale through efficient operations, storage capacity and a central location. Economic benefits are realized, for example, through consolidation and accumulation operations. Consolidation operations cut outbound delivery costs for both the business and its customers. Instead of shipping items individually from multiple sources, items are delivered to a central warehouse, packaged together and shipped back out as a complete order. Accumulation operations allow a warehouse to act as a buffer, balancing supply and demand for seasonal and long-term storage. This can be vital to business profitability when demand for a product is year-round but the product may only be available at certain times of the year.

Service Benefits

Warehouses can serve as part of a contingency plan to ensure outbound orders are filled in full and on time. A practice called safety stocking allows businesses to maintain a predetermined number of inventory items at its warehouse. On the inbound side, safety stocking means that an emergency such as a transportation delay or a shipment containing defective or damaged goods won’t delay filling and shipping customers order. On the outbound side, safety stocking is insurance against out-of-stock items.

3.4 Functions of Warehousing:

The function of storage can be carried out successful with the help of warehouses used for storing the goods. Warehousing can also be defined as assumption of responsibility for the storage of goods. By storing the goods throughout the year and releasing them as and when they are needed, warehousing creates time utility.

1. Storage:

This is the basic function of warehousing. Surplus commodities which are not needed immediately can be stored in warehouses. They can be supplied as and when needed by the customers.

2. Price Stabilization:

Warehouses play an important role in the process of price stabilization. It is achieved by the creation of time utility by warehousing. Fall in the prices of goods when their supply is in abundance and rise in their prices during the slack season are avoided.

3. Risk bearing:

When the goods are stored in warehouses they are exposed to many risks in the form of theft, deterioration, exploration, fire etc. Warehouses are constructed in such a way as to minimize these risks. Contract of bailment operates when the goods are stored in wave-houses.

The person keeping the goods in warehouses acts as boiler and warehouse keeper acts as boiler. A warehouse keeper has to take the reasonable care of the goods and safeguard them against various risks. For any loss or damage sustained by goods, warehouse keeper shall be liable to the owner of the goods.

4. Financing:

Loans can be raised from the warehouse keeper against the goods stored by the owner. Goods act as security for the warehouse keeper. Similarly, banks and other financial institutions also advance loans against warehouse receipts. In this manner, warehousing acts as a source of finance for the businessmen for meeting business operations.

5. Grading and Packing:

Warehouses nowadays provide the facilities of packing, processing and grading of goods. Goods can be packed in convenient sizes as per the instructions of the owner.

3.5 Planning and Optimizing Warehouse Layout

The layout of a warehouse may need to be changed to accommodate new product lines or to add greater flexibility to the warehouse operations. When a new warehouse layout is proposed a detailed planning process should be followed to ensure the success of the project. The planning process should include the following six steps.

Define Objectives

When deciding on the layout for a warehouse, the objectives should clearly be defined. The objectives should be aligned with the overall warehousing strategy of the company. Objectives can be defined at a high level such as to reduce warehousing costs or to provide maximum customer service. Equally, the objectives can be more specific, such as maximizing warehousing space, providing maximum flexibility in the warehouse, or increasing warehousing efficiency without increasing resources.

Collect Information

The specific information of the proposed warehouse should be collected. This includes the specifications of the warehouse from the architectural drawings that can affect storage and material handling. The details should include a physical map of the warehouse space to show columns, doors, height restrictions, docks and storage racks. External features that can affect the receiving, storage and shipment of materials should also be noted.

Analysis

After the specific information about the warehouse has been collected the analysis can commence with respect to the objectives that have been defined for the warehouse layout. The analysis should determine if the overall objectives can be met and if not how the objectives can be modified. At this point in the planning process, decisions need to be made by warehouse management to determine what actions need to be taken if the overall objectives cannot be met or will need substantial changes.

Create Plan

The detailed implementation plan should show all the steps that are required to create the warehouse layout. The objectives and the analysis of the information gathered should be used in creating the plan. The plan should first be at a high level showing the major tasks and then each of those should be sub-divided into the individual tasks that are required. Each task should be reviewed and an allocated the appropriate resources, as the allocation of estimated time required to complete the task. The plan should indicate when a task is required to start and finish based on the availability of resources, either internal or outside contractors, or if it is dependent on another task. The plan should be checked to ensure that all dependencies have been correctly linked. Once the plan has been created it should be checked to see if the timeline is attainable and if there are enough resources are available.

Implementation

Sometimes the warehouse layout that is implemented is not the one that is in the plan. This can occur due to unrealistic timelines in the plan, lack of resources, unavailability of outside contractors or poor analysis of the information that was gathered.

To ensure that the plan for the warehouse layout is achieved the implementation should be timed so that there is little or no movements of materials in the warehouse. An ideal time for this would be during a plant shutdown or at a weekend if the implementation was of a smaller size. However in modern warehouses, this is not always possible so often additional warehouse resources are needed to keep shipping products during the implementation. If this is the case then this will need to be factored into the plan. The implementation should ensure that all changes made in the warehouse are replicated in the warehouse management system that is operated so that each item can be found. A physical inventory of the products in the warehouse after implementation should be carried out to ensure that the system accurately reflects the warehouse.

Post Implementation

After the layout has been implemented, there should be a series of checks to ensure that the layout is exactly as defined by the approved drawings. Every item should be stored according to the overall plan and this should be checked to ensure the layout is correct. If there are errors, this could lead to picking errors or lost material within the warehouse. Shipping could be disrupted if the warehouse systems have not been updated accurately with the correct layout information or if items have been stored in the wrong locations. For a period of time after the new layout has been implemented, regular checks should be made to ensure that the layout is working and that there are no operational problems that have occurred due to the new layout.

3.6 Importance of Warehousing In the Development of Trade and Commerce:

Warehousing or storage refers to the holding and preservation of goods until they are dispatched to the consumers. Generally, there is a time gap between the production and consumption of products. By bridging this gap, storage creates time utility.

There is need for storing the goods so as to make them available to buyers as and when required. Some amount of goods is stored at every stage in the marketing process. Proper and adequate arrangements to retail the goods in perfect condition are essential for success in marketing. Storage enables a firm to carry on production in anticipation of demand in future.

A warehouse is a place used for the storage or accumulation of goods. It may also be defined as an establishment that assumes responsibility for the safe custody of goods. Warehouses enable the businessmen to carry on production throughout the year and to sell their products, whenever there is adequate demand.

Need for warehouse arises also because some goods are produced only in a particular season but are demanded throughout the year. Similarly certain products are produced throughout the year but demanded only during a particular season. Warehousing facilitates production and distribution on a large scale.

3.7 What is the role of Warehousing in the supply chain?

Warehousing refers to the activities involving storage of goods on a large-scale in

a systematic and orderly manner and making them available conveniently whenever the need arises. In other words, warehousing means holding or preserving goods in huge quantities from the time of their purchase or production till their actual use or sale.

- Warehousing is one of the important components of any trade. It creates time utility by bridging the time gap between production and consumption of goods.

- Warehousing is an important element of activity across the supply chains, in the distribution of goods that may vary from raw materials to finished products.

- Warehouse allow transport optimization along the supply chain, and allow companies to work with an optimal inventory regarding service quality.

- Nowadays there are many companies who provide warehousing facilities. This includes a wide range of integrated warehouse storage services such as storage, consolidation, re-parking, documentation, labeling, invoicing, finished and spares inventory management, distribution and service support, cross-stuffing, etc. Many Warehousing Companies in India are well equipped with the right cutting edge technology and expertise which is needed to simplify the process of warehousing.

3.8 Type of Warehouses:

There are three types of warehouses as described below:

Private Warehouses:

The private warehouses are owned and operated by big manufacturers and merchants to fulfill their own storage needs. The goods manufactured or purchased by the owner of the warehouses have a limited value or utility as businessmen in general cannot make use of them because of the heavy investment required in the construction of a warehouse, some big business firms which need large storage capacity on a regular basis and who can afford money,

construct and maintain their private warehouses. A big manufacturer or wholesaler may have a network of his own warehouses in different parts of the country.

Public Warehouses:

A public warehouse is a specialized business establishment that provides storage facilities to the general public for a certain charge. It may be owned and operated by an individual or a cooperative society. It has to work under a license from the government in accordance with the prescribed rules and regulations.

Public warehouses are very important in the marketing of agricultural products and therefore the government is encouraging the establishment of public warehouses in the cooperative sector. A public warehouse is also known as duty-paid warehouse.

Public warehouses are very useful to the business community. Most of the business enterprises cannot afford to maintain their own warehouses due to huge capital Investment. In many cases the storage facilities required by a business enterprise do not warrant the maintenance of a private warehouse. Such enterprises can meet their storage needs easily and economically by making use of the public warehouses, without heavy investment.

Public warehouses provide storage facilities to small manufacturers and traders at low cost. These warehouses are well constructed and guarded round the clock to ensure safe custody of goods. Public warehouses are generally located near the junctions of railways, highways and waterways.

They provide, therefore, excellent facilities for the easy receipt, despatch, loading and unloading of goods. They also use mechanical devices for the handling of heavy and bulky goods. A public warehouse enables a businessman to serve his customers quickly and economically by carrying regional stocks near the important trading centres or markets of two countries.

Public warehouses provide facilities for the inspection of goods by prospective buyers. They also permit packaging, grading and grading of goods. The public warehouses receipts are good collateral securities for borrowings.

Bonded Warehouses:
Bonded warehouses are licensed by the government to accept imported goods for storage until the payment of custom duty. They are located near the ports. These warehouses are either operated by the government or work under the control of custom authorities.

The warehouse is required to give an undertaking or 'Bond' that it will not allow the goods to be removed without the consent of the custom authorities. The goods are held in bond and cannot be withdrawn without paying the custom duty. The goods stored in bonded warehouses cannot be interfered by the owner without the permission of customs authorities. Hence the name bonded warehouse.

Bonded warehouses are very helpful to importers and exporters. If an importer is unable or unwilling to pay customs duty immediately after the arrival of goods he can store the goods in a bonded warehouse. He can withdraw the goods in installments by paying the customs duty proportionately.

In case he wishes to export the goods, he need not pay customs duty. Moreover, a bonded warehouse provides all services which are provided by public warehouses. Goods lying in a bonded warehouse can be packaged, graded and branded for the purpose of sale.

3.9 What is a Warehouse Management System?

A Warehouse Management System (WMS) is a software application specializing in supporting the day to day operations within a warehouse. The application does this by allowing the users to have a centralized system where different

warehouse management tasks are managed through an interface on a handheld device or a tablet working in the warehouse or a desktop in the office. This makes running a warehouse both efficient and easy, and also ensures that minimal if any losses occur in the different warehouse processes. The real gain is in customer service. Imagine knowing exactly where every product is, knowing when to re-order, and how much to re-order or produce. These things seem like a business goal, but for a customer it means they can get the product faster, without backorders or errors, so they are more likely to return.

A warehouse management system is used to control and track the transfer and storage of materials in a warehouse. The system involves a number of processes that are important when shipping, receiving, or even putting away materials and integrates with other systems in the supply chain to ensure data transparency throughout your enterprise.

Receiving goods

The WMS provides a simple process that is to be followed when handling a shipment that has arrived at the warehouse. The process can be customized to suit different users' requirements but its core function is to ensure that all shipments are handled properly to minimize on losses and also save on time.

Tracking inventory

A WMS enables warehouse owners to keep a tab of all the stock in the warehouse. This is important because it ensures that the warehouse management team is able to know when there is enough stock in the warehouse and know when to order for more stock to prevent shortages. This saves on space as overstocking is prevented and also ensures that resources are well distributed to ensure a smooth warehouse management.

Slotting for Efficiency

A WMS enables users to model an efficient way of storing different products in a warehouse depending on different factors like demand and weight. This ensures that the warehouse is arranged in such a way that products that move faster or

are heavier are stored close to the door for faster processing of orders, and products that are used together are stored in close proximity. This makes running the warehouse easy and efficient.

Labor visibility

The WMS system eliminates the need to get more labor to undertake some of the functions that are managed at a central point in WMS. Probably the biggest labor savings is eliminating full inventory counts which can often happen monthly or even weekly. A WMS can allow you to do periodic cycle counts without interfering with day to day operations. Reducing on labor can obviously greatly cut back on expenditure simply because the system is not labor intensive.

Document preparation

A WMS automates most of the different processes, eliminating the need for paper documents that are bulky, and eat up quite a huge chunk of money when it comes to purchasing them and storing them appropriately. By giving visibility to the system to everyone simultaneously, everyone has the data needed to do their job at their fingertips.

Picking and Shipping

A proper WMS ensures that the right product is picked based on your business rules (LIFO or FIFO). A good WMS will make sure that the right orders are shipped to the right people at the right time. With this accuracy, the mistakes that can arise when transporting goods are avoided and ends up as a more efficient and less costly transport system.

Customer service

A WMS improves the overall customer service by ensuring that orders are received and processed on time, and the right products are delivered to all customers when and where they need them. The quality of products is maintained enabling users to retain their customers and attract new ones.

Tracking and Visibility

For industries that require advanced tracking capabilities, a WMS will allow you to track lot information, expiry dates, UPC, and serial numbers. Each data point adds to the cost to maintain, but often comes with great returns when advanced visibility is required. Recalls and warranty issues are quickly resolved by solving the root problem through trace back instead of just a payout to the customer.

Reporting

The best Warehouse Management Systems will be in an easy to use database, like Microsoft SQL and include many reports out of the box. One hidden advantage to having systems is the ability to look at data in new and exciting ways. What percentage of your warehouse is utilized? Should you expand, or find a smaller space? How many transactions are each employee doing per hour? Can you reduce headcount? Can you negotiate better rates with your parcel service based on your cube and weight throughput? Is your pick path setup to be as efficient as possible for your pickers?

3.10 Benefits from Warehouses:

1. Regular production:

Raw materials need to be stored to enable mass production to be carried on continuously. Sometimes, goods are stored in anticipation of a rise in prices. Warehouses enable manufacturers to produce goods in anticipation of demand in future.

2. Time utility:

A warehouse creates time utility by bringing the time gap between the production and consumption of goods. It helps in making available the goods whenever required or demanded by the customers.

Some goods are produced throughout the year but demanded only during particular seasons, e.g., wool, raincoat, umbrella, heater, etc. on the other hand,

some products are demanded throughout the year but they are produced in certain region, e.g., wheat, rice, potatoes, etc. Goods like rice, tobacco, liquor and jaggery become more valuable with the passage of time.

3. Store of surplus goods:

Basically, a warehouse acts as a store of surplus goods which are not needed immediately. Goods are often produced in anticipation of demand and need to be preserved properly until they are demanded by the customers. Goods which are not required immediately can be stored in a warehouse to meet the demand in future.

4. Price stabilization:

Warehouses reduce violent fluctuations in prices by storing goods when their supply exceeds demand and by releasing them when the demand is more than immediate productions. Warehouses ensure a regular supply of goods in the market. This matching of supply with demand helps to stabilize prices.

5. Minimization of risk:

Warehouses provide for the safe custody of goods. Perishable products can be preserved in cold storage. By keeping their goods in warehouses, businessmen can minimize the loss from damage, fire, theft etc. The goods kept in the warehouse are generally insured. In case of loss or damage to the goods, the owner of goods can get full compensation from the insurance company.

6. Packing and grading:

Certain products have to be conditioned or processed to make them fit for human use, e.g., coffee, tobacco, etc. A modern warehouse provides facilities for processing, packing, blending, grading etc., of the goods for the purpose of sale. The prospective buyers can inspect the goods kept in a warehouse.

7. Financing:

Warehouses provide a receipt to the owner of goods for the goods kept in the warehouse. The owner can borrow money against the security of goods by

making an endorsement on the warehouse receipt. In some countries, warehouse authorities advance money against the goods deposited in the warehouse. By keeping the imported goods in a bonded warehouse, a businessman can pay customs duty in installments.

3.11 Today’s Warehouse plays a new role

Warehouses are no longer just for storage. In today's cost-conscious, efficiency-driven environment, many manufacturers are reevaluating their definition of warehousing. Anything that doesn't lend itself to a high-speed, highly mechanized, low-labor environment is being sent to the warehouse.

Driving this evolution is a desire to take links out of the supply chain and make sure that costs are optimized and as close to the customer as possible.

INNOVATIVE WAREHOUSE USES

As a result of this shift, manufacturers are gradually expanding the services they expect from their warehousing providers, seeking ways to increase flexibility, improve inventory control, manage costs, and streamline the supply chain.

Four services, in particular, are drawing considerable interest:

1. Shared space environment. Companies with dramatic seasonal or promotional fluctuations face unique warehousing challenges. They don't want to invest in space that they can't fill year-round, but they must accommodate business surges. A shared space environment accommodates shipping peaks and valleys by balancing multiple manufacturers' requirements with complementary surges.

To manage this arrangement, a third-party provider analyzes shippers' space requirements and identifies peak periods of activity. Shippers with peaks at opposite times of the year can be paired in a single facility. For example, a sunscreen manufacturer might be paired with a holiday gift basket company.

The companies' operations are located at opposite ends of the building and ebb and flow toward the middle as required. Both companies are guaranteed additional overflow space, but only pay for the space as they need it. They're able to meet maximum requirements and accommodate business growth without having to invest in permanent space and equipment. Locating the facility in an optimal location also helps minimize transportation costs and maximize responsiveness to customer needs.

2. Secondary packaging. Many manufacturers also want to bring functions such as secondary packaging closer to the customer to give them the flexibility to accommodate seasonal fluctuations or delay product configuration until the last minute to meet current demand.

Approximately 40 percent of manufacturers currently outsource some or all of their secondary packaging services, according to the 2009 Secondary Packaging Outsourcing Report, sponsored by Saddle Creek Corporation. Increased flexibility and reduced costs are the top benefits reported.

Whether it's assembling a back-to-school point of purchase promotion, adding a colored face plate to a cell phone, shrink-wrapping a rainbow pack of sports drinks, or formatting computer disks with the latest software, outsourcing secondary packaging services allows manufacturers to meet customer needs and increase efficiency without increasing overhead. The move can also reduce transportation and labor costs, as well as costs associated with carrying and managing inventory.

3. Cross-docking. As manufacturers seek ways to move products more efficiently and cost-effectively, many are rediscovering cross-docking—moving product directly from receiving to shipping with little or no inventory and minimal handling. The process is resurfacing as a way to take costs out of the supply chain, accelerate inventory velocity, and improve service levels.

While historically used for durable goods, high turn rates and reduced handling make cross-docking an effective solution for everything from perishable products

to high-value/high-security goods. The process helps get product to market quickly and economically while reducing the need for warehouse space and inventory carry costs.

Many companies are exploring variations on traditional, "pure" cross-docking, integrating transportation strategies such as consolidation and deconsolidation to maximize savings. For example, a company may receive inbound loads daily but ship out just twice a week, reducing transportation spend while making deliveries that meet end-user requirements.

1. INVOLVING A 3PL

Many manufacturers are recognizing that 3PLs are often better positioned than their own internal operations to adapt to the expanded warehouse role.

Experienced 3PLs offer convenient facilities with a skilled workforce, state-of-the-art equipment and facilities, and established systems and processes for peak performance. Because warehousing, packaging, and transportation operations take place under a single roof, communication and planning improve, helping to ensure performance quality and timeliness. Effective 3PLs also routinely review forecasting, scheduling, processes, equipment and other variables, looking for opportunities for improvement.

Demand for specialized warehouse services will climb for the foreseeable future as manufacturers intensify their focus on core competencies. Fortunately, third-party providers can provide innovative, flexible solutions to help streamline their supply chains, increase flexibility, and better manage costs.

3.12 Let’s sum-up

Warehousing’s role in the supply chain has become more critical and at an escalating rate during the past two decades. Responsibilities of warehouse operators have evolved from maintaining long-term storage of materials and products to supporting economies of purchasing, production, and transportation

to including light manufacturing and facilitating time-based supply chain strategies.

Warehouse operations contribute to the overall total cost of managing a supply chain, and as such, the trade-offs between warehousing costs and services to that of other critical functions of the firm must be evaluated. It is when warehousing contributes to reduced costs and improved service, flexibility, and responsiveness that warehouses become more valued to the organization and supply chain as a whole.

Value is provided through

- Storing product to fulfill customer demand and protect against uncertainties in demand and lead-time
- Providing customers with product assortment
- Postponing or delaying inventory commitment to form or location until demand is better known
- Achieving low total cost and improved lead-time through consolidating multiple orders
- Reducing lead-time through cross-docking
- Sequencing materials and components from multiple third-party logistics (3PLs) providers for time-based delivery to factory production lines
- Performing light manufacturing, assembly, and kitting

Most important, warehouses impact the receiving customer in many critical ways. Frontline warehouse personnel may be the final customer service defense in ensuring product accuracy, quantity, timing of shipment and delivery, accuracy of documentation, and overall product condition—all of which impact total cost and customer perception of the brand.

3.13 Key Terms

Shrinkage: The costs associated with breakage, pilferage, and deterioration of inventories. Usually pertains to the loss of material through handling damage, theft, or neglect.

Total Obsolescence for Raw Material, WIP, and Finished Goods Inventory: Inventory reserves taken due to obsolescence and scrap and includes products exceeding the shelf life, i.e., spoils and is no good for use in its original purpose (do not include reserves taken for Field Service Parts).

Item coding

An arrangement for giving every package of material moved an identifying tag, usually a barcode or magnetic strip

ABC Analysis

A classification of items in an inventory according to importance defined in terms of criteria such as sales volume and purchase volume.

Cross-docking

—in its purest form cross-docking is the action of unloading materials from an incoming trailer or rail car and immediately loading these materials in outbound trailers or rail cars, thus eliminating the need for warehousing (storage). In reality, pure cross-docking is rare outside of transportation hubs and hub-and-spoke type distribution networks. Many "cross-docking" operations require large staging areas where inbound materials are sorted, consolidated, and stored until the outbound shipment is complete and ready to ship. This staging may take hours, days, or even weeks in which case the "staging area" is essentially a "warehouse".

Dry storage

—though dry storage can have other meanings in different industries, in warehousing it is typically used to describe non-refrigerated storage of food products (canned goods, dry goods, etc). See also Cold storage

Dunnage

—fill material. Types of Dunnage include loose fill (packing peanuts), paper, bubble wrap, foam, and air pillows.

Private warehouse

—as opposed to "public warehouse" (see separate listing), a private warehouse simply means the warehouse is owned/leased and operated by the private company whose warehouse operations are conducted within that building. For example, if a manufacturer or distributor has their own warehouse that they operate out of, that is a private warehouse. Also see article Public Warehouses, Contract Warehouses, and 3PLs Explained.

Public warehouse

—a business that provides short or long-term storage to a variety of businesses, usually on a month-to-month basis. A public warehouse will generally use their own equipment and staff, however, agreements may be made where the client either buys or subsidizes equipment. Public warehouse fees are usually a combination of storage fees (per pallet or actual sq. footage) and transaction fees (inbound and outbound). Public warehouses are most often used to supplement space requirements of a private warehouse. Also see Contract Warehouse and 3PL and article on Public Warehouses and 3PLs

Reserve storage

—refers to locations used to store additional inventory that will eventually replenish forward pick locations. Also called overflow storage, reserve locations, backup storage. See also Forward Pick Locations.

Reverse logistics

—fancy term for Returns. Reverse Logistics covers activities related to returned product, returned pallets and containers, returned materials for disposal or recycling.

Slot

—the physical space where an item is stored. Examples of slots would include a parts bin on a shelf, a pallet location in pallet rack, or a storage lane where multiple pallets of an item are stacked on the floor.

Slotting

—the activities associated with optimizing product placement in pick locations in a warehouse. There are software packages designed just for slotting, and many WMS packages will also have slotting functionality. Slotting decisions will generally use item velocity (times picked), cube usage (cubic velocity), and minimum pick face dimensions to determine best location, but there are numerous other factors that may need to be considered in a given environment. See article on Slotting

Warehouse management system

—computer software designed specifically for managing the movement and storage of materials throughout the warehouse. WMS functionality is generally broken down into the following three operations: Putaway, Replenishment, and Picking. The key to these systems is the logic to direct these operations to specific locations based on user defined criteria. WMSs are often set up to integrate with data-collection systems. Read my article on Warehouse Management Systems.

3.14 Self-assessment Questions

1. What are warehousing elements?

2. Discuss the tradeoff between warehousing cost and services.

3. What is cross docking?

3.15 Further Readings

1. The Definitive Guide to Warehousing- Managing the Storage and Handling of Materials and Products in the Supply Chainby CSCMP, Scott B. Keller, Brian C. Keller

2. Supply Chain Management and Knowledge Management: Integrating Critical Perspectives in Theory & Practices. Edited by Ashish. Dwivedi, Tim. Butcher

3.16 Model Questions

1. Discuss functions of Warehousing.

2. Discuss warehouse innovative used in the context of present day challenges in warehousing management.

3. Discuss the differences between private, public and bonded warehouses.