MEASI INSTITUTE OF MANAGEMENT
CHENNAI-14
Approved by All India Council for Technical Education and
Affiliated to the University of Madras, ISO 9001:2015 Certified Institute

INVENTORY AND WAREHOUSING MANAGEMENT PMF28

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CHENNAI – 600 014

VISION & MISSION STATEMENTS

VISION

- To emerge as the most preferred Business School with Global recognition by producing most competent Ethical Managers, Entrepreneurs and Researchers through Quality Education.

MISSION

- **Knowledge through Quality Teaching Learning Process**: To enable the students to meet the challenges of the fast challenging global business environment through quality teaching learning process.
- **Managerial Competencies with Industry Institute Interface**: To impart conceptual and practical skills for meeting managerial competencies required in competitive environment with the help of effective Industry Institute Interface.
- **Continuous Improvement with the State of Art Infrastructure Facilities**: To aid the students in achieving their full potential by enhancing their learning experience with the state of art infrastructure and facilities.
- **Values and Ethics:** To inculcate value based education through professional ethics, human values and societal responsibilities.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

PEO 1: Placement - To equip the students with requisite knowledge skills and right attitude necessary to get placed as efficient managers in corporate companies.

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PEO 2: Entrepreneur - To create effective entrepreneurs by enhancing their critical thinking, problem solving and decision-making skill.

PEO 3 Research and Development - To make sustained efforts for holistic development of the students by encouraging them towards research and development.

PEO4: Contribution to Society - To produce proficient professionals with strong integrity to contribute to society.

Program Outcomes

PO1: Problem Solving Skill -

Apply knowledge of management theories and practices to solve business problems.

PO2: Decision Making Skill

Foster analytical and critical thinking abilities for data-based decision making.

PO3: Ethical Value

Ability to develop value based leadership ability.

PO4: Communication Skill

Ability to understand, analyze and communicate global, economic, legal and ethical aspects of business.

PO5: Individual and Leadership Skill

Ability to lead themselves and others in the achievement of organizational goals, contributing effectively to a team environment.

PO6: Employability Skill

Foster and enhance employability skills through subject knowledge.

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PO7: Entrepreneurial Skill

Equipped with skills and competencies to become an entrepreneur.

PO8: Contribution to Community

Succeed in career endeavors and contribute significantly to the community.

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Subject Code	Subject Name	L	T	P	S	C
PMF28	INVENTORY & WAREHOUSING MANAGEMENT	3	0	0	0	3

Course Objectives	
C1	To enable the students to understand the fundamentals of Inventory Management and its impact on Logistics
C2	To acquaint the students with various models, tools and techniques of Inventory control and inventory management
C3	To impart the students, knowledge of various inventory ranking methods, and how to use technology in inventory control
C4	To acquaint the students with basics of warehouse management, its location, layout and principles of warehouse design.
C5	To impart knowledge about the standardization, codification, safety and security of inventory and the role of Information technology in warehouse management.

SYLLABUS

Unit. No.	Details	Hours
Unit I	**Introduction to Inventory** – Definition, principles, role, functions and importance of Inventory, Types of Inventory, Inventory Policy, Costs Associated with Inventory, Inventory and Profitability, Impact of Inventory on total logical cost – Inventory management – objectives / importance, symptoms of poor inventory management, Improving effectiveness of inventory management.	9
Unit II	**Inventory Control and models** – Importance and scope of Inventory control, Selective Inventory control, Inventory Models – Economic Lot size, EOQ, Economic Batch Quantity [EBQ], ROL – reorder level, P model, Q model, two bin system, fair share allocation model, MRP, ABC analysis, Just in Time (JIT). Modern methods Kanban, DRP and ERP.	9
Unit III	**Inventory Methods** – Inventory ranking methods and Quadrant technique, FIFO. LIFC, Weighted average method, Inventory under certainly and uncertainly, Risk Management, Work in progress inventories, Finished Goods Inventories, Spare parts inventories, Use of Computers in Inventory Management – RFID, EDI, Satellite tracking system.	9
Unit IV	**Warehouse Management** – Definition, Principles, Roles, Importance of Warehouses, Need for Warehousing, Warehouse selection and planning, functions and operations of a warehouse, Warehouse location, Area of Warehouse, Factors affecting warehousing cost, Warehouse layout, Design principles.	9

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Unit V	**Planning** – codification and standardization of the Materials, Incoming Materials Receipts, Retrieval and Transaction Processing System, Security and Loss Prevention, Consumption Based Planning – MRP and lot sixing procedure, Forecasting parameter and result, planned order planning file consolidation, Breakbulk, Crossdocking, Mixing, Assembly – competitive advantage, production support warehouse – ERP, Role of IT in warehousing	9
	TOTAL HOURS	45

Reference Books	
1.	Tony wild – Best Practice in Inventory Management – John wiley and sons
2.	Hadley G and Whitin T. M. ; Analysis of Inventory systems, Prentice Hall
3.	Naddor E, Inventory system, John Wiley
4.	Buchan, J and Konigsberg E ; Scientific inventory Management, Prentice Hall
5.	Silver E and Peterson. R ; Decision System for Inventory Management and Production, Wiley
6.	Inventory Management Explained ; A focus on Forecasting, lot sizing, safety stock, and ordering systems, OPS publishing

E-Sources	
1.	https://smallbusiness.chron.com/different-types-inventory-methods-20680.html
2.	https://www.capterra.com/inventory-management-software/
3.	https://www.vkok.ee/logontrain/wp-content/uploads/2014/03/Riga-3-july-2014.pdf
4.	https://ocw.mit.edu/courses/engineering-systems-division/esd-260j-logistics-systems-fall-2006/lecture-notes/lect15.pdf
5.	http://www2.unb.ca/~ddu/4690/Lecture_notes/Lec2.pdf

Assessment Tools Used			
1.	Assignments	6.	Group Discussion
2.	Internal Assessment Tests	7.	Management games
3.	Model Exam	8.	Role play
4.	Seminar	9.	Simulation
5.	Case studies	10.	Synetics

Content Beyond Syllabus	
1.	Risk aversion and supply chain management
2.	Revenue management – joint pricing and inventory decisions
3.	Assemble-to-Order system, allocation rules and component commonality
4.	Supply chain incentive issues and contract – coordination and competition
5.	Improve Inventory Management and Security Using Barcodingor Radio Frequency Identification to Track Products
Additional Reference Books	

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1.	Supply Chain Management; Design, Coordination and Operation. A.G. de Kok and Stephen C. Graves eds., 2003. Handbooks in Operations Research and Management Science (HORMS), Elsevier.
2.	Foundations of Inventory Management. By Paul Zipkin. 2000. McGraw Hill. ISBN 0-256-11379-3
3.	P. Zipkin (2000). Chapters 6 and 8 (optimal policy in serial system, challenge of finding optimal policy in distribution systems, performance evaluation and optimization in serial and distribution systems.
4.	D. Simchi-Levi and Y. Zhao 2006. A Comparison of Three Generic Methods for Analyzing Stochastic Multi-Echelon Inventory Systems.
5.	Graves, S.C. and S.P.Willems (2000) Optimizing strategic safety stock placement in supply chains. Manufacturing and Service Operations Management 2; 68-83

Course Outcomes

CO. No.	On completion of this course successfully the students will;	**Program Outcomes (PO)**
C328.1	Understand the fundamentals of Inventory Management and its impact on Logistics	PO6, PO7
C328.2	Become familiar with various models, tools and techniques of Inventory control and inventory management	PO6, PO1, PO2, PO6 Models
C328.3	Have knowledge of various inventory ranking methods, and how to use technology in inventory control	PO1, PO2, PO6, PO7
C328.4	Will become acquainted with basics of warehouse management, its location, layout and principles of warehouse design.	PO1, PO6, PO7
C328.5	Possess knowledge about the standardization, codification, safety and security of inventory and the role of Information technology in warehouse management.	PO1, PO2, PO6

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INVENTORY AND WAREHOUSING MANAGEMENT

Unit – I

Introduction to Inventory – Definition, principles, role, functions and importance of Inventory, Types of Inventory, Inventory Policy, Costs Associated with Inventory, Inventory and Profitability, Impact of Inventory on total logical cost – Inventory management – objectives / importance, symptoms of poor inventory management, Improving effectiveness of inventory management.

Inventory- meaning

Inventories are usually made up of a combination of goods, raw materials and finished prod`ucts, and effective management of these items is essential to ensure optimal stock levels and to maximize the earning potential of the company. It also allows a business to prevent or mitigate any inventory-associated losses.

Defining Inventory

Inventory is an asset that is owned by a business that has the express purpose of being sold to a customer. Inventory refers to the stock pile of the product a firm is offering for sale and the components that make up the product. In other words, the inventory is used to represent the aggregate of those items of tangible assets which are –

- Held for sale in ordinary course of the business.
- In process of production for such sale.
- To be currently consumed in the production of goods or services to be available for sale.

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.

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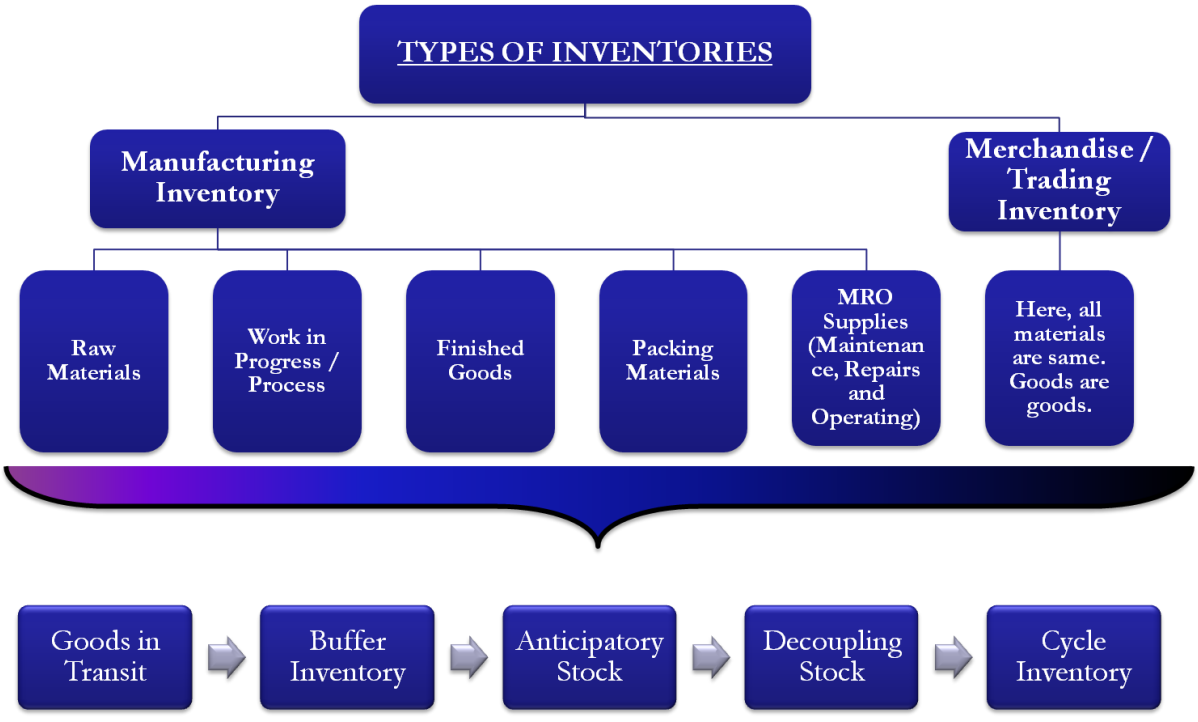
From the above definition the following points stand out with reference to inventory:

- 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.

Different Types of Inventory

The inventory may be classified into three categories:
¬ Raw material and supplies: It refers to the unfinished items which go in the production process.
¬ Work in Progress: It refers to the semi-finished goods which are not 100% complete but some work has been done on them.
¬ Finished goods: It refers to the goods on which 100% work has been done and which are ready for sale.



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Inventory of materials occurs at various stages and departments of an organization.

A manufacturing organization holds inventory of raw materials and consumables required for production. It also holds inventory of semi-finished goods at various stages in the plant with various departments.

Finished goods inventory is held at plant, FG Stores, distribution centers etc

Further both raw materials and finished goods those that are in transit at various locations also form a part of inventory depending upon who owns the inventory at the particular juncture. Finished goods inventory is held by the organization at various stocking points or with dealers and stockiest until it reaches the market and end customers.

Besides Raw materials and finished goods, organizations also hold inventories of spare parts to service the products. Defective products, defective parts and scrap also forms a part of inventory as long as these items are inventoried in the books of the company and have economic value.

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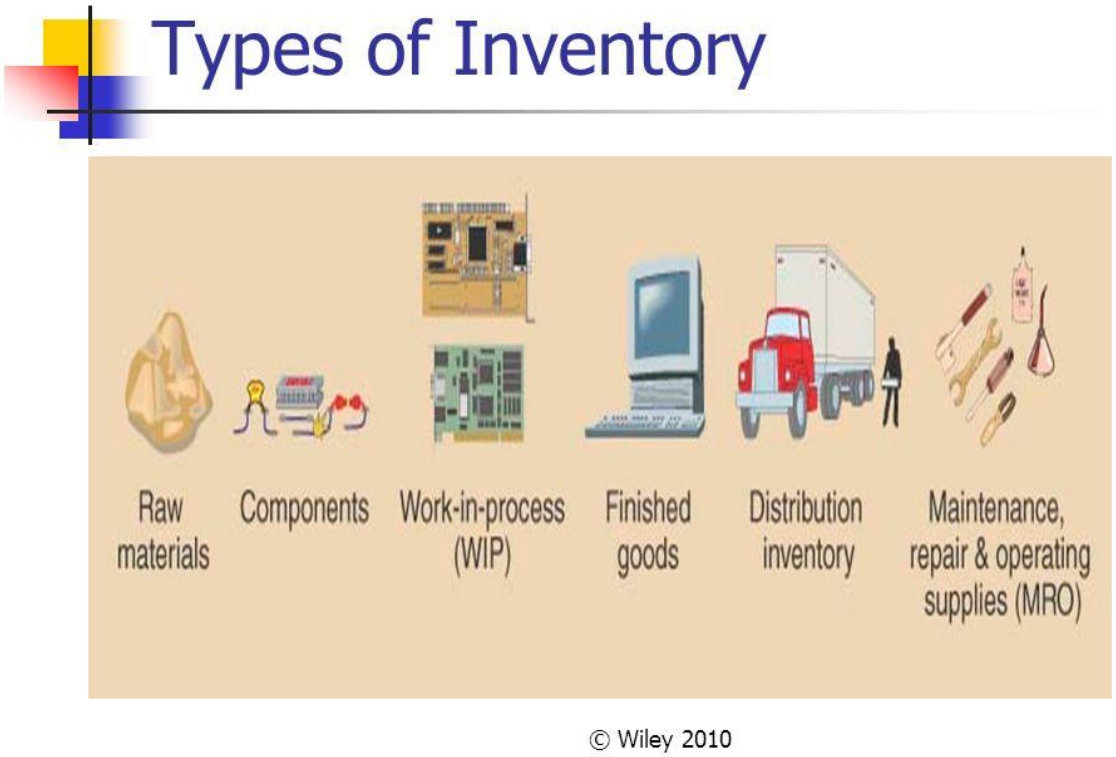

Types of Inventory by Function

INPUT	PROCESS	OUTPUT
Raw Materials	Work in Process	Finished Goods
Consumables required for processing. Eg : Fuel, Stationary, Bolts & Nuts etc. required in manufacturing	Semi - Finished Production in various stages, lying with various departments like Production, WIP Stores, QC, Final Assembly, Paint Shop, Packing, Outbound Store etc.	Finished Goods at Distribution Centres through- out Supply Chain

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Maintenance Items/Consumables	Production Waste and Scrap	Finished Goods in transit
Maintenance Items/Consumables	Production Waste and Scrap	Finished Goods in transit
Packing Materials	Rejections and Defectives	Finished Goods with Stockiest and Dealers

Significance of holding inventory

Inventory is considered to be one of the most important assets of a business. Its management needs to be proactive, accurate and efficient.

Inventory is essential for every organization to ensure smooth running of the production process, to reduce the ordering cost of inventory, to take advantage of quantity discount, avoid opportunity loss on sales, to utilize and optimize the plant capacity and to reduce the overall price. Thus, it can be said that inventory is inevitable and has to be maintained in appropriate quantity. However, the concept of Just In Time (JIT) is becoming popular which is an inventory strategy companies employ to increase efficiency and decrease waste by receiving goods only as they are needed in the production process, thereby reducing inventory costs. This method requires producers to forecast demand accurately.

Meaning of Inventory Management

Inventory management is the practice overseeing and controlling of the ordering, storage and use of components that a company uses in the production of the items it sells. A component of supply chain management, inventory management supervises the flow of goods from manufacturers to warehouses and from these facilities to point of sale. Inventory control means efficient management of capital invested in raw materials and supplies, work- in – progress and finished goods.

An inventory management system monitors all aspects of a company's inventory as items move through the production and sales process. The process involves tracking customer orders, shipping, costs, stock and sales.

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MRN/GRN- Materials Receipt Note/ Goods Receipt Note

Importance of Inventory Management

- Effective inventory management is important as not only is inventory one of the most valuable assets to a business; there is a direct link between inventory levels and company profits. Inventory represents an investment that is tied up until either the item is sold, or it is used in the production of another item that is sold.

- Businesses are reliant on having items in stock; otherwise customers will simply go to a competitor who can provide what they want.

However, holding inventory in stock is not without costs – storage, insurance and maintenance all must be considered. When it comes to replenishing stock levels, most management plans seek to strike a balance between having enough units when required, and ensuring supplies are not overstocked. This is why having an inventory management system can be advantageous.

Costs associated with inventory

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There are several costs associated with inventory:

1.Ordering cost

2. Setup cost

3. Holding Cost

4. Shortage Cost

1.Ordering Cost: Ordering costs are the expenses incurred to create and process an order to a supplier. These costs are included in the determination of the economic order quantity for an inventory item. Examples of ordering costs are:

- Cost to prepare a purchase requisition
- Cost to prepare a purchase order
- Cost of the labor required to inspect goods when they are received
- Cost to put away goods once they have been received
- Cost to process the supplier invoice related to an order
- Cost to prepare and issue a payment to the supplier

2. Inventory carrying costs/ Holding cost: Inventory carrying costs typically include the physical cost of storage such as building and facility maintenance related costs. These costs can include:

- Financing expenses
- The cost of storage space and warehousing
- Security, which may include securing restricted or hazardous materials
- Insurance against theft, loss or damage
- Opportunity cost – capital tied up in inventory that could be spent elsewhere
- Deterioration, theft, spoilage, or obsolescence.

Building rent and warehousing expenses, including overheads such as electricity, lighting and temperature control, are part of carrying costs.

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3. **Shortage costs:** Shortage costs are those costs that are incurred when a business runs out of stock, including*:*

- Time lost when raw materials are not available
- Cost of shrinkage, pilferage and obsolescence
- Idle employees
- Lost sales
- Machinery set up costs,

Filling back-orders through expedited shipping or replenishing stock at higher than wholesale prices are some examples of shortage costs. The most damaging cost of shortage however is a dissatisfied customer and the temporary or permanent loss of sales through insufficient stock levels.

4. Set up cost: It is the cost incurred to get equipment ready to process a different batch of goods. Hence, setup cost is regarded as a *batch-level* cost in activity based costing.
Setup cost is considered to be a non-value-added cost that should be minimized.
Setup costs include the following:

- Costs of changing the tools or dies on the equipment
- Preparing and moving materials or components to the equipment
- Testing the initial output to be certain it meets the specifications

In addition to the out-of-pocket costs, such as the labor cost of setting up the equipment, there is also an opportunity cost. The opportunity cost of setting up the equipment is the lost opportunity to manufacture profitable output during the time that the equipment is being set up.

Reducing inventory costs

- Understanding the three categories of inventory costs will help your business to identify what works and what doesn't. You are then able to provide an analysis of your current position.

- Negative relationships will often exist between ordering costs and carrying costs. Larger orders, placed less frequently will minimize ordering costs but will lead to an increase in carrying costs.

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- In turn, reducing your carrying costs means placing smaller more frequent orders, which subsequently increases ordering costs for the period. If that's not enough to give you a headache, you can run into shortage costs if the smaller orders are not covering current demand.

Sound confusing? It doesn't need to be. A good inventory management system will give you a clear picture of where costs are being incurred with regards to inventory. An inventory management system can also streamline operations and monitor inventory levels in real-time to improve forecasting, increase efficiency and reduce the ordering, carrying and shortage costs of inventory.

Special terms used in inventory management

- **Stock Keeping Unit (SKU)** SKUs are clear, internal identification numbers assigned to each of the products and their variants. SKUs can be any combination of letters and numbers chosen, just as long as the system is consistent and used for all the products in the inventory.[6]
- **Stockout** means running out of the inventory of an SKU.[7]
- "**New old stock**" (sometimes abbreviated NOS) is a term used in business to refer to merchandise being offered for sale that was manufactured long ago but that has never been used. Such merchandise may not be produced anymore, and the new old stock may represent the only market source of a particular item at the present time.
- **Buffer/safety stock**
- **Reorder level**
- **Cycle stock** (Used in batch processes, it is the available inventory, excluding buffer stock)
- **De-coupling** (Buffer stock held between the machines in a single process which serves as a buffer for the next one allowing smooth flow of work instead of waiting the previous or next machine in the same process)
- **Anticipation stock** (Building up extra stock for periods of increased demand – e.g. ice cream for summer)
- **Pipeline stock** (Goods still in transit or in the process of distribution – have left the factory but not arrived at the customer yet)

Objectives of Inventory Management

The objective of inventory management is to maintain inventory at an appropriate level to avoid excess or shortage of inventory. Inventory management systems reduce the cost of

carrying inventory and ensure that the supply of raw material and finished goods remains continuous throughout the business operations.

Effective Inventory Management enables a company to meet or exceed customers' expectations of product availability with the amount of each item that will maximize net profits or minimize your inventory investment."

The **objectives** specifically may be divided into two categories mentioned below:

A. **Operating objectives:** They are related to the operating activities of the business like purchase, production, sales etc.

a. To ensure continuous supply of materials.

b. To ensure uninterrupted production process.

c. To minimize the risks and losses incurred due to shortage of inventory.

d. To ensure better customer services.

e. Avoiding of stock out danger.

B**. Financial Objectives:**

a. To minimize the capital investment in the inventory.

b. To minimize inventory costs.

c. Economy in purchase

Relationship between inventory and Profitability

There is no doubt that inventory management has an effect on the profitability of a business. In fact, it influences a number of factors.

- The first factor is overall organization of the inventory, meaning that the inventory items are stored in a clean area, where it is easy to distinguish items from one another.
- The second factor is a high turnover of products. You don't want stock gathering dust on the shelves; the most efficient businesses have a high turnover.
- Another factor that affects profitability is overheads. By reducing overheads as much as possible, profitability of your business will increase accordingly.

Improving Effectiveness of Inventory Management

Let's take a look at these three factors more closely

Well-Organized Inventory — Having a disorganized storage facility for products will only make your business less efficient. It will lead to a struggle to keep track of the quantity of each item in your inventory. Not being aware of the quantity of each item can cause items to go out-of-stock and prevent you from making more potential sales. A well-organized inventory is easier to maintain and helps you to keep track of item quantities. Inventory analysis and planning applications can help keep track of item quantities, but having a well-organized inventory is up to the business owner and their staff.

High Turnover of Â Products — The products in your inventory should sell. They should have a high turnover for your business profitability to increase. By having control of your inventory, you will be able to see which products are the "best-sellers". This way you can optimize the products in your inventory. Instead of trawling through spreadsheet after spreadsheet of sales data, inventory analysis and planning applications can speed up this process.

Reduce Overheads — You don't need to be a genius to figure out that if you reduce your overheads, your profitability will increase. Hidden overheads are often tied up in inventory. One large overhead surrounding inventory management is manual labor. This could be anything from counting stock, to organizing and transporting. By making your inventory management more efficient, some of these overheads can be reduced. Counting stock can be eliminated with the help of a reliable inventory management software, while organizing and transporting can be made more efficient by only having the amount of stock you need when you need it.

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The Trade-off between inventory carrying costs and customer service.

Better managing inventory can be a company's competitive advantage and the key to increased profitability. So, how do you better manage inventory?

- Analyze demand & trends so you can reduce inventory investment & make better purchasing decision
- Gain control over your inventory investment & COGS with improved inventory control
- Place managing inventory at the centre of your business & consistently adhere to inventory management processes & procedures.

Risks in Inventory Management

The main risk in inventory management is that market value of inventory may fall below what firm paid for it, thereby causing inventory losses. The sources of market value of risk depend on type of inventory. Purchased inventory of manufactured goods is subject to losses due to changes in technology. Such changes may sharply reduce final prices of goods when they are sold or may even make the goods unsaleable. There are also substantial risks in inventories of goods dependent on current styles. The ready-made industry is particularly susceptible to risk of changing consumer tastes. Agricultural commodities are a type of inventory subject to risks due to unpredictable changes in production and demand.

Moreover, all inventories are exposed to losses due to spoilage, shrinkage, theft or other risks of this sort. Insurance is available to cover many of these risks and if purchased is one of the costs of holding inventory. Hence, the financial manager must be aware of the degree of risk involve infirm investment in inventories. The manager must take those risks into account in evaluating the appropriate level of investment.

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INVENTORY AND WAREHOUSING MANAGEMENT (PMF28)

UNIT II

Inventory Control and models – Importance and scope of Inventory control, Selective Inventory control, Inventory Models – Economic Lot size, EOQ, Economic Batch Quantity [EBQ], ROL – reorder level, P model, Q model, two bin system, fair share allocation model, MRP, ABC analysis, Just in Time (JIT). Modern methods Kanban, DRP and ERP.

Inventory Control-Terminology:

a. Demand: it is the number of items (products) required per unit of time. The demand may be either deterministic or probabilistic in nature.
b**. Order cycle**: The time period between two successive orders is called order cycle.
c. **Lead time:** The length of time between placing an order and receipt of items is called lead time.
d. Safety stock: It is also called buffer stock or minimum stock. It is the stock or inventory needed to account for delays in materials supply and to account for sudden increase in demand due to rush orders.
e. **Inventory turnover:** If the company maintains inventories equal to 3 months consumption. It means that inventory turnover is 4 times a year, i.e. the entire inventory is used up and replaced 4 times a year.
f. Re-order level (ROL): It is the point at which the replenishment action is initiated. When the stock level reached R.O.L., the order is placed for the item.
g. Re-order quantity: This is the quantity of material (items) to be ordered at the re-order level. Normally this quantity equals the economic order quantity.

Inventory Cost Relationships

There are two major costs associated with inventory. Procurement cost (ordering cost) and inventory carrying cost.

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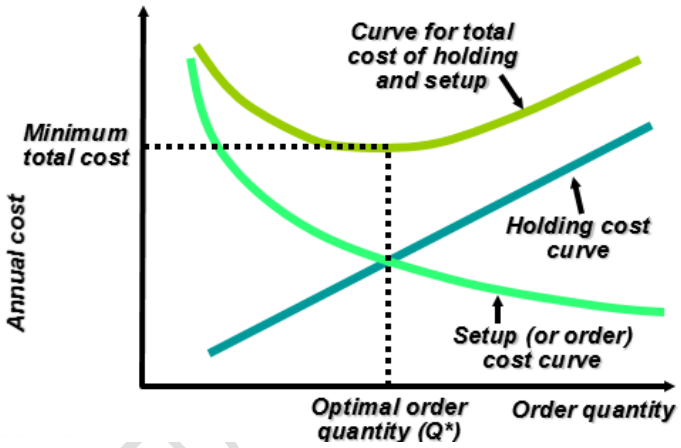
Annual procurement cost varies with the number of orders. This implies that the procurement cost will be high, if the item is procured frequently in small lots. The procurement cost is expressed as Rs. /Order.

The annual inventory carrying cost (Product of average inventory X Carrying cost) is directly proportional to the quantity in stock. The inventory carrying cost decreases, if the quantity to be ordered per order is small. The two costs are diametrically opposite to each other. The right quantity to be ordered is one that strikes a balance between the two opposing costs. This quantity is referred to as "Economic order quantity" (EOQ). The cost relationships are show in the Fig.2.1



Inventory Models:

One basic problem of inventory management is to find out the order quantity so that it is most economical from overall operational point of view. Here that problem lies in minimizing the two conflicting costs, i.e. ordering cost and inventory carrying cost. Inventory models help to find out the order quantity which minimizes the total costs (sum of ordering costs and inventory carrying costs). Inventory models are classified as shown in Fig. 2.2

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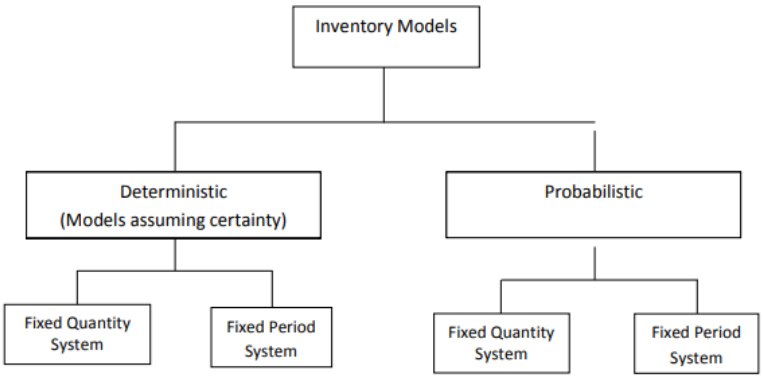
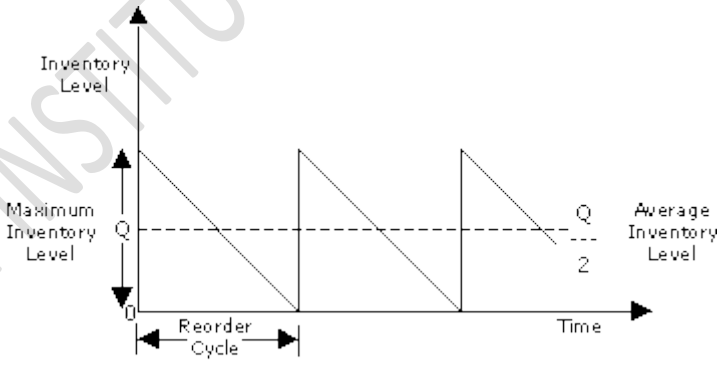


Fig. 2.2 Inventory models

Model I: Economic Order Quantity with Instantaneous Stock Replenishment (Basic Inventory Model) Fig.2.3

Assumptions:

(i) Demand is deterministic, constant and it is known.
(ii) Stock replenishment is instantaneous (lead time is zero)
(iii) Price of the materials is fixed (quantity discounts are not allowed)
(iv) Ordering cost does not vary with order quantity.



Basic Inventory Model) Fig.2.3

Let D be the annual demand (units per year)

Co = Ordering costs (Rs. /order)

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Cc = Inventory carrying costs (Rs./unit/unit time)

Cp = Price per unit Q = Order quantity

Q* = Economic order quantity

N = Number of orders placed per annum

Tc = Total cost per annum

Q* = Thus, optimal Q* (EOQ) is derived to be

EOQ = $Q^* = \sqrt{\frac{2DC_o}{Cc}}$

The period t is given by $t^* = \frac{Q^*}{D}$

Optimal number of orders per year is given by $N^* = \frac{D}{Q^*}$

Minimum total yearly inventory cost $TC^* = \sqrt{2DC_oC_h}$

Example :

Annual usage	500 pieces
Cost per piece	Rs. 100
Ordering cost	Rs. 10 per order
Inventory holding cost	20% of Average Inventory

Solution.

D=500pieces
C_o =10
C_h = 100 X 20% = Rs. 20

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$$EOQ = \sqrt{\frac{(2 \times 10 \times 500)}{20}}$$

EOQ = 22 pieces (rounded)

Model II: Economic Order Quantity when stock replenishment is non-instantaneous (Production Model)

This model is applicable when inventory continuously builds up over a period of time after placing an order or when the units are manufactured and used (or sold) at a constant rate. Because this model is especially suitable for the manufacturing environment where there is a simultaneous production and consumption, it is called "Production Model". Fig 2.4

Assumptions

(i) The item is sold or consumed at the constant demand rate which is known.
(ii) Set up cost is fixed and it does not change with lot size.
(iii) The increase in inventory is not instantaneous but it is gradual

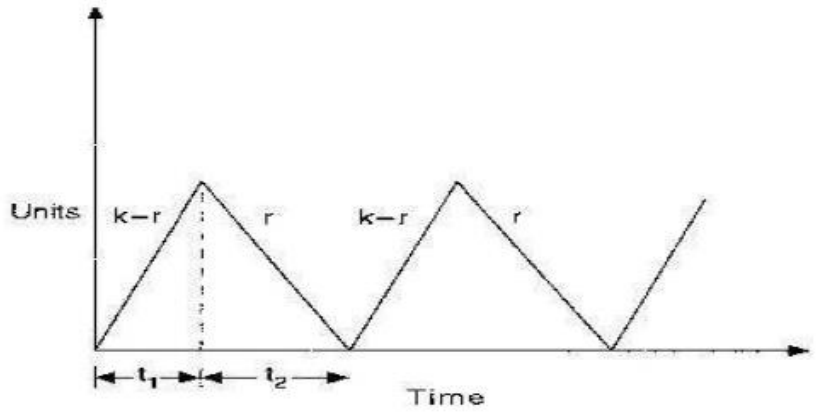


Fig. 2.4 Production inventory model

D is the demand or consumption rate.

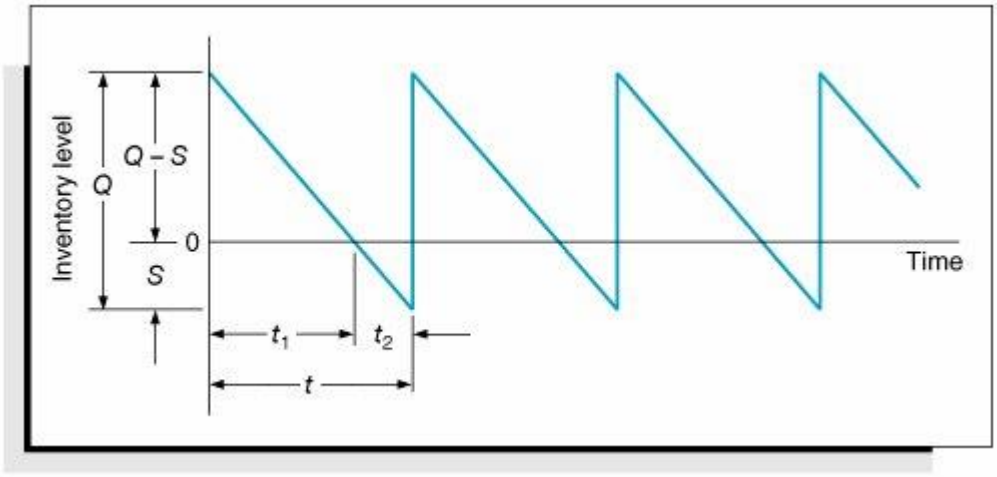
Co = Ordering costs (Rs. /order)

Cc = Inventory carrying costs (Rs./unit/unit time)

Replenishment of inventory under this system build-up during the period tp and consumption takes place during the entire cycle T.

Model III: An Inventory Model when shortages are permitted

In many practical situations, shortages or stock outs are not permitted. So, it is must that stocks out situations are to be avoided. There are occasions where stock out are economically justifiable. This situation is observed normally when cost per unit is very high



Cs = Shortage Cost (Stock out cost) per unit per period.

S = Balance units after back orders are satisfied.

Q-S = Number of shortages per order.

t1 = Time period during which inventory is positive.

t2 = Time during which shortage exists.

T = Time between the receipt of orders.

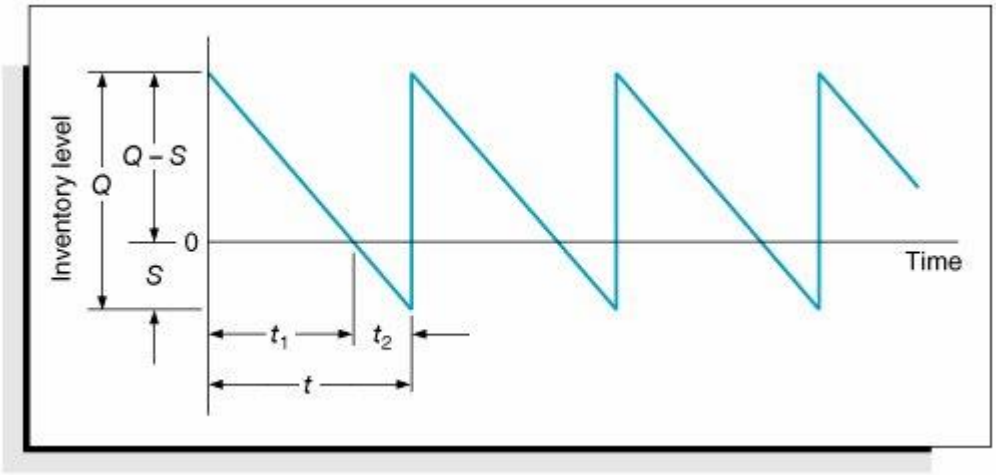
The basic assumption is that there is no loss of sales due to stick out or shortages.

[Page 742 (continued)]
One of the assumptions of our basic EOQ model is that shortages and back ordering are not allowed. The third model variation that we will describe, the EOQ model with shortages,

relaxes this assumption. However, it will be assumed that all demand not met because of inventory shortage can be back ordered and delivered to the customer later. Thus, all demand is eventually met. The EOQ model with shortages is illustrated in Figure 16.7.

Figure 16.7. The EOQ model with shortages

(This item is displayed on page 743 in the print version)



$$\text{total shortage costs} = C_s \frac{S^2}{2Q}$$

$$\text{total carrying cost} = C_c \frac{(Q-S)^2}{2Q}$$

$$\text{total ordering cost} = C_o \frac{D}{Q}$$

Combining these individual cost components results in the total inventory cost formula:

$$TC = C_s \frac{S^2}{2Q} + C_c \frac{(Q-S)^2}{2Q} + C_o \frac{D}{Q}$$

$$Q_{opt} = \sqrt{\frac{2C_O D}{C_c}\left(\frac{C_s + C_c}{C_s}\right)}$$

$$S_{opt} = Q_{opt}\left(\frac{C_c}{C_c + C_s}\right)$$

Model IV: Inventory Model with price discounts

When items are bought in large quantities, the supplier often gives discounts. However, if the material is purchased to take advantage of discount, the average inventory level and so the inventory carrying costs will increase. Benefits for the purchaser from large orders are, lower cost per unit, lower shipping and transportation cost, reduced handling cost and reduction in ordering costs due to less number of orders. These benefits are to be compared with the increase in carrying costs. As the order size increases, more space should be provided to stock the items. A decision is, therefore, to be taken whether the buyer should stick to economic order quantity or

Safety Stock

The economic order quantity formula is developed based on the assumption that the demand is known and certain and that the lead time is constant and does not vary. In actual practical situations, there is an uncertainty with respect to both demand as well as lead time. The total forecasted demand may be more or less than actual demand and the lead time may vary from the estimated time. In order to minimize the effect of this uncertainty due to demand and lead time, a firm maintains safety stock, reserve stock or buffer stock. The safety stock is defined as "the additional stock of material to be maintained in order to meet the unanticipated increase in demand arising out of uncontrollable factors." Because it is difficult to predict the exact amount of safety stock to be maintained, by using statistical methods and simulation, it is possible to determine the level of safety stock to be maintained.

a. FSN analysis: All the items in the inventory are not required at the same frequency. Some are required regularly, some occasionally and some very rarely. FSN analysis classifies items into fast moving, slow moving and non-moving.

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b. SOS analysis: this classification is based on the seasonality of the items as seasonal and off seasonal. Seasonal items are available only for a limited period and, hence, they are procured to meet the demand till the next season.

c. XYZ analysis: This analysis is based on the value of the stocks on hand (i.e., capital employed to procure inventory). Items whose inventory values are high are called X category and whose values are low are called Z items. Usually XYZ analysis is used in association with A.B.C. analysis.

Just in Time Philosophy

The roots of the JIT system can probably be traced to the Japanese environment. Japan has inherent limitations of lack of space and lack of natural resources. Japanese have developed an aversion towards all kinds of wastes. They view scrap and rework as waste and hence strive for perfect quality. They strongly believe that inventory storage wastes space and results in locking up of valuable materials and capital. Anything that does not contribute value to the product is viewed as waste. Thus, it is quite natural for the JIT philosophy to develop in Japan. Apart from eliminating wastes JIT has another important feature utilizing the full capability of the worker. Workers in JIT system are charged with responsibility for producing quality parts just in time to support the next production process. The objective of JIT system is to improve profits and return on investment through cost reductions, inventory reduction and quality improvement. Involvement of workers and elimination of waste are the means of achieving these objectives. So, JIT manufacturing is a broad philosophy of continuous improvement that includes three mutually supportive components such as,

a. The People Participation and Involvement: The stock less production or zero inventories have created an impression that JIT is only an inventory program. JIT has a strong human resource management component that must be recognized in order to exploit the full potential of technology component. The success of JIT depends upon how the companies train their human resource to have an appropriate skill, responsibility and co-ordinate and motivate people JIT seeks to fully utilize the creative talents of employees, suppliers, subcontractors and others who may contribute to the company's improvement. Teamwork, discipline and supplier involvement are the important components that contribute to the success of JIT.
b. Total Quality Control (TQC): Total Quality Control refers to the achievement and improvement in quality in a JIT company, which involves every department and each employee in the company, can remain competitive.

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c. Internal customer Concept- JIT companies believe in broad definition of a customer. The traditional organization define that customer is a person outside the company who buys and uses the products and services. JIT companies adds to this definition the concept of immediate customer (or internal customer) who is the next person or department or process who uses or further processes them. If each worker sends only defect free items to his immediate customer. No defective final products will be produced.
d. Quality at Source- Each employee is given the responsibility for quality at his work-station. Employees are trained in quality principles and testing procedures. They inspect their own work to ensure that the defectives are not passed onto the next process. The defective element is more easily detected by the immediate customer than by the person who is responsible for it. e.g., a part may not fit in to the assembly if it is not properly made. A procedure called "JIDOKA" is brought in to effect. Any employee who senses that a process is producing defects or is about to go out of proper specification has the authority and the responsibility to stop the process. The concept behind this is that it is better to stop the production rather than producing defects.
e. TQC is a culture not a program: The TQC philosophy aims at the culture of continuous improvement in which people always strive to do better. Companies continue to look for incremental product improvements and process refinements. The objective here is to reduce variability in processes and in parts because it is the variation, which makes the product deviation from quality. Total quality efforts extend to suppliers. When suppliers' quality reaches a consistently high quality, there is no need for for the supplier to go through incoming inspection. f. JIT Flow: A queue in front of the work center represents the work in process (WIP). Any form of inventory is a waste as per the JIT philosophy when the queues are long, the cost of holding the WIP becomes high and the required for a job to flow through the required work centers becomes excessive. The major objective of JIT is to have only the right item at the right place at the right time. This practice reduces the WIP and hence the working capital requirement but also the floor space and the flow through time. Thus the important aspects that support the JIT flow are: a. Uniform production rate and mixed model assembly. b. Pull method of co-coordinating work centers. c. Quick and inexpensive set ups. d. Multi skilled work force and flexible facilities. e. High quality levels with no rejects or reworks.

Basic Elements of JIT:

a. Flow layout: The physical layout of production facilities is arranged, so that the process flow is streamlined, i.e., for each component, the proportion of value-added

time should be more; there should be minimum queuing and non-value-added times. Use of dedicated lines, U-shaped or parallel lines, use of small machines is preferred. Flexibility of equipment is essential to adjust quickly to changing market demand.

b. Smoothed build up rate: The buildup rate should be smooth over a monthly cycle. To achieve this, under capacity scheduling is resorted to so that they can respond to demand changes.

c. Mixed model scheduling: JIT objective is to match the production rate to demand as closely as possible. One way of doing this is to increase the flexibility of production lines to allow concurrent assembly of different models on the same line.

d. Small lots and minimum set-up time: The objective of minimizing set-up times is to reduce the batch sizes to the minimum possible. This reduces the manufacturing cycle time and inventory. Use of SMED technique (single minute exchange of dies) is recommended.

e. Buffer stock removal: Constant elimination of buffer stocks is emphasized to highlight production problems scheduled by high inventory levels.

f. Kanban card: It is a pull system of managing material movement comprising of "Kanban card" based on information system. It helps to trigger the movements of material from one operation to another (next). Merely by alternating the frequency of the circulating Kanban, the production system can be made to adjust to demand fluctuations within limits. The number of cards in the system determines the total inventory. Hence, the objective is to minimizethe number of kanbans.

g. Quality: The achievement of high quality levels is a prerequisite of successful JIT. Zero defect, statistical process control, process data collection and worker centered quality are commonly used quality programmes.

h. Product and process simplification: This is achieved through (i) Rationalization of product range (ii) Simplification of methods of manufacture (iii) Simplification through component item standardization.

i. Standard container: JIT emphasize small standardized containers. This simplifies materials movement and use of material handling equipment.

j. Preventive maintenance: JIT requires removal of causes of uncertainty and waste. Breakdown is a major cause of the uncertainty. Rigorous preventive maintenance attempts to remove the uncertainty.

k. Flexible workforce: This is the critical requirement of JIT. Flexible workforce is developed through cross functional training. It is necessary to match production rate and demand rate as closely as possible. l. Organization in modules or cells: Many JIT factories are organized in small autonomous modules or cells, each cell being totally

responsible for its own production and supply of adjacent module. The cells are designed so that material flow between the cells is minimized. m. Continuous improvement: JIT is not one time effort. Kit is a philosophy of continuous improvement. It seeks the involvement of everyone in the continuous improvement. n. JIT purchasing: Materials and components are purchased in accordance with well defined requirements in terms of quality, quantity and delivery. JIT purchasing vendor development, long-term buyer-seller relationship, vendor involvement in design of products high quality if purchased material, frequent part delivery, etc. supplier JIT is a prerequisite in JIT manufacture. The key elements are represented in a Table. Key Elements of JIT (i) Have a flexible workforce capable of using multiple skills. Strive for reduced set-up times and small lot sizes.

-

(iii) Work for a constant master schedule. (iv) Insist for defect free materials and supplies be delivered when needed. (v) Use a Kanban or comparable system to pull needed inventory through the system. (vi) Necessary support system to be developed (Reliable vendors, employee involvement and cooperation, total productive maintenance).

Benefits of JIT The most significant benefit of JIT is to improve the responsiveness of the form to the changes in themarketplace thus providing an advantage in competition. The benefits are:

a. Product Cost: It is greatly reduced due to reduction of manufacturing cycle time, reduction of waste,inventories and elimination of non-value-added operations.

b. Quality: Itis improved because of continuous quality improvement programmes.

c. Design: Due to fast response to engineering change, alternative designs can be quickly brought on the shop floor.

d. Productivity improvement.

e. Higher production system flexibility.

f. Administrative easeand simplicity.

Implementation of JIT

To facilitate the implementation of JIT,

a. Obtain commitment from top management. b. Prepare an implementation plan. c. Gain the co-operation of the work force. d. Create a strong leadership on the shop floor. e. Guarantee stable employment, engage training and encourage participation and teamwork. f. Level the production and smoothen the flow. g. Reduce set up times

of machines/equipments. h. Balance fabrication rates with final assembly rates. i. Provide spare capacities in all areas. j. Extend JIT to suppliers. k. Remove the bottlenecks and stabilize delivery schedules.

KANBAN SYSTEM Kanban system is a simple information system used by a work center to signal its supplier work center to request a replacement container and to authorize production of another container of that particular item. The name comes from a Japanese work "Kanban" which means card or sign. Originally a card was used to signal the supplying work center. A work center can use a variety e.g. a flashing light, the empty container or a computer communication or a message. The purpose of the Kanban system is to signal the need for more parts and to ensure that those parts are produced in time to support subsequent fabrication or assembly. This is achieved by pulling parts through the assembly line. Only final assembly line receives a schedule from the dispatch office. All other operators and suppliers receive production orders (Kanban cards) from the subsequent (using) work centers. The Kanban system is a physical control system consisting of cards and containers. In the two cards Kanban system, two types of cards are used. The production card (P-card) authorizes the work centers to make on standard container of a particular part specified on the card.

The second type of one container of the specified part from a particular work center to another work, center as specified on the card. Since these cards are continually reused, they are issued only when the production of an item is to be started or changed significantly. Assume that the containers are moved one at a time. When the containers of the parts is emptied at worker center B, the empty container and the withdrawal card are taken back to work center A. The production card from a full container of parts is removed from its container and replaced by the withdrawal card. The production card is then placed in the Kanban receiving post at work center A, there by authorizing production of another container of parts. The empty container is left at work center A. The full container and its withdrawal card are moved to work center B and placed in the input area. When this container or parts is used, its withdrawal card is empty container are taken back to work and the cycle is repeated. The number of containers needed to operate a work center is a function of the demand rate container rate and the circulating time for a container. The number of containers can be found mathematically.

Comparison between JIT and MRP

In comparing the relationship between JIT and MRP, it is important to understand the distinction between push and pull system of production control.

A push system like MRP pushes material into production to meet future needs. Master schedule is based on future forecasts/orders which determine what components are to be ordered and pushed through production.

In pull system, such as JIT, material is pulled through production by subsequent work centers. Materials are only provided only when there is a subsequent demand; there is no pushing of materials in to production to meet future demands.

MRP can be used for a dynamic situation i.e. when the demand could change significantly in future; JIT is incapable of taking large and sudden variations.

JIT is a single unit production where as MRP involve lot sizes at all levels of the product. JIT eliminates inventories where as MRP is able to make some compromises and even keep safety stocks to insure against demand and supply variations. MRP does not require human orientation as a pre requisite as in JIT

In MRP there is not much stress on vendor relations as it is as important element of JIT. Planning in JIT is easy one needs to plan only the smoothened production of the finished products, whereas, in MRP one needs to plan for every intermediate product and process as well. JIT is preferred in case of repetitive (mass) production where as MRP is suited for job or batch production.

REORDER LEVEL

Reorder Level in management accounting, reorder level (or reorder point) is the inventory level at which a company would place a new order or start a new manufacturing run.

Reorder level depends on a company's work-order lead time and its demand during that time and whether the company maintain a safety stock. Work-order lead time is the time the company's suppliers take in manufacturing and delivering the ordered units.

Identifying the correct reorder level is important. If a company places a new order too soon, it may receive the ordered units earlier than expected and it would have to bear additional carrying costs in the form of warehousing rent, opportunity cost, etc. However, if the company places an order too late, it would result in stock-out costs, for example lost sales, etc.

Reorder level depends on whether a safety stock is maintained.

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If there is no safety stock, reorder level can be worked out using the following formula:

Reorder Level = Average Demand × Lead Time

Both demand and lead time must be in the same unit of time i.e. both should in in days or weeks, etc. If a company maintains a safety stock, reorder level calculation changes are follows:

Reorder Level = Average Demand × Lead Time + Safety Stock

Examples

Example 1: ABC Ltd. is a retailer of footwear. It sells 500 units of one of a famous brand daily. Its supplier takes a week to deliver any ordered units.

The inventory manager should place an order before the inventories drop below 3,500 units (500 units of daily usage multiplied with 7 days of lead time) in order to avoid a stock-out.

Example 2: ABC Ltd. has decided to hold a safety stock equivalent to average usage of 5 days. Calculate the reorder level.

Safety stock which ABC Ltd. has decided to hold equals 2,500 units (500 units of daily usage multiplied by 5 days).

In this scenario, reorder level would be 6,000 units (2,500 of safety stock plus 3,500 units based on 7 days of lead time).

Inventory Replenishment Systems: Continuous Review (also called Fixed Quantity or Q system):

Inventory is reviewed continuously and when inventory drops to a certain (prefixed) reorder level, a fixed quantity is ordered. This model is generally used for high volume, valuable, or important items.

Periodic Review (also called as P system): Inventory is reviewed at (prefixed) periodic intervals irrespective of the levels to which inventory drops; an order is placed to bring up the inventory to the maximum level. This is used for moderate volume items.

Other inventory systems: Several other systems use a combination of traditional approaches. Optional replenishment system: Inventory is reviewed on a fixed frequency and a

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specific quantity is ordered, if inventory is below a certain level. This is a mix of the P and Q systems.

Two-bin system: An inventory amount equal to R is kept in reserve in a second bin. When the first bin is emptied, the second bin is emptied into the first and an order of size Q is placed. One-bin system: where one bin is reviewed at a fixed interval and inventory is brought up to a certain level.

Material Requirements Planning

Material requirements planning (MRP) is a planning and control system for inventory, production, and scheduling. MRP converts the master schedule of production into a detailed schedule, so that you can purchase raw materials and components. Used mostly in the manufacturing and fabrication industries, this system is a push type of inventory control, meaning that organizations use forecasting to determine the customer demand for products. The manufacturing or fabrication company will forecast the amount and type of products they will purchase, along with the quantity of materials to produce them. They then push the products to the consumers. This contrasts with a pull system, where the customer first places an order. The main disadvantage of a push system is its vulnerability when sales vary. In this scenario, the forecasts become inaccurate, which for manufacturing, cause either a shortage of inventory or an excess of inventory that requires storage.

Inventory is divided into two categories, independent and dependent demand. Independent demand is a desire for finished products, such as cell phones or automobiles, whereas dependent demand is the demand for components, parts, or incomplete assemblies (sometimes called sub-assemblies), such as phone screens or tires for automobiles. You determine quantities for the dependent demand by determining quantities for the independent demand. For example, if you forecast your independent demand for the number of completely assembled cell phones that you expect to sell, you can forecast the quantities of your dependent demand materials, such as your screens, processors, batteries, and antennas. These part quantities depend on the quantity of cell phones you want to produce. This relationship between the materials and the finished product are shown on a bill of materials (BOM) and are calculated with MRP.

The three key questions that you must ask when planning for dependent demand are:

- What components do we need?
- How many of each component do we need?

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- When do we need the components?

In determining how much material your product needs, MRP differs from consumption-based planning (CBP). MRP logic uses information received either directly from customers or from the sales forecast, calculating the material required based on the dependencies of other materials. CBP calculates material requirements only via historical consumption data. CBP does not consider the dependencies between different materials, as it presumes that future consumption will follow the same pattern that the historical data did.

MRP synchronizes the flow of materials, components, and parts in a phased order system, considering the production schedule. It also combines and tracks hundreds of variables, including:

- Purchase orders
- Sales orders
- Shortage of materials
- Expedited orders
- Due dates
- Forecasts
- Marketplace demand
- Material
- Inventory
- Data
- Bill of material

For all companies, MRP has a few goals in common. These include making sure that the inventory level is at a minimum, but high enough to provide for the customer need, and that you plan all of the activities, including delivery, purchasing, and manufacturing.

There are some terms that will come up in MRP repeatedly. Some are terms related to MRP as a concept, and some are specific to MRP software. These terms are as follows:

- **Item:** In MRP, an item is the name or code number used for the event you're scheduling.
- **Low-Level Code:** This is the lowest level code of an item in the bill of materials and indicates the sequence in which you run items through an MRP. You use low-level

code because an MRP system recognizes and connects the level that an item appears in the product chain and uses it to plan the proper time to meet all of the system demands.

- **Lot Size:** This is the quantity of units you order during manufacturing
- **Lead Time (LT):** This is the time you need to assemble or manufacture an item from beginning to end. Two types of lead time are ordering lead time and manufacturing lead time. Ordering lead time is the time it takes from starting the purchase to receiving the purchase. Manufacturing lead time is the time it takes for the company to completely manufacture a product from start to end.
- **Past Due (PD):** This is the time during which you consider orders behind schedule.
- **Gross Requirements (GR):** You generate this MRP calculation through forecast scheduling using the number of produced units, the amount of required material for each produced unit, the current stock, and the ordered stock /stock in transit. This is the total demand for an item during a specific time period.
- **Scheduled Receipts (SR):** These are the open orders for products that the company currently possesses but has not yet fulfilled.
- **Projected on Hand (POH):** This is the amount of inventory you've estimated to be available after you meet the gross requirements. To calculate this sum, you add the POH from the previous time period to the scheduled order receipts and the planned order receipts and then subtract the gross requirements. (Current POH = Previous POH + SR + POR – GR)
- **Net Requirements (NR):** You generate this MRP calculation through master scheduling using gross requirements, on-hand inventory, and other quantities. This is the actual, required quantity to be produced in a particular time period.
- **Planned Order Receipts (POR):** The quantity of orders during a time period that is expected to be received. This planning for orders keeps the inventory from going below the threshold necessary.
- **Planned Order Releases (PORL):** This is the amount you plan to order per time period. This is POR offset by the lead time.

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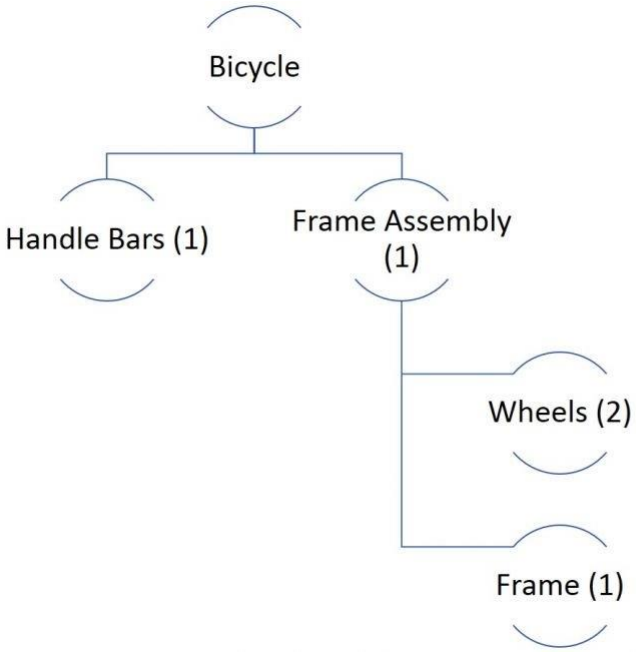
- **Cumulative Lead Time:** This is the greatest amount of time that it takes to develop the product. You may calculate it by looking at each BOM and figuring out which one takes the longest.
- **Product Structure Tree:** This is a visual depiction of the bill of materials, showing how many of each part and how many sub-parts you need to produce the product.



- **Net-Change Systems:** These are systems which identify only the changes between the new and old plan.
- **Master Production Schedule (MPS):** This is the schedule of finished products that drives the MRP process. The quantities in MPS represent what you need to produce to meet the forecast.
- **Lumpiness:** This is when product/material that is low or at zero suddenly spikes. Examples of lumpy or uneven demand include the need for service parts. You only need service parts when an appliance breaks, so forecasting the need for the parts may be difficult, as the demand is not continuous.
- **Time Fence:** Time fences are boundaries between different MRP planning periods. They offer the opportunity for programming changes, such as rules and restrictions.

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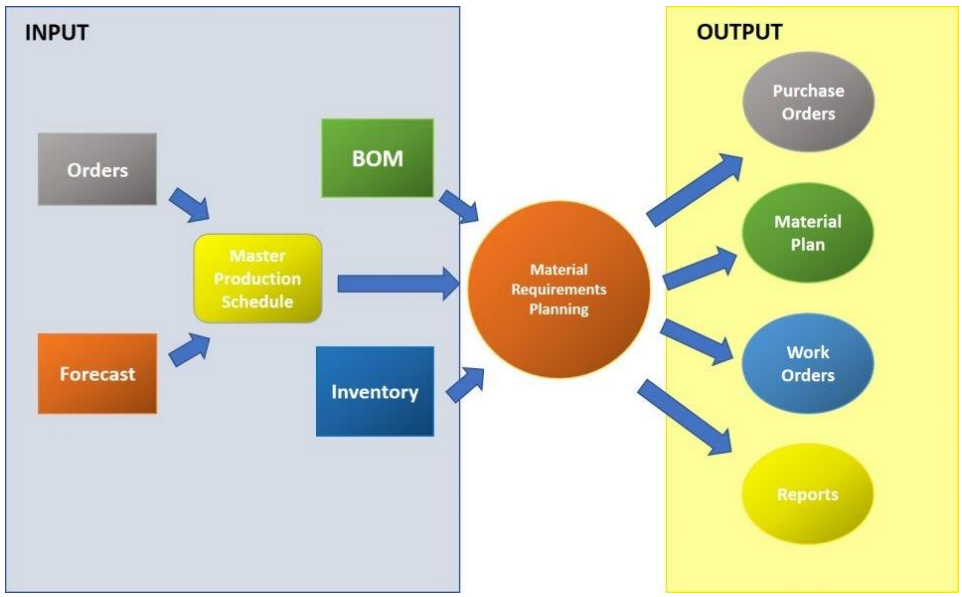

The calculations that MRP performs are based on the data inputs. As shown in the diagram above, these data inputs include:

- **Customer Orders:** This refers to the specific information you receive from customers and includes one-offs and regular ordering patterns.
- **Forecast Demand:** This is a prediction from the marketplace about how much probable demand there will be for a product or service. It is based on historic accounting and current trend analysis.
- **Master Production Schedule (MPS):** Both forecast demand and customer orders feed into the master production schedule. The MPS is a plan that a company develops for production, staffing, or inventory. It is the production future plan that includes the quantities you need to produce the products in a specified time period. It also includes inventory costs, production costs, inventory information, supply, lot size, lead time, and development capacity.
- **Bill of Materials (BOM):** Also called a product structure file, this includes the details and quantities of the raw materials, assemblies, and components that make up each end product.
- **Inventory Records:** These are the raw materials and the completed products that you either have on hand or have already ordered.

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- **Inventory Records:** These are the raw materials and the completed products that you either have on hand or have already ordered.

After MRP receives the input, it generates the output. There are four main outputs. These include:

- **Purchase Orders (PO):** This is the recommended purchasing schedule that includes the order you give to suppliers to send the materials. The PO includes a schedule with quantities and start and finish dates to meet the MPS.
- **Material Plan:** This details the raw materials, assembly items, and component needs to make the end products with quantities and dates. We recommend that you use attribute settings to set the time fences and to firm orders.
- **Work Orders:** This details the work that goes into producing the end product, including which departments are responsible for what part, what materials are necessary, and what the start and end dates are.
- **Reports:** MRP generates primary and secondary reports. The primary reports include all three of the above — those that deal with production and inventory planning and control. Secondary reports are those that detail things, such as performance control, exception data (e.g., errors or late orders), deviations, and predictors of future inventories and contracts.

Distribution requirements planning (DRP)

Distribution requirements planning (DRP) is a systematic process to make the delivery of goods more efficient by determining which goods, in what quantities, and at what location are required to meet anticipated demand. The goal is to minimize shortages and reduce the costs of ordering, transporting, and holding goods.

Also known as distribution replenishment planning, DRP is a time-based approach that determines when inventory is likely to be depleted and plans replenishment to avoid shortages. DRP uses a tree-like structure where a central facility, such as a warehouse, supplies regional facilities which then supply other facilities in the tree. This structure can contain any number of layers.

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A key element of DRP is the DRP table, which usually includes elements that are important in the process, including:

- forecast demands
- current inventory levels
- target safety stock
- recommended replenishment quantities
- replenishment lead times

DRP distribution works by either a pull or push method. The pull method has goods move up through the network by fulfilling customer orders. This provides more availability for consumers because local management controls the availability of the goods. However, managing distribution inventory can be difficult because every order is new to the supplying location as demand flows up the network. This is called the "bullwhip effect:" small changes in consumer demand that generate large swings in demand higher up the network.

In contrast, the push method sends goods down through the network. It generally has lower costs because shipments are planned globally and stored centrally. However, service levels can suffer if central planning is too far removed from the actual demand.

DRP ideally combines the service levels of pull with the efficiency of push, but this depends on accurate forecasts and stable processes to be successful. If both of these exist, DRP produces high fulfillment performance with minimal inventory. Companies usually try to hedge their bets by using safety stock, but that can reduce the overall effectiveness of the DRP strategy, resulting in higher inventory levels or shortages.

A number of vendors include DRP modules in their ERP software.

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ERP (enterprise resource planning)

ERP, or enterprise resource planning, is a modular software system designed to integrate the main functional areas of an organization's business processes into a unified system.

An ERP system includes core software components, often called modules, that focus on essential business areas, such as finance and accounting, HR, production and materials management, customer relationship management (CRM) and supply chain management. Organizations choose which core modules to use based on which are most important to their particular business.

What primarily distinguishes ERP software from stand-alone targeted software -- which many vendors and industry analysts refer to as best-of-breed solutions -- is a common central database from which the various ERP software modules access information, some of which is shared with the other modules involved in a given business process. This means that companies using ERP are largely saved from having to make double entries to update information because the system shares the data, in turn enabling greater accuracy and collaboration between the organization's departments.

ERP implementation options include on premises, cloud and a mix of the two, called hybrid, such as with platform as a service (PaaS) and infrastructure as a service (IaaS). Although ERP has historically been associated with expensive, monolithic, end-to-end implementations, cloud versions now enable easier deployments, which SMBs are taking advantage of in greater numbers.

Some ERP systems also offer next-generation capabilities, such as AI, IoT and advanced analytics, to foster digital transformation. Businesses typically turn to an ERP system when they outgrow spreadsheets and disparate, often siloed software systems and need the unifying capabilities of an ERP system to enable growth. As with many technology products, the specific definition of what constitutes ERP can vary widely from vendor to vendor.

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How ERP works

ERP systems rely on a centralized relational database, which collects business information and stores them in tables. Having the data stored centrally allows end users, such as from finance, sales and other departments, to quickly access the desired information for analysis.

Instead of employees in different departments managing their own spreadsheets and reports, ERP systems allow for reporting to be generated from a single, centralized system. Information updated in one ERP module, such as CRM, HR and finance, is sent to a central, shared database. The appropriate information in the central database is then shared with the other modules.

Importance of ERP

Experts list four important business benefits of ERP:

- IT cost savings
- Business process efficiency
- A business process platform for process standardization
- A catalyst for business innovation

While businesses often focus on the first two areas because they're easy to quantify, the latter two areas can create greater impact for businesses.

ERP makes real-time business data available throughout the organization, which enables businesses to adapt quickly and respond to changes. The business data available in ERP systems provides for more informed decision making within an enterprise. ERP systems can

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also share data with third party partners and vendors to improve efficiencies in the supply chain.

Benefits of ERP systems

ERP offers a plethora of benefits, most of which come from information sharing and standardization. Because ERP components can share data more easily than disparate systems, they can make cross-departmental business processes easier to manage on a daily basis. They can also enable better insights from data, especially with the newer technologies that many ERP systems are including, such as powerful analytics, machine learning and industrial IoT capabilities.

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Unit – III

Inventory Methods – Inventory ranking methods and Quadrant technique, FIFO. LIFC, Weighted average method, Inventory under certainly and uncertainly, Risk Management, Work in progress inventories, Finished Goods Inventories, Spare parts inventories, Use of Computers in Inventory Management – RFID, EDI, Satellite tracking system.

Inventory Ranking Methods

In inventory management, ABC codes and movement classes are used to identify categories of stock that may require different management and controls. By using these categorization methods, we can rank inventory items by their cost and turnover, respectively. This information can be used to group items for planning physical inventory counts and for making strategic and tactical decisions.

Inventory Control Techniques Inventory control techniques are employed by the inventory control organization within the framework of one of the basic inventory models, viz., fixed order quantity system or fixed order period system. Inventory control techniques represent the operational aspect of inventory management and help realize the objectives of inventory management and control. Several techniques of inventory control are in use and it depends on the convenience of the firm to adopt any of the techniques.

The techniques most commonly used are the following:

a. **ABC Analysis**: ABC analysis is a business term used to define an inventory categorization technique often used in materials management. It is also known as 'Selective Inventory Control.' ABC analysis provides a mechanism for identifying items which will have a significant impact on overall inventory cost whilst also providing a mechanism for identifying different categories of stock that will require different management and controls. When carrying out an ABC analysis, inventory items are valued (item cost multiplied by quantity issued/consumed in period) with the results then ranked. The results are then grouped typically into three bands. These bands are called ABC codes.
ABC CODES "A class" inventory will typically contain items that account for 80% of total value, or 20% of total items.
"B class" inventory will have around 15% of total value, or 30% of total items.
"C class" inventory will account for the remaining 5%, or 50% of total items. ABC Analysis is similar to the Pareto principle in that the "A class" group will typically

account for a large proportion of the overall value but a small percentage of the overall volume of inventory.

USAGE OF ABC ANALYSIS 1. In day to day warehouse operations, materials are some time under issued, over issued, issued and not accounted into the system, misplaced, stolen etc. This results into inaccuracy in the inventory. Cycle counting is the process to count and reconcile the materials. Ideally, every material in the warehouse should be counted during a fixed interval (every year) for maintaining 100% accuracy, but counting & reconciling every material is not cost effective and very expensive. To count the accuracy of the inventory in a cost effective manner, it is recommended to count the materials based on inventory classification. If A class materials are counted within a fixed interval (could be six months or a year) then the firm needs to count only 5% to 10% of the total materials and it will cover 60% to 80% of the inventory value. It means that firm only counts 5 % to 10% of the materials and remove the inaccuracy from the inventory value from 60% to 80%. Similarly B class materials can also be counted on a less frequency (from once in 18 months to 24 Months) as the number of materials become higher and C class materials at even lesser frequency (once in 27 months to 36 months) as number of material becomes more (60% to 85% of the total materials).

2. An inventory controller shall be concentrating more on the A class items for reducing the inventory as he/she shall be concentrating only 5% to 10% of the total items and shall be getting the opportunity to reduce inventory on 60% to 80% of the value.

3. Any reduction in lead time of A class items shall result in reduction in inventory, so procurement manager will work out with suppliers to reduce the lead time.

4. On issue of materials, tight control on A class, Moderate control on B class, Loose Control on C class. So 'A' class items may be issued after getting the approvals from Senior Executives of the company. B may be moderately controlled. Very little control can be exercised while issuing C class item

b. High, Medium and Low Classification: The High, medium and Low (HML) classification follows the same procedure as is adopted in ABC classification. Only difference is that in HML, the classification unit value is the criterion and not the annual consumption value. The items of inventory should be listed in the descending order of unit value and it is up to the management to fix limits for three categories. The HML analysis is useful for keeping control over consumption at departmental levels, for deciding the frequency of physical verification, and for controlling purchases. Procurement department is more concerned with prices of materials so this

analysis helps them to take them the decisions such as, who will procure what based on the hierarchy and price of material. Some of the other objective can be as under Helps in taking the decision such as whether to procure in exact requirement or opt for EOQ or purchase only when needed When it is desired to evolve purchasing policies then also HML analysis is carried out i.e. whether to purchase in exact quantities as required or to purchase in EOQ or purchase only when absolutely necessary When the objective is to keep control over consumption at the department level then authorization to draw materials from the stores will be given to senior staff for H item, next lower level in seniority for M class item and junior level staff for L class items. Cycle counting can also be planned based on HML analysis. H class items shall be counted very frequently, M class shall be counted at lesser frequency and L class shall be counted at least frequency as compared to H & M class.

c. VED Classification: While in ABC, classification inventories are classified on the basis of their consumption value and in HML analysis the unit value is the basis, criticality of inventories is the basis for vital, essential and desirable categorization. The VED analysis is done to determine the criticality of an item and its effect on production and other services. It is specially used for classification of spare parts.

d. SDE Classification: The SDE analysis is based upon the availability of items and is very useful in the context of scarcity of supply. In this analysis, items, generally imported, and those which are in short supply. It refers to difficult items which are available indigenously but are difficult items to procure. Items which have to come from distant places or for which reliable suppliers are difficult to come by fall into category. It also refers to items which are easy to acquire and which are available in the local markets. The SDE classification, based on problems faced in procurement, is vital to the lead time analysis and in deciding on purchasing strategies. SDE analysis is done based on purchasing problems associated with items on day-to-day basis. Some of the purchasing problems are as under: - Long Lead Times. Scarcity and hardly available Sourcing the same material from many geographically scattered sources Uncertain and unreliable sources of supply Purchasing department classifies these materials and formulates the strategy and policy of procurement of these items accordingly. So classification of materials is done based on level of difficulty in sourcing

e. FSN Classification: FSN stands for fast moving, slow moving and non-moving. Here, classification is based on the pattern of issues from stores and is useful in controlling obsolescence. To carry out an FSN analysis, the date of receipt or the last date of issue, whichever is later, is taken to determine the number of months, which

have lapsed since the last transaction. The items are usually grouped in periods of months. FSN analysis is helpful in identifying active items which need to be reviewed regularly and surplus items which have to be examined further. Non-moving items may be examined further and their disposal can be considered.

f. SOS Analysis: 'S' stands for Seasonal items and 'OS' stands for off-seasonal items. It may be advantageous to buy seasonal items at low prices and keep inventory or buy at high price during off seasons. Based on the fluctuation in prices and availability, suitable decision has to be taken regarding how much to purchase and at what prices.

g. XYZ Analysis: XYZ analysis is calculated by dividing an item's current stock value by the total stock value of the stores. The items are first sorted on descending order of their current stock value. The values are then accumulated till values reach say 60% of the total stock value. These items are grouped as 'X'. Similarly, other items are grouped as 'Y' and 'Z' items based on their accumulated value reaching another 30% & 10% respectively. The XYZ analysis gives an immediate view of which items are expensive to hold. Through this analysis, firm can reduce its money locked up by keeping as little as possible of these expensive items.

h. GOLF Analysis: This stands for Government, Open market, Local or Foreign source of supply. For many items imports are canalized through government agencies such as State Trading Corporations, Mineral and Metals Trading Corporations, Indian Drugs and Pharmaceuticals etc. For such items, the buying firms cannot apply any inventory control techniques and have to accept the quota allotted by the Government. 'Open market' categories are those who form bulk of suppliers and procurement is rather easy. 'L' category includes those local suppliers from whom items can be purchased offthe – shell on cash purchase basis. 'F' category indicates foreign suppliers. Since an elaborate import procedure is involved, it is better to buy imported items in bigger lots usually covering the annual requirements. of demand is constant The lead time is fixed The purchase price of the item is constant i.e. no discount is available The replenishment is made instantaneously; the whole batch is delivered at once.

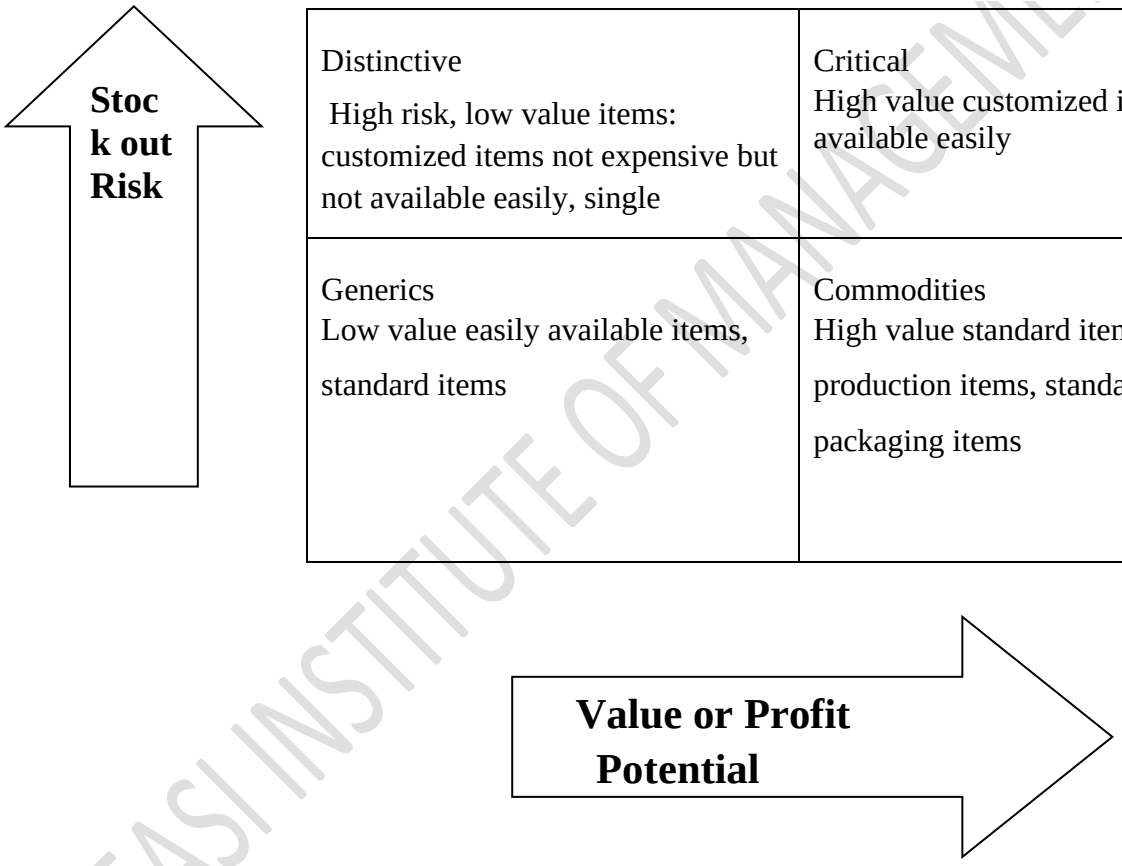
Quadrant Technique

Results of ABC Analysis should be applied judiciously to a situation while deciding priorities. ABC Analysis analyses the items in stock from the perspective of cost or value alone. In running business other considerations also play significant roles. One such consideration is risk of stock-out. Standard items have a low risk of stock-out, as they are

available with several suppliers with low lead times. Specifically, engineered items being non-standard in nature run the risk of stock-out.

An approach keeping the above quadrant in mind is sound from logistical perspective.

ABC Analysis: What is 80 –20 rule or Pareto Analysis based on value ref. KKK for example and make your own notes in the class.



Inventory Valuation

What is Inventory Valuation?

Inventory valuation method is the total cost that you associate with your current inventory. In other words, it is the total amount of money you've spent on acquiring the inventory and storing it. It is imperative that you place a value on your inventory because it is the basis of your Cost Of Goods Sold (COGS) calculation in your income statement. What's more, if you

ever seek a loan with your inventory as the collateral guarantee, you need to know the value of your inventory so you can get the right loan amount.

Note that technically **Inventory Value is not equal to COGS.**

Difference 1: Inventory Value is the value of your inventory assets. COGS is the part of that value that was sold.

Difference 2: Inventory Value impacts your Balance sheets while COGS impacts your Profit & Loss Statement.

So, what attributes can you include in inventory valuation?

Any and all costs you incur to get the product ready for sale can be included. However, you cannot include selling costs, such as the cost of advertising your products, in this calculation.

Why are there different Inventory Valuation Methods?
For one, accounting principles across the globe are quite varied. Businesses registered in the United States follow the Generally Accepted Accounting Principles (GAAP) while those in most other countries follow the International Financial Reporting Standards or IFRS for short.

Now, the IFRS does not accept the LIFO method (which we'll look at in a bit) while GAAP does. Based on where your retail business is registered, you may need to follow a specific set of principles. That's just the tip of the iceberg- there are also differences in how inventory is valued according to these principles.

Moreover, different valuation methods give you different results. The FIFO method (also discussed in a bit) gives you the lowest Cost Of Goods Sold and the highest net income while LIFO does the exact opposite. However, neither of these may be the most accurate picture of your inventory value, which is where WAC (yeah, you know by now) comes in.

What are the different Inventory Valuation Methods?
There are three most common methods that retailers use:

- First-In-First-Out (FIFO)
- Last-In-First-Out (LIFO)
- Weighted Average Cost (WAC)

Each of these methods has some distinct benefits and even more powerful pitfalls. The method you choose for your business depends on which method most accurately reflects the

current state of your business. A well-versed accounting can give you advice on which inventory valuation method to use.

Also, bear in mind that you cannot switch between inventory valuation methods. Once you choose a method, you stick with it for all financial reports at all times.

Let us now look into each inventory valuation method and the implications of using it for your business.

First-In-First-Out Method (FIFO)

In this method, you assume that the first products to enter the inventory are also the first ones to be sold. You always sell your oldest inventory first. The obvious benefit of this method is that it accurately reflects how most retailers do business.

FIFO Example

For example, you may be a retailer of men's clothes. In January 2019, you order 40 pants of a specific type for $10 each from your vendor. In February, order the same 40 pants but at $15 each. So, if you sell 30 shirts, the cost of goods in this method would be $300.

Cost of Goods Sold = Quantity (30) X FIFO cost ($10) = $300

If instead, you sell 50 pants, your new cost of goods sold would be as follows:

Cost of Goods Sold = [Quantity 1 (40) X FIFO cost 1 ($10)] + [Quantity 2 (50-40=10) X FIFO Cost 2 ($15)] = $550

You will continue to calculate the cost of goods in this manner for the given financial year.

Last-In-First-Out Method (LIFO)

In this method, the end result of calculations is the exact opposite of what it is in FIFO. You assume that the last products to enter your inventory are the first ones to be sold.

LIFO Example

For the same example above, your LIFO calculations would look like this:

For 30 products:

Cost Of Goods Sold = Quantity (30) X LIFO Cost ($15) = $450

Likewise, had you sold fifty products, the calculation would be

Cost of Goods Sold = [Quantity 1 (40) X LIFO cost 1 ($15)] + [Quantity 2 (50-40=10) X LIFO Cost 2 ($10)] = $700

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In LIFO, the net income would be the lowest possible number to report, since the latest, most expensive costs are used first. LIFO is used because it keeps taxable income to a minimum. However, your reported profits would also be lower. Moreover, as discussed earlier, LIFO is only accepted under US GAAP rules. If you choose to expand operations to other countries, you're signing up for accounting problems with LIFO.

Weighted Average Cost (WAC)

Because both FIFO and LIFO deal with extreme case scenarios, it is important to have a system that balances out the pitfalls of both. Enter, Weighted Average Cost or WAC. This method is useful if your business does not have too much variation in inventory levels.

Weighted Average Cost Example

Let us continue with the same example. You added a total of 80 pants to your inventory, of which you paid $10 per product for 40 of them and $15 per product for the rest. You would calculate the WAC cost as

Cost of Goods Sold (per item)= {[Cost 1 X Quantity 1] + [Cost 2 X Quantity 2]} / Total quantity

In this example

Cost of Goods Sold (per item) = {[10 X 40] + [15 X 40]}/ 80 = $12.5

Irrespective of which order you sell the product in, for that time period, you will always account for the cost of goods as $12.5 per product.

In general, given how different the results produced by each method are, you should carefully consider what benefits outweigh which pitfall. A certified accountant is the right person to guide you on choosing the best inventory valuation method for your business.

Types of Inventory

Inventory is defined as a stock or store of goods. These goods are maintained on hand at or near a business's location so that the firm may meet demand and fulfill its reason for existence. If the firm is a retail establishment, a customer may look elsewhere to have his or her needs satisfied if the firm does not have the required item in stock when the customer arrives. If the firm is a manufacturer, it must maintain some inventory of raw materials and work-in-process in order to keep the factory running. In addition, it must maintain some supply of finished goods in order to meet demand.

Following are the different types of inventory:

#1 – Raw Material Inventory:

Raw materials are the basic materials that a manufacturing company buys from its suppliers and that are used by the former to convert them into the final products by applying a set of manufacturing processes. For example, aluminum scrap is the raw material for a company that produces aluminum ingots. Flour is the raw material for a company that produces bread or pizza. Similarly, metal parts and ingots are the raw materials bought by a company that manufactures cars and crude oil is the raw material for an oil refinery.

Typically, raw materials are commodities such as ore, grain, minerals, petroleum, chemicals, paper, wood, paint, steel, and food items. However, items such as nuts and bolts, ball bearings, key stock, casters, seats, wheels, and even engines may be regarded as raw materials if they are purchased from outside the firm.

#2 – Work in Progress (WIP) Inventory

Work in progress inventory can also be called semi-finished goods. They are the raw materials that have been taken out of the raw materials store and are now undergoing the process of their conversion into the final products. These are the partly processed raw materials lying on the production floor. And they have also not reached the stage where they have been converted into the final product.

Work-in-process (WIP) is made up of all the materials, parts (components), assemblies, and subassemblies that are being processed or are waiting to be processed within the system. This generally includes all material—from raw material that has been released for initial processing up to material that has been completely processed and is awaiting final inspection and acceptance before inclusion in finished goods.

The extent of inventory locked-up as work in progress is lower the better. This is understandable as the inventory under process is of no use till it gets converted into the final product. It may be saleable at some price but it cannot be sold to generate any revenue for the company's core business. In fact, in lean manufacturing systems, the work in progress inventory is considered as waste.

So it is most desirable that the volume of inventory that is lying in the form of work in progress be minimized and the time is taken to convert it into the final also be minimized so that the locked-up value can be released as quickly as possible. The idea is that this capital, which is locked-up in the form of work in progress inventory, can otherwise be invested somewhere else in order to achieve much better returns.

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#3 – Finished Goods Inventory:

Finished goods are indeed the final products obtained after the application of the manufacturing processes on the raw materials and the semi-finished goods discussed above in the article. They are saleable and their sale contributes fully to the revenue from the core operations of the company.

Regarding the level of finished goods inventory, there are two types of industries that we need to look at. First, we would take the industries in which the finished goods are mass produced and the sale happens after the production. Examples of such industries are the FMCG industry and the oil industry. For a company in such an industry, the correct approach is to maintain the finished goods inventory in a similar manner as the raw material inventory is maintained i.e. at an optimized level as per the demand in the market.

It is very common and easy to observe that the final products of one company are bought as raw materials for some other company. For instance, many oil drilling companies produce crude oil as their final product. On the other hand, the same crude oil is bought by oil refining companies as raw materials in order to produce their final products i.e. gasoline, kerosene, paraffin etc.

Why and when do Organizations hold Finished Goods Inventories ?

1. Markets and Supply Chain Design

   Organizations carry out detailed analysis of the markets both at national as well as international / global levels and work out the Supply Chain strategy with the help of SCM strategists as to the ideal location for setting up production facilities, the network of and number of warehouses required to reach products to the markets within and outside the country as well as the mode or transportation, inventory holding plan, transit times and order management lead times etc, keeping in mind the most important parameter being, to achieve Customer Satisfaction and Demand Fulfillment.

2. Production Strategy necessitates Inventory holding

   The blue print of the entire Production strategy is dependant upon the marketing strategy. Accordingly organizations produce based on marketing orders. The production is planned based on Build to stock or Build to Order strategies.

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While Build to Order strategy is manufactured against specific orders and does not warrant holding of stocks other than in transit stocking, Build to Stock production gets inventoried at various central and forward locations to be able to cater to the market demands.

3. Market penetration

   Marketing departments of companies frequently run branding and sales promotion campaigns to increase brand awareness and demand generation. Aggressive market penetration strategy depends upon ready availability of inventory of all products at nearest warehousing location so that product can be made available at short notice - in terms of number of hours lead time, at all sales locations through out the state and city.

   Any non-availability of stock at the point of sale counter will lead to dip in market demand and sales. Hence holding inventories becomes a necessity.

4. Market Size, location and supply design

   Supply chain design takes into account the location of market, market size, demand pattern and the transit lead time required to reach stocks to the market and determine optimum inventory holding locations and network to be able to hold inventories at national, regional and local levels and achieve two major objectives. The first objective would be to ensure correct product stock is available to service the market. Secondly stocks are held in places where it is required and avoid unwanted stock build up.

5. Transportation and Physical Barriers

   Market location and the physical terrain of the market coupled with the local trucking and transportation network often demand inventory holding at nearest locations. Hilly regions for example may require longer lead-time to service. All kinds of vehicles may not be available and one may have to hire dedicated containerized vehicles of huge capacities. In such cases the will have to have an inventory holding plan for such markets.

   Far away market locations means longer lead times and transportation delays. Inventory holding policy will take into account these factors to work out the plan.

6. Local tax and other Govt. Rules

   In many countries where GST is not implemented, regional state tax rules apply and vary from state to state. Accordingly while one state may offer a tax rebate for a

particular set of product category, another state may charge higher local taxes and lower inter state taxes. In such cases the demand for product from the neighboring state may increase than from the local state. Accordingly inventory holding would have to be planned to cater to the market fluctuation.

While in case of exports from the country of origin into another market situated in another country, one needs to take into account the rules regarding import and customs duties to decide optimum inventories to be held en route or at destination.

7. Production lead times

   FG inventory holding becomes necessary in cases where the lead-time for production is long. Sudden market demand or opportunities in such cases require FG inventories to be built up and supplies to be effected.

8. Speculative gain

   Companies always keep a watch on the economy, annual state budget, financial environment and international environment and are able to foresee and estimate situations, which can have an impact on their business and sales.

   In cases where they are able to estimate a increase in industry prices, taxes or other levies which will result in an overall price increase, they tend to buy and hold huge stocks of raw materials at current prices. They also hold up finished stock in warehouses in anticipation of a impending sale price increase. All such moves cause companies to hold inventories at various stages.

9. Avoid Certain Costs

   Finally organizations hold FG inventories to satisfy customer demand, to reduce sales management and ordering costs, stock out costs and reduce transportation costs and lead times.

Spare parts inventory management: Five Critical Steps

Spare parts inventory management shares many traits with standard inventory management, but requires an extra layer of cost consideration.

Whether a maintenance and repair organization (MRO) is internal to a larger business, or providing maintenance services to an external customer, efficient spare parts inventory management plays a critical role in reducing costs and maximizing customer service.

For this example, we will look at an internal MRO to a production facility. These five steps collect the information you need for executing effective spare parts inventory management.

Step #1: Understanding existing (or projected) consumption

Because repairs happen due to system failures, rather than as part of a production plan, many logistics professionals overlook consumption predictions.
Depending on the age of the MRO, spare parts consumption can be based on either actual historic consumption, or projected based on equipment manufacturer preventative maintenance recommendations and fleet records of other system owners.

Step #2: Calculating system failure costs

In-stock levels and the size of your on-site inventory should be directly linked to costs of system failure or "down time". Every machine in a production facility plays a role.
Some have redundancy, like the multiple fork lifts in a warehouse, while others act as a single point of failure for the whole building, such as an automated full-building outbound sorter.

Step #3: Estimate soft cost impact of out-of-stocks

It is a picture familiar to many industry professionals: parts hoarded in toolboxes, a spare motor under a desk in the maintenance supervisor's office, or the "secret stash" closet with thousands of dollars worth of parts.
Reducing inventory dollars on the books as part of spare parts inventory management can lead to an off-books rise in inventory costs. You are guaranteed these behaviors will start when your out-of-stock rate in your frequently requested spare parts inventory reaches 4-5%.

Step #4: Work with vendors for cost-reduction and in-stock improvement

In many instances, leveraging vendor relationships will allow you to reduce your overall inventory dollars and keep better in-stocks.
Rather than using your own time and resources to monitor spare parts usage, establish reorder points, and project parts required for preventative maintenance, the manufacturer can often provide you a starting point for your stocking levels.
In the best cases, you can find vendors willing to provide spare parts inventory management on a consignment bases: you pay only for parts consumed.

Step #5: Calculate costs (hard and soft) of expedited orders

It is sometimes impossible to maintain a spare parts inventory for every contingency. The key is to establish an expedited spare parts ordering process and understand the costs involved. This allows subordinate managers and maintenance person to make good decisions on what to expedite and what to order on standard orders.
These five steps are just the beginning to achieving optimum spare parts inventory management. From these basics, you can measure, evaluate and further stream line your spare parts inventory control processes.
Cost reduction, increased system availability, and improved moral because workers have the tools they need to do their jobs are just some of the benefits you can experience.

The importance of efficient inventory management processes

Warehouse management is a well-known challenge in today's retail. Without sufficient insight into inventory, supply chain, and processes, stores may lose sales due to missing items

in the warehouse. The lack of overview affects the overall customer experience. If a customer wishes to buy a product of a certain size or color and the item is out of stock, the store not only losses sales but also customer satisfaction.

Do you have the proper systems in place to ensure you do not have any items in the backroom that should be sold in the store?

1. RFID (Radio Frequency identification)

RFID (Radio Frequency Identification) is used to identify and detect individual objects, including products and items. The technology is controlled by radio waves that communicate between a tag on the product and the reader.

For retailers, RFID technology for inventory management has a number of advantages:

1. FID tags are serialized, enabling unique identification of each item in your supply chain, inventory, and store
2. High read rate. An RFID reader can count several items per second
3. Line of sight not required. An RFID reader can identify items several meters away – even if the item is behind a wall or in a cardboard box.

What is the result of using RFID to optimize inventory management?

University of Leicester has recently published a new report titled "Measuring the Impact of RFID in Retailing: key lessons from 10 case-study companies". The report shows the results of 10 European retailers using RFID technology in their businesses – and the results are impressive. According to the report, RFID increased sales in the stores. 7 of 10 retail companies experienced increased sales in the range from 1.5 to 5.5%.

RFID also improved the accuracy of the storage. Before RFID technology, companies had 65-75% accurate inventory. This accuracy increased to 93-99% with RFID technology. The solution also increased inventory availability and reduced staff costs. All 10 companies said they achieved a positive return on their investment in RFID.

2. Electronic Data Interchange (EDI)

is the *computer-to-computer* exchange of *business documents* in a *standard electronic format* between *business partners*.
By moving from a paper-based exchange of business document to one that is electronic, businesses enjoy major benefits such as reduced cost, increased processing speed, reduced errors and improved relationships with business partners. Learn more about the benefits of EDI

- **Computer-to-computer**– EDI replaces postal mail, fax and email. While email is also an electronic approach, the documents exchanged via email must still be handled by people rather than computers. Having people involved slows down the processing of the documents and also introduces errors. Instead, EDI documents can flow straight through to the appropriate application on the receiver's computer (e.g. the Order Management System) and processing can begin immediately.

A typical manual process looks like this, with lots of paper and people involvement:

3. Asset Tracking

Asset tracking is a feature or service that helps locate and track any object that the user may want to keep track of geographically. If you have ever used navigation software on your smart phone or GPS console, you would notice how the device tracks your current location to calculate directions. Likewise, asset tracking tracks the current location of any object anywhere in the world, from small electronic devices to large freight transportation containers. This applies to any physical property, such as a company's equipment, vehicles, or stock.

There are a vast number of tracking technologies each with its own set of merits and drawbacks. The important thing is to match the tracking technology to the item being tracked. For instance, if you are tracking toothbrushes, then using a GPS-based system that costs more than the box of toothbrushes you are tracking would not make sense financially. Instead, a simple barcode or RFID tag may be the best fit here.

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Barcode Tracking

One of the simplest forms of tracking technology is the humble barcode. The cost is very low, but the barcode reader must be right next to the barcode to scan it, so the tracking range is also very low. Additionally, the barcode must be lined up with the barcode reader, requiring oversight to properly align the barcode and making this tracking option more labour intensive. The information frequency is also low, because someone must scan and transmit the information, and only if they know where the item is.

This is typically how parcel shipments via FedEx or UPS work. When tracking a package throughout the shipping process, updates are only given as the item reaches each facility point. For instance, you would receive an update that the package left the sorting facility, but then you would have to wait until it reached the next warehouse for a new update. Between those two points you would not know where the package is, and if the package got lost between those two points, you would not know where it went.

Satellite Tracking

A satellite tracking system transmits location via satellite and sends frequent location updates over a satellite network. The cost of operation is high, but this allows an item to be tracked all across the globe. As long as the item being tracked is within the coverage area of the satellite data network, then the location will be transmitted. There are obstacles that can impede tracking however; if the receiver is underground or inside a metal container, then the satellite signal would not be able to reach the object. Overall, high-value assets that need to be tracked frequently without human oversight can benefit from satellite asset tracking.

Unit – IV

Warehouse Management – Definition, Principles, Roles, Importance of Warehouses, Need for Warehousing, Warehouse selection and planning, functions and operations of a warehouse, Warehouse location, Area of Warehouse, Factors affecting warehousing cost, Warehouse layout, Design principles.

Warehouse Management -Meaning

A warehouse is typically viewed as a place to store inventory. However, in many logistical system designs, the role of the warehouse is more properly viewed as a switching facility as contrasted to a storage facility.

Benefits of Warehousing

1. **Consolidation Shipment** consolidation is an economic benefit of warehousing. With this arrangement, the consolidating warehouse receives and consolidates materials

from a number of manufacturing plants destined to a specific customer on a single transportation shipment.
The benefits are the realization of the lowest possible transportation rate and reduced congestion at a customer's receiving dock.
The primary benefit of consolidation is that it combines the logistical flow of several small shipments to a specific market area.
Consolidation warehousing may be used by a single firm, or a number of firms may join together and use a for-hire consolidation service. ν Through the use of such a program, each individua1 manufacturer or shipper can enjoy lower total distribution cost than could be realized on a direct shipment basis individually. 7 Break bulk warehouses ν

2. **Break bulk warehouse** operations are similar to consolidation except that no storage is performed. ν A break bulk operation receives combined customer orders from manufacturers and ships them to individual customers. ν The break bulk warehouse sorts or splits individual orders and arranges for local delivery. ν Because the long-distance transportation movement is a large shipment, transport costs are lower and there is less difficulty in tracking. Break bulk warehouses…
3. **Processing/Postponement Warehouses** can also be used to postpone, or delay, production by performing processing and light manufacturing activities. ν A warehouse with packaging or labeling capability allows postponement of final production until actual demand is known. For example, vegetables can be processed and canned in "brights" at the manufacturer. Brights are cans with no pre-attached labels. The use of brights for a private label product means that the item does not have to be committed to a specific customer or package configuration at the manufacturer's plant. ν Once a specific customer order is received, the warehouse can complete final processing by adding the label and finalizing the packaging. Processing and postponement provide two economic benefits: ν First, risk is minimized because final packaging is not completed until an order for a specific label and package has been received. ν Second, the required level of total inventory can be reduced by using the basic product (brights) for a variety of labeling and packaging configurations.
4. **Stockpiling** The economic benefit of stockpiling comes from the need of seasonal storage. ν For example, lawn furniture and toys are produced year-round and primarily sold during a very short marketing period. ν In contrast, agricultural products are harvested at specific times with subsequent consumption occurring throughout the year. ν Both situations require warehouse stockpiling to support marketing efforts. ν Stockpiling provides an inventory buffer, which allows production efficiencies within the constraints imposed by material sources and the

customer.

5. **Service Benefits** Five basic service benefits are achieved through warehousing: ν spot stock,
   assortment,
   mixing,
   production support,
   market presence.

   Spot Stock ν Under spot stocking, a selected amount of a firm's product line is placed or "spot stocked" in a warehouse to fill customer orders during a critical marketing period. ν In particular, manufacturers with limited or highly seasonal product lines are partial to this service. ν Rather than placing inventories in warehouse facilities on a year-round basis or shipping directly from manufacturing plants, delivery time can be substantially reduced by advanced inventory commitment to strategic markets. 15 Spot Stock… ν Utilizing warehouse facilities for stock spotting allows inventories to be placed in a variety of markets adjacent to key customers just prior to a maximum period of seasonal sales. ν Suppliers of agricultural products to farmers often use spot stocking to position their products closer to a service-sensitive market during the growing season. ν Following the sales season, the remaining inventory is withdrawn to a central warehouse.

   Assortment ν An assortment warehouse stocks product combinations in anticipation of customer orders. ν The assortments may represent multiple products from different manufacturers or special assortments as specified by customers. ν In the first case, for example, an athletic wholesaler would stock products from a number of clothing suppliers so that customers can be offered assortments. ν In the second case, the wholesaler would create a specific team uniform including shirt, pants, and shoes.

   Assortment vs. Spot Stock ν The differential between stock spotting and complete line assortment is the degree and duration of warehouse utilization. ν A firm following a stock spotting would typically warehouse a narrow product assortment and place stocks in a large number of small warehouses dedicated to specific markets for a limited time period.

   Distribution assortment warehouse usually has a broad product line, is limited to a few strategic locations, and is functional year-round. ν The combined assortments also allow larger shipment quantities, which in turn reduce transportation cost.

   Mixing ν In a typical mixing situation, truckloads of products are shipped from manufacturing plants to warehouses. ν Each large shipment enjoys the lowest possible

transportation rate. ν Upon arrival at the mixing warehouse, factory shipments are unloaded and the desired combination of each product for each customer or market is selected. ν When plants are geographically separated, overall transportation charges and warehouse requirements can be reduced by mixing.

Production Support ν Production support warehousing provides a steady supply of components and materials to assembly plants. ν Safety stocks on items purchased from outside vendors may be justified because of long lead times or significant variations in usage. ν The operation of a production support warehouse is to supply or "feed" processed materials, components, and subassemblies into the assembly plant in an economic and timely manner. Market Presence ν While a market presence benefit may not be so obvious, it is often cited by marketing managers as a major advantage of local warehouses. ν The market presence factor is based on the perception or belief that local warehouses can be more responsive to customer needs and offer quicker delivery than more distant warehouses. ν As a result, it is also thought that a local warehouse will enhance market share and potentially increase profitability.

Warehouse Operating Principles

Once it has been determined to use a warehouse, the next step is designing it. ν Whether the warehouse is a small manual operation or a large automated facility, the following three principles are relevant:
Design criteria,
Handling technology, and
Storage plan.

1. **Design Criteria** ν Warehouse design criteria address physical facility characteristics and product movement.
   Three factors to be considered in the design process are:
   a. The number of stories in the facility,
   b. Height utilization, and
   c. product flow.
   The number of stories in the facility

   The ideal warehouse design is limited to a single story so that product does not have to be moved up and down.

The use of elevators to move product from one floor to the next requires time and energy. The elevator is also often a bottleneck in product flow since many material handlers are usually competing for a limited number of elevators. ν

While it is not always possible, particularly in central business districts where land is restricted or expensive, warehouses should be limited to a single story.

Height utilization Regardless of facility size, the design should maximize the usage of the available cubic space by allowing for the greatest use of height on each floor. νMost warehouses have 20- to 30-foot ceilings (1 foot = 12 inch; 1 inch = 2.54 cm), although modern automated and high-rise facilities can effectively use ceiling heights up to 100 feet.

Through the use of racking or other hardware, it should be possible to store products up to the building's ceiling. ν Maximum effective warehouse height is limited by the safe lifting capabilities of material-handling equipment, such as forklifts.

Product flow ν Warehouse design should also allow for straight product flow through the facility whether items are stored or not. ν In general, this means that product should be received at one end of the building, stored in the middle, and then shipped from the other end. ν Straight-line product flow minimizes congestion and confusion.

2. **Handling technology** ν The second principle focuses on the effectiveness and efficiency of material- handling technology. ν The elements of this principle concern: ν movement continuity and ν movement scale economies. 27 Movement continuity ν Movement continuity means that it is better for a material handler or piece of handling equipment to make a longer move than to have a number of handlers make numerous, individual, short segments of the same move. ν Exchanging the product between handlers or moving it from one piece of equipment to another wastes time and increases the potential for damage. ν Thus, as a general rule, fewer longer movements in the warehouse are preferred. 28 Movement scale economies ν Movement scale economies imply that all warehouse activities should handle or move the largest quantities possible. ν Instead of moving individual cases, warehouse activities should be designed to move groups of cases such as pallets or containers. ν This grouping or batching might mean that multiple products or orders must be moved or selected at the

same time. ν While this might increase the complexity of an individual's activities since multiple products or orders must be considered, the principle reduces the number of activities and the resulting cost.

3. **Storage Plan** ν According to the third principle, a warehouse design should consider product characteristics, particularly those pertaining to volume, weight, and storage. ν Product volume is the major concern when defining a warehouse storage plan. ν High-volume sales or throughput product should be stored in a location that minimizes the distance it is moved, such as near primary aisles and in low storage racks. ν Such a location minimizes travel distance and the need for extended lifting. ν Conversely, low-volume product can be assigned locations that are distant from primary aisles or higher up in storage racks. A Sample Storage Area Storage Plan… ν Similarly, the plan should include a specific strategy for products dependent on weight and storage characteristics. ν Relatively heavy items should be assigned to locations low to the ground to minimize the effort and risk of heavy lifting. ν Bulky or low-density products require extensive storage volume, so open floor space or high-level racks can be used for them. ν On the other hand, smaller items may require storage shelves or drawers. ν The integrated storage plan must consider and address the specific characteristics of each product.

Types of warehouses

Warehouse alternatives include:

(1) **Private warehouses** A private warehouse facility is owned and managed by the same enterprise that owns the merchandise handled and stored at the facility. A private warehouse is operated by the firm owning the product. ν The actual facility, however, may be owned or leased.

The decision as to which strategy best fits an individual firm is essentially financial. ν Often it is not possible to find a warehouse for lease that fits the exact requirements of a firm.

The major benefits of private warehousing include

Control,
flexibility,
cost, and
other intangible benefits.

a. Private warehouses provide more control since the enterprise has absolute decision-making authority over all activities and priorities in the facility.

This control facilitates the ability to integrate warehouse operations with the rest of the firm's internal logistics process.

b. Private warehousing is usually considered less costly than public warehousing because private facility costs do not have a profit markup.

This perceived benefit, however, may be misleading since public warehouses often are more efficient or may operate at lower wage scales.

c. Private warehousing has also some intangible benefits, particularly with respect to market presence. A private warehouse with a firm's name on it may produce customer perceptions of responsiveness and stability. ν This perception sometimes provides a firm with a marketing advantage over other enterprises.

(2) **Public warehouses** A public warehouse, in contrast, is operated as an independent business offering a range of services -such as storage, handling, and transportation- on the basis of a fixed or variable fee. ν Public warehouse operators generally offer relatively standardized services to all clients.

On the basis of the range of specialized operations performed, public warehouses are classified as

(1) general merchandise,
(2) refrigerated,
(3) special commodity,
(4) bonded, and
(5) household goods and furniture.

Each warehouse type differs in its material handling and storage technology as a result of the product and environmental characteristics.…

General merchandise warehouses are designed to handIe general package commodities such as paper, small appliances, and household supplies. ν Refrigerated warehouses (either frozen or chilled) handle and maintain food, medical items, and chemical products with special temperature requirements. ν Commodity warehouses are designed to handle bulk material or items with special handling considerations, such as tires or clothing. … ν Bonded warehouses are licensed by the government to store goods prior to payment of taxes or duties. ν They exert very tight control over all movements in and out of the facility since government documents must be filed with each move.

For example, cigarettes are often stored in bonded warehouses prior to having the tax stamp applied. ν This tactic saves the firm money by delaying tax payments; it also reduces inventory value substantially. 40 Public Warehouses… ν Finally, a household goods or furniture warehouse is designed to handle and store large, bulky items such

as appliances and furniture. ν Of course, many public warehouses offer combinations of these operations.

Public Warehouses…

From a financial perspective, public warehousing may have a lower variable cost than comparable privately operated facilities. ν The lower variable cost may be the result of lower pay scales, better productivity, or economy of scale. ν Public warehouses certainly result in lower capital costs. ν When management performance is judged according to return on investment (ROI), the use of public warehousing can substantially increase enterprise return.

Public Warehouses… ν Public warehousing offers flexibility in that it is easy to change the location, size, and number of facilities, allowing a firm to quickly respond to supplier, customer, and seasonal demands. ν Private warehouses are relatively fixed and difficult to change because buildings have to be constructed or sold. ν Public warehousing can also offer significant scale economies since the volume for each customer is leveraged with that of other users. ν This results in high-volume operations that can spread fixed costs and justify more efficient handling equipment. A public warehouse can also leverage transportation by providing delivery of loads that represent many public warehouse customers. ν For example, rather than have vendor A and vendor B each deliver to a retail store from their own warehouse, a public warehouse serving both vendors could deliver a single combined load more efficiently. 44 Public Warehouses… ν A public warehouse charges clients a basic fee for handling and storage. ν In the case of handling, the charge is based on the number of cases or pounds handled. ν For storage, the charge is assessed on the number of cases or weight in storage during the month. ν Such charges normally exceed the cost of private warehousing if adequate private facility volume exists. ν However, when economies of scale are not possible in a private facility, public warehousing may be a lowcost alternative.

(2) **Contract warehouses**. Contract warehousing, which is evolving from the public warehouse segment, provides benefits of both the private and public alternatives. ν Contract warehousing is a long term, mutually beneficial arrangement which provides unique and specially tailored warehousing and logistics services exclusively to one client, where the vendor and client share the risks associated with the operation. ν Important dimensions that differentiate contract warehousing operators from public warehouse operators are the extended time frame of the service relationship, tailored services, exclusivity, and shared risk.

Contract Warehouses ν Contract warehousing combines the best characteristics of both private and public operations. ν The long-term relationship and shared risk result in lower cost than typical public warehouse arrangements. ν Contract warehouse operations can provide benefits of expertise, flexibility, and economies of scale by sharing management, labor, equipment, and information resources across a number of clients.

Contract Warehouses… ν Although it is common for contract warehouse operators to share resources across clients in the same industry such as grocery products, it is not common that direct competitors will want to share resources. ν Contract warehouse operators are also expanding the scope of their services to include other logistics activities such as transportation, inventory control, order processing, customer service, and returns processing. For example, Rich Products, a frozen food manufacturer in Buffalo, New York, has increasingly utilized contract warehousing. ν Since 1992, Rich has had a long term commitment with a refrigerated warehousing and distribution company, Christian Salvesen, for storage, handling, and distribution services at its facilities in New York. ν The nature of the arrangement benefits both parties and allows Rich to expand its distribution network without incurring any fixed facility cost. Rich is assured that there will always be storage space for its products. ν Christian Salvesen doesn't have to be concerned with filling space in its warehouses and can focus on providing service. ν Moreover, the longer Rich Products utilizes Christian Salvesen's services, the better the contract warehousing firm will be able to understand Rich's business needs and provide customized services.

Warehousing Strategy

Many firms utilize a combination of private, public, and contract facilities. ν A private or contract facility may be used to cover basic year round requirements, while public facilities are used to handle peak seasons. ν In other situations, central warehouses may be private, while market area or field warehouses are public facilities. ν Each use of warehouse combinations will be discussed now. … ν **Full warehouse utilization** throughout a year is a remote possibility. ν As a planning rule, a warehouse designed for full capacity utilization will in fact be fully utilized between 75 and 85 percent of the time. ν Thus from 15 to 25 percent of the time, the space needed to meet peak requirements is not utilized. ν In such situations, it may be

more efficient to build private facilities to cover the 75 percent requirement and use public facilities to accommodate peak demand. It may be more efficient to build private facilities to cover the 75 percent requirement and use public facilities to accommodate peak demand.

The second form of combined public warehousing may result from market requirements. ν A firm may find that private warehousing is justified at specific locations on the basis of distribution volume. ν In other markets, public facilities may be the least cost option. ν In logistical system design the objective is to determine whatever combination of warehouse strategies most economically meets customer service objectives.

Integrated warehouse strategy

An integrated warehouse strategy focuses on two questions.

The first concerns how many warehouses should be employed.

The second question concerns which warehouse types should be used to meet market requirements.

For many firms, the answer is a combination that can be differentiated by customer and product. ν Specifically, some customer groups may be served best from a private warehouse, while a public warehouse may be appropriate for others.

Other qualitative factors that should be considered include:

(1) **Presence synergies**-Presence synergies refer to the marketing benefits of having inventory located nearby in a building that is clearly affiliated with the enterprise (e.g., the building has the firm's name on the door). ν It is widely thought that customers are more comfortable when suppliers maintain inventory in nearby locations. ν Products and customers that benefit from local presence should be served from private or contract facilities.

(2) Industry synergies Industry synergies refer to the operating benefits of collocating with other firms serving the same industry. ν For example, firms in the grocery business often receive substantial benefits when they share public warehouse facilities with other suppliers serving the same industry. ν Reduced transportation cost is the major benefit since joint use of the same public warehouse allows frequent delivery of consolidated loads from multiple suppliers. ν Public and contract warehousing increase the potential for industry synergy.

(3) **Operating flexibility,** Operating flexibility refers to the ability to adjust internal policies and procedures to meet product and customer needs. ν Since private warehouses operate under the complete control of the enterprise, they are usually perceived to

demonstrate more operating flexibility. ν On the other hand, a public warehouse often employs policies and procedures that are consistent across its clients to minimize operating confusion. ν There are many public and contract warehouse operations that have demonstrated substantial flexibility and responsiveness.

(4) **Location flexibility,** Location flexibility refers to the ability to quickly adjust warehouse location and number in accordance with seasonal or permanent demand changes. ν For example, in-season demand for agricultural chemicals requires that warehouses be located near markets that allow customer pickup. ν Outside the growing season, however, these local warehouses are unnecessary. ν Thus, the desirable strategy is to be able to open and close local facilities seasonally. ν Public and contract warehouses offer the location flexibility to accomplish such requirements. 59 Scale economies ν

(5) **Scale economies.** Scale economies refer to the ability to reduce material-handling and storage through application of advanced technologies. ν High-volume warehouses generally have greater opportunity to achieve these benefits because they can spread technology's fixed cost over larger volumes. ν In addition, capital investment in automated equipment can reduce direct variable cost. ν Public and contract warehouses are generally perceived to offer better scale economies since they are able to design operations and facilities to meet higher volumes of multiple clients.

Qualitative Decision Factors Presence synergy and Operating flexibility is higher in Private Warehouses. Other factors are higher in Public Warehouses. Planning the Distribution Warehouse ν The initial decisions of warehousing are related to planning. ν A master plan of the layout, space requirements, and material-handling design should be developed first and a specific site for the warehouse selected. ν These decisions establish the character of the warehouse, which, in turn determines the degree of attainable handling efficiency.

Site Selection

Location analysis techniques are available to assist in selecting a general area for warehouse location. ν Once location analysis is completed, a specific building site must be selected.

Three areas in a community may be considered for location:

1) commercial zones,
2) outlying areas served by motor truck only, and
3) central or downtown areas.

The primary factors in site selection are

1.**The availability of services and cost.** ν The cost of procurement is the most important factor governing site selection.

2. **A warehouse need not be located in a major industrial area**. ν In many cities, one observes warehouses among industrial plants and in areas zoned for light or heavy industry. ν Interestingly, this is not a legal necessity because most warehouses can operate under the restrictions placed on commercial property.

3. **Beyond procurement cost, setup and operating expenses** such as rail sidings, utility expenses, taxes, insurance rates, and highway access require evaluation. ν These expenses vary between sites.

4. The location must offer adequate **room for expansion**. ν Necessary utilities must be available. ν The soil must be capable of supporting the structure, and the site must be sufficiently high to afford proper drainage

5. **Product-Mix Considerations** ν The design and operation of a warehouse are related directly to the character of the product mix. ν Each product should be analyzed in terms of annual sales, stability of demand, weight, and packaging. ν It is also desirable to determine the total size and weight of the average order processed through the warehouse. ν These data provide necessary information for determining requirements in warehouse space, design and layout, material-handling equipment operating procedures, and controls.

6**. ExpansionFuture expansion** is often neglected when an enterprise consider initial establishment of its warehouse facilities. ν Inclusion of a warehouse into the logistical system should be based partially on estimated requirements for future operations. ν Well-managed organizations often establish five- to ten-year expansion plans. ν Such expansion considerations may require purchase or option of a site three to five times the size of the initial structure. Special construction is often considered to ease expansion without seriously affecting normal operations. ν Some walls may be constructed of semi permanent materials to allow easy removal. ν Floor areas, designed to support heavy movements, are extended to these walls in a manner that facilitates expansion.

7. **Selection of Material-Handling System** ν A material-handling system is one of the initial considerations of warehouse planning. ν Movement is the main function within a warehouse. ν Consequently, the warehouse is viewed as a structure designed to facilitate

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maximum product flow. ν It is important to stress that the material-handling system should be selected early in the warehouse design stage.

8. **Warehouse Layout** ν Layout of a warehouse depends on the proposed material handling system and requires development of a floor plan to facilitate product flow. ν It is difficult to generalize about warehouse layouts since they must be refined to fit specific needs. ν If pallets are to be utilized, the first step is to determine the pallet size. ν A pallet of nonstandard size may be desirable for specialized products, but whenever possible, standardized pallets should be used because of their lower cost.

Warehouse Layout

- Size of the pallets: The most common sizes are 40 by 48 inches and 32 by 40 inches. ν In general, the larger the pallet load, the lower the cost of movement per package over a given distance. ν The packages to be placed on the pallet and the related patterns will determine, to a certain extent, the size of pallet best suited to the operation. ν Regardless of the size finally selected, management should adopt one size for the total operation.
- The second step in planning a layout involves the pallet positioning. ν The basic method of positioning pallets in a mechanized warehouse is a ninety-degree, or square, placement. ν Square placement means that the pallet is positioned perpendicular to the aisle. ν The square method is widely used because of layout ease.

9. **Pilferage Protection** ν Protection against theft of merchandise has become a major factor in warehouse operations. ν Such protection is required as a result of the increased vulnerability of firms to riots and civil disturbances. ν All normal precautions employed throughout the enterprise should be strictly enforced at each warehouse. ν Security begins at the fence. ν As standard procedure, only authorized personnel should be permitted into the facility and surrounding grounds and entry to the warehouse yard should be controlled through a single gate. Without exception, no private automobile-regardless of management rank or customer status-should be allowed to penetrate the yard adjacent to the warehouse.

10. Shortages are always a major consideration in warehouse operations. ν Many are honest mistakes in order selection and shipment, but the purpose of security is to restrict theft from all angles. ν The majority of thefts occur during normal working hours.

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Computerized inventory control and order processing systems help protect merchandise from being carried out of the warehouse doors. ν No items should be released from the warehouse unless accompanied by a computer release document.

11**. Product Deterioration** ν Within the warehouse, a number of factors can reduce a product or material to a non-usable or nonmarketable state. ν The most obvious form of product deterioration is damage from careless transfer or storage. ν Another major form of deterioration is non compatibility of products stored in the same facility. Product Deterioration… ν The primary concern is deterioration that results from improper warehouse work procedures. ν A constant concern is the carelessness of warehouse employees. ν In this respect, the forklift truck may well be management's worst enemy. ν Regardless of how often operators are warned against carrying overloads, some still attempt such shortcuts when not properly supervised. In one situation, a stack of four pallets was dropped off a forklift truck at the receiving dock of a food warehouse. ν Standard procedure was to move two pallets per load. ν The value of the damaged merchandise exceeded the average daily profit of two supermarkets. ν Product deterioration from careless handling within the warehouse is a form of loss that cannot be insured against and constitutes a 100 percent cost with no compensating revenue.

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Unit – V

Planning – codification and standardization of the Materials, Incoming Materials Receipts, Retrieval and Transaction Processing System, Security and Loss Prevention, Consumption Based Planning – MRP and lot sixing procedure, Forecasting parameter and result, planned order planning file consolidation, Breakbulk, Crossdocking, Mixing, Assembly – competitive advantage, production support warehouse – ERP, Role of IT in warehousing.

Inventory Planning

Inventory planning includes creating forecasts to determine how much **inventory** should be on hand to meet consumer demand. **Inventory control** is the process by which **managers** count and maintain **inventory** items in the business.

Every organization that is engaged in production, sale or trading of Products holds inventory in one or the other form. While production and manufacturing organizations hold raw material inventories, finished goods and spare parts inventories, trading companies might hold only finished goods inventories depending upon the business model.

When in case of raw material inventory management function is essentially dealing with two major functions. First function deals with inventory planning and the second being inventory tracking. As inventory planners, their main job consists in analyzing demand and deciding when to order and how much to order new inventories. Traditional inventory management approach consists of two models namely:

- EOQ - Economic Order Quantity
- Continuous Ordering
- Periodic Ordering

1. **EOQ:** Economic Order Quantity method determines the optimal order quantity that will minimize the total inventory cost. EOQ is a basic model and further models developed based on this model include production Quantity Model and Quantity Discount Model.
2. **Continuous Order Model:** works on fixed order quantity basis where a trigger for fixed quantity replenishment is released whenever the inventory level reaches predetermined safety level and triggers re ordering.
3. **Periodic System Model:** This model works on the basis of placing order after a fixed period of time.

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Codification and Standardization of Inventory

Due to the growth of industrial activity and diverse kind of industrial requirements, a large no. of organizations have to store a large number of items, often running into several thousands and even lacks. Therefore, there should be some means of identifying them. A common practice is to describe the items by individuals' names. Since several departments use the same item, they call the same item by different names and store them in different places. One of the most useful techniques of "Inventory Management'' is a rationalized codification system for properly classifying equipment, raw materials, components and spares to suit to the particular needs of any organization.

Codification

An article of stores is identified by its simple description or nomenclature. Difficulty arises when the same article is known by different names. For example, chipping goggles, grinder goggles, or white goggles are one item but may be stored separately under same nomenclature as different items. One storekeeper might classify an item as Sal Ammoniac, whereas a research chemist might identify it under the name of Ammonium Chloride, only to be told that it is not available.

The need for Codification arises because of the following reasons:

(i) Speed,
(ii) Unambiguity,
(iii) Saving of Effort,
(iv) Space Saving on forms,
(v) Ease of classification,
(vi) Mechanization.

Characteristics of Codes

As far as possible uniform dimension say, the metric system should be adopted.

i) Code should be Simple.
ii) Code should be unique.
iii) Coding should be compact, concise and consistent.
iv) Code should be sufficiently flexible to meet future demands.

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An ideal material code should

i) Identify commodities
ii) Name commodities
iii) Specify commodities
iv) Classify commodities
v) Indicate inter-relationships between commodities
vi) Indicate the source of origin of commodities
vii) Refer specifically to an individual and unique commodity.
viii) Retrieval and Transaction
ix) Processing System

Codification Systems

One of the prerequisites of classification and codification is to know the basic nature and characteristics of all materials used in an enterprise and then classify them in broad categories and then to group and sub-group them in logical progression of kinds, type and sizes etc. As for example, Raw materials, Semi-processed Materials, Mechanical (Products and equipment), Electrical (products and equipment), Chemicals (Allied products and chemical processing equipment), Laboratory and office (equipment and supplies) etc. can be classified, grouped and sub-grouped first.

Therefore, codification is a process of representing each item by a number, the digits of which indicate the group, the subgroup, the type and the dimension of item. The first two digits normally represent the major groups, such as raw tools, oil stationery, etc. The next two digits indicate the sub-groups, such as ferrous, non-ferrous, etc. Dimensional characteristics of length, width, head diameter usually constitute the further three digits and the last digit is reserved for minor variations.
Some of the systems of codification are:

Arbitrary Systems

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Arbitrary system as the word 'arbitrary' indicates is based on the serial number under which a material is received and the same is allotted as a code number. Using this approach, all inventory items are simply assigned arbitrary numbers in sequence as they are added to the stores account. Each item thus has a discrete number, but it bears no systematic relationship to the numbers assigned to related items. Two similar items or two mating parts may have numbers several thousand digits apart. For example, if bolts are received and suppose a number 2521has already been allotted to the previous item received, then the code number of these bearings will be 2522. This system has the advantage that there is no fixed limit for codifying any number of items. The main disadvantage is that one cannot know the characteristics or history of the items. This is the reason why the system is not popular.

Mnemonic System

A mnemonic system functions much like a numerical system. However, it combines numeric and alphabetic notations in its symbols. For example, the carriage-bolt described under the numerical system in the following manner:

P Fa BCS 503

P denotes a purchased part, Fa is a fastener, BCS stands for bolt, carriage, with a square neck, and 503 represent the specific number of the bolt. Mnemonic systems, particularly where a small number of items are involved, frequently make visual identification easier because they are more descriptive and they are often shorter. As more and different types of items are added to the inventory, however, this advantage diminishes because the numbers of good symbols are limited.

Brisch System

The Brisch system consists of seven digits applied in three stages. The items are grouped into suitable preliminary categories, such as assemblies, sub-assemblies, components and off the shelf items. After these preliminary categories, items are grouped within the respective class in order to bring similar items together. The Brisch

system through it consists only of seven digits, is quite comprehensive as the basis is on logical major groupings.

Kodak System

The Kodak system consists of 10 digits of numerical code. The logic of major grouping is based on sources of supply. All materials are divided into 100 basic classifications, contributed only by procurement considerations. For instance, a bolt is listed as hardware item if this is listed in hardware catalogues and available with hardware suppliers. If this bolt is available as a part of the machine, it will be available under maintenance.

Standardization

Mass production techniques of industrial production are based on the principle of uniformity and interchange ability of many parts, components and material used in the production process. Standard products can be manufactured on a mass scale and their production cost can be kept minimum. Standardisation leads to cheaper and easier procurement and cost of replacement can also be reduced.

In our country Indian Standards Institution (ISI), now known as the Bureau of Indian Standards (BIS), is the national body which deals with standardisation at national level. There are various committees dealing with different industries who formulate national standards.

1. INCOMING MATERIAL RECEIPTS

The receiving section of a warehouse is responsible for the receipt, identification and general inspection of all incoming materials. Receiving is also responsible for notifying all interested parties of the arrival and condition of incoming materials. The importance of the receiving function is often underrated. It is only at the receiving desk that the purchasing control document actually meet the physical materials. Any problem or error in a specific purchase transaction should come to light during the receiving operation. If the problem (shortage in quantity, damaged material, wrong items shipped etc.) is not detected and corrected during the receiving operation, then the cost to correct the mistake later may be much higher.

The receiving procedure of incoming material involves the following stages:

a) Unloading and checking the shipment: The number of containers unloaded from the carriers vehicle should be checked against the carriers consignment document to make certain that the full consignment has been delivered. All containers should also be inspected for external damage, if any, any damage found should be inspected along with the carriers representative and noted on the receipt which the receiving personal signs. Failure to follow this procedure before accepting a shipment can relieve the carrier of all liability for concealed damage not evident until the container is unpacked.

b) Unpacked and inspecting the material: The receiving personnel is responsible for three verification. First, the material received is checked against the sellers packing slip and against a copy of the firms purchase in order to verify that the correct items have been shipped. Second, the quantity is to be verified in the same manner. Finally, the general condition of the material is inspected to determine whether any external damage was incurred during shipment.

c) Completion of the receiving report: A receiving document or report is prepared as a by-product of the purchase order. Upon completion of the inspection, the report is prepared to mention what has been actually received indicating the items of the total order which have not been supplied. The different work groups who generally require notification about the receipt of the materials are the requisitioner (or the inventory control section in case of stock material), the purchasing department, the accounting department, and the incoming or receiving inspection department.

d) Delivery of the materials: in case of non-stock material, the receiving department is usually responsible for delivering them to the reqisitioner or for releasing them to an internal delivery service that transports them to the requisitioner. In case of inventory materials, the practice varies. In some firm, the receiving department is responsible for deliveries, while in other this function is performed by transportation service. In some firm, the stores personnel are responsible for picking up their own materials. This delivery system depends somewhat upon the relative location of the receiving and the store area. Upon delivery of the material, the recipient signs the receiving report as a confirmation of acceptance.

2. STORE RECORDS SYSTEM

Development of appropriate recording system for stores is important to provide right information regarding the physical inventory and accounting of the organization. Two records are usually kept of materials and other goods received issued or transferred, namely, Bin (or stock) card and the store ledger. a) Bin Card: For each kind of material, a separate record is

kept on Bin Card which shows details of quantities of each type of materials received, issued and on hand each day. A storekeeper maintains Bin Cards up-to-date and usually in duplicate. One card is attached to each bin on shelf containing the material and the other record remains with the storekeeper for reference. (Exhibit. 17.2.1) b) Stores Ledger: This is similar to bin card except that there money values are shown. The store ledger may be maintained by a separate material accounting department. The entries regarding the materials ordered, received and issued are made from the purchase order, receiving section report and material requisitions respectively. (Exhibit. 17.2.2) Today most of the stores are maintaining the data of Bin-Card and Stores Ledger with the help of computer, which has made the retrieval process much simpler and economical.

3.THE STORAGE SYSTEM

Processing System Selecting the most suitable storage system means dealing with a number of interacting, and often conflicting factors. The degree of mechanization affects layout, while scarcity of space affects height. The need for rapid over-picking means on easy accessibility to stock, it weighs against space economy. Any storage system is therefore, a compromise between the use of space and use of time. The storage and retrieval are matched processes. The quick location of any item in the stores is required to minimize the retrieval delays. It is possible only where there is definite place for keeping each item and it is kept there. Moreover, the address of that place is conveniently defined. Every item carried have a specific store location address in the form of a code which may be written in the inventory catalogue, or a separate store location index may be prepared. The location code should not be confused with material identification code. Three basis ways of storing: a) Fixed location b) Random location c) Zoned location The first means that while stock can be found immediately without a complex system of recording there can be a considerable waste of space. The second system means space is better utilized, but good and elaborate records have to be kept about where the materials are: Zonal location means that goods of a particular product group are stored in a given area. They may be randomly stored in a zoned location or stored according to fixed location. Particularly in a large highly mechanized or automated store-house fast-moving or high turnover goods and sometimes, medium and slow-movers are also grouped together. The purpose is to assign most suitable types of storage and materials handling equipment to different kinds of stock movement. Fast-moving lines are usually positioned near the input and output end of a stores with the object of reducing the travel time.

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4.AUTOMATED STORAGE/RETRIEVAL

Significant developments have taken place in the area of stores management in the past few decades. The concept of a totally automated storage and retrieval system has been inviting the attention of professionals to match the storage system with the rapid development in the technology. High rise storage systems have been commonly used in advanced countries. Automated material handling systems are used for the unit load type storage retrieval system. But for the systems in which different quantities of different item are to be retrieved the semi automatic kind of material handling with manual operator are used.

Some of the system to improve the efficiency of automated storage/retrieved systems are as follows: i) Sequencing in a optimal way by picking stocks in a signal picking tour. ii) Allowing a single operator to perform all storage and order picking operations in an aisle. iii) Make a picking list based on a single customer's order. iv) Stores items in pairs such as nuts, bolts, washers etc. v) Locating items from the rack as per the structure and importance of orders. vi) Allocating all items related to a specific facility to a single aisle.

5.TRANSACTION PROCESSING SYSTEM

A ***transaction*** is an elementary activity conducted during business operations. ***Transaction processing systems*** (TPS) process the company's business transactions and thus support the operations of an enterprise. A TPS records a non-inquiry transaction itself, as well as all of its effects, in the database and produces documents relating to the transaction.

Transaction Processing Systems (TPS)

TPS are necessary to conduct business in almost any organization today. TPSs bring data into the organizational databases, these systems are also a foundation on which management oriented information systems rest.•Computerized system that performs and records the daily routine transactions necessary to conduct the business; these systems serve the operational level of the organization •Information system used to support and record transactions

"the information system that support business processes, mainly accounting & finance transactions, with some sales, personnel, & production activities as well is the backbone of an organization's information systems.It monitors, collects, stores, processes & disseminates information for all routine core business transactions. These data are input data to functional information systems applications, DSS, and CRM.

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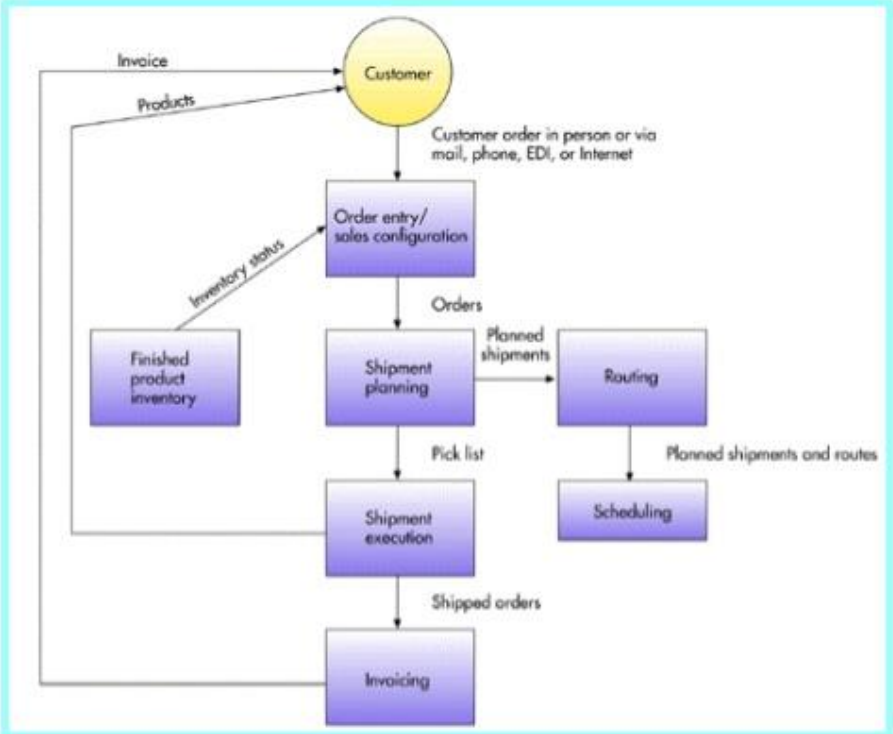
TRADITIONAL TRANSACTION PROCESSING SYSTEMS

Traditional transaction processing systems include order processing, purchasing, and accounting. Systems that support these processing are mentioned in the table.

Order Processing	Purchasing	Accounting
• Order entry	• Inventory control (raw materials, packing materials, spare parts, supplies)	• Budget
• Sales configuration	• Purchase order processing	• Accounts receivable
• Shipment planning	• Receiving	• Payroll
• Shipment execution	• Accounts payable	• Asset management
• Inventory control (finished product)		• General ledger
• Invoicing		
• Customer interaction		
• Routing and scheduling		

Order Processing Systems

- Order processing systems include order entry, sales configuration, shipment planning, shipment execution, inventory control, invoicing, customer interaction, and routing and scheduling.
- Figure below is a system-level flowchart that shows various systems and the information that flows between them.
- A *rectangle* represents a system, a *line* represents a flow of information from one system to another, and a *circle* represents any entity outside the system.
- The systems that support an order processing system are described in the following.



Order Entry

- The order entry system captures the basic data needed to process a customer order.

Sales Configuration

- Ensures that products and services ordered by a customer will work together and are sufficient to accomplish customer's objectives.
- Example: when buying a computer and other peripherals, make sure the peripherals are compatible to the computer.

Shipment Planning

- A system that determines which open orders will be filled and from which location they will be shipped.
- The output of this system is a plan that shows where each order is to be filled and a precise schedule for shipping with a specific carrier on specific date and time.
- The system also prepares a pick list for the warehouse personnel for shipment of each order (containing item and quantity).

Shipment Execution

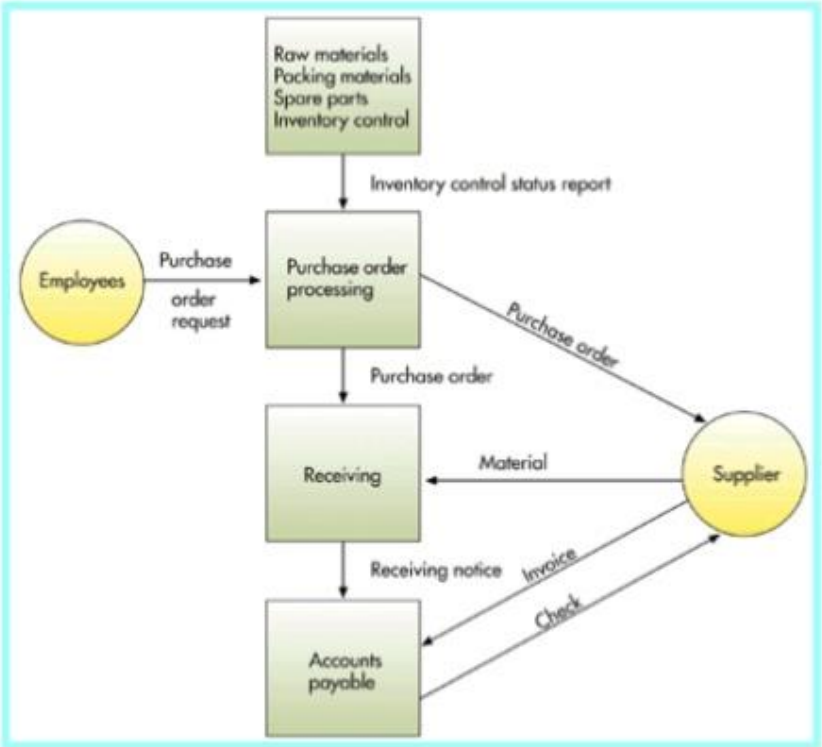
- A system that coordinates the outflow of all products and goods from the organization, with the objective of delivering quality products on time to customers.
- Warehouse operators pack items in the box and item number and quantity for each item is entered in the system.
- It also creates a packing document for each order, which is enclosed with the shipping materials.
- The system passes shipped information (item number and quantity) to the inventory control system to update the inventory.
- The shipped information is also passed onto the Invoicing system to create an invoice.

Inventory Control

- A system that updates the inventory records to reflect the exact quantity on hand of each stock keeping unit.
- When a shipment is made, the quantity of the item is deducted from the

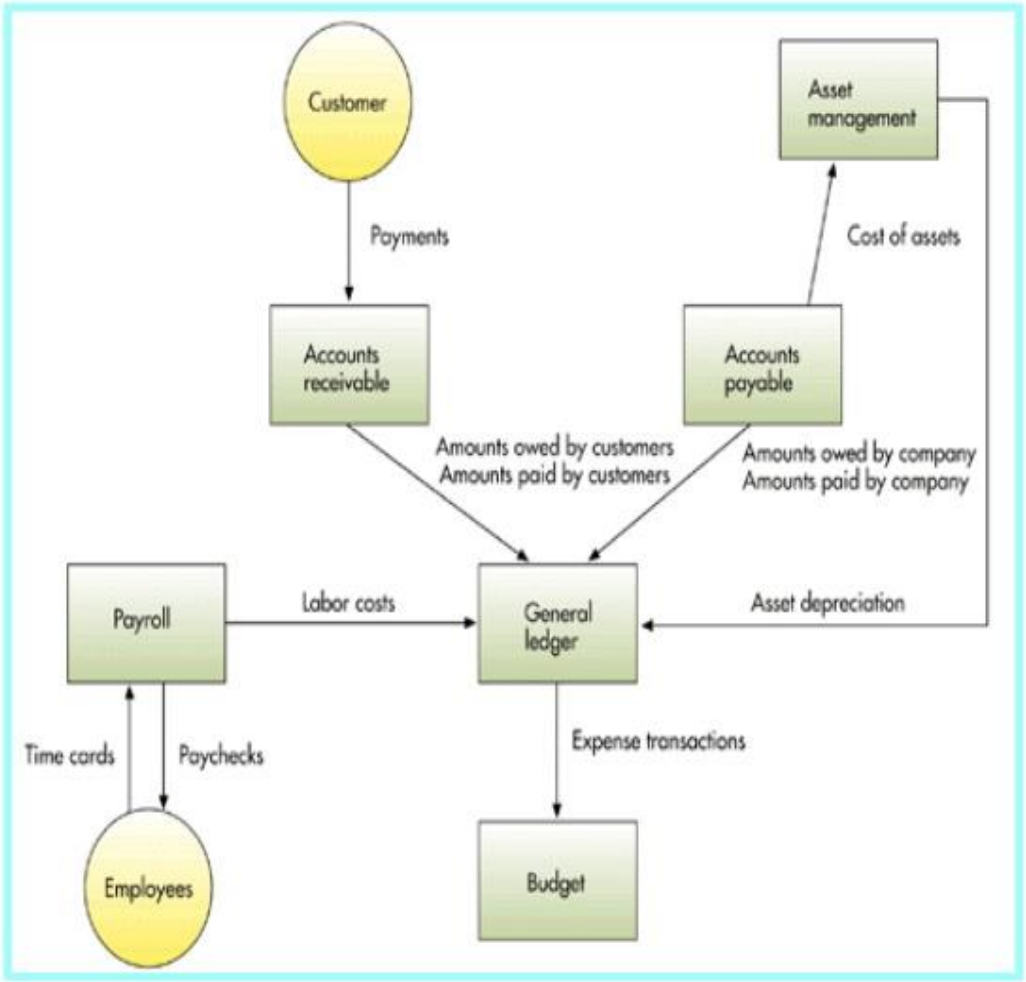
Purchasing System

The purchasing transaction processing system is used when an item (such as a chair or software) is ordered to a supplier from a company. It includes inventory control, purchase order processing, receiving, and accounts payable. These systems are described in the following.



Accounting Systems

An accounting system includes budget, accounts receivable, payroll, asset management, general ledger. These are described in the following.



Loss Prevention Security Measures

1. Stay Alert on the Sales Floor
2. Install a Wireless Security System
3. Include Safety & Security in Your Employee Training
4. Advertise Your Security Measures
5. Monitor Inventory with Your POS System
6. Use Technology to Minimize Loss Stop Taking Cash Payments
7. Add Large Mirrors to Your Store
8. Revise Your Store Layout
9. Establish a Loss Prevention Plan
10. 10.Hire Security Officers
11. Install Security Cameras
12. Give Employees the Tools to Take Responsibility
13. Use Security Display Hooks
14. Keep Your Store Well-organized
15. Understand the Root Cause of Inventory Shrinkage
16. Be Aware of In-store Theft Strategies
17. Add an RFID System

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Consumption Based Planning

Consumption-based planning is based on **past consumption values** and uses the forecast or other statistical procedures to determine future requirements. The procedures in consumption-based planning do not refer to the master production schedule. That is, the net requirements calculation is not triggered either by planned independent requirements or dependent requirement. Instead, it is triggered when stock levels fall below a **predefined reorder point** or by **forecast requirements** calculated using past consumption values.

Consumption-based planning procedures are simple materials planning procedures, which you can use to achieve, set targets with relatively little effort. Therefore, these planning procedures are used in areas without in-house production and/or in production plants for **planning both B- and C-parts** and **operating supplies**.

The prerequisites for implementing consumption-based planning are:

- If you use forecast requirements, the consumption pattern should be fairly constant or linear with few irregularities.
- Your Inventory Management must function well and should always be up-to-date.

Integration

Consumption-based planning is integrated in the *Materials Management* component. You can access the consumption-based planning functions from the SAP Easy Access Menu by choosing *Logistics ® Materials Management ® Materials Planning ® MRP.*

Material Requirements Planning (MRP)

Material requirements planning (MRP) is a computer-based inventory management system designed to improve productivity for businesses. Companies use material requirements-planning systems to estimate quantities of raw materials and schedule their deliveries.

How MRP Works

MRP is designed to answer three questions: *What* is needed? *How much* is needed? *When* is it needed?" MRP works backward from a production plan for finished goods, which is converted into a list of requirements for the subassemblies, component parts, and raw materials that are needed to produce the final product within the established schedule.

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By parsing raw data—like bills of lading and shelf life of stored materials—this technology provides meaningful information to managers about their need for labor and supplies, which can help companies improve their production efficiency.

MRP Systems: Background

Material requirements planning was the earliest of the integrated information technology (IT) systems that aimed to improve productivity for businesses by using computers and software technology. The first MRP systems of inventory management evolved in the 1940s and 1950s. They used mainframe computers to extrapolate information from a bill of materials for a specific finished product into a production and purchasing plan. Soon, MRP systems expanded to include information feedback loops so that production managers could change and update the system inputs as needed.

MRP Procedures

In consumption-based planning, the following MRP procedures are available:

- Reorder point procedure
- Forecast-based planning
- Time-phased materials planning

Creation of procurement proposals

The type of procurement proposal to be created automatically in the planning run depends on the procurement type of the material. For in-house production, the system always creates a planned order. For external procurement, the MRP controller can choose between a planned order and a purchase requisition. If the MRP controller chooses a planned order, it then has to be converted into a purchase requisition in a separate step so that it is made available to Purchasing.

The advantage of creating a planned order is that the MRP controller has more control over the procurement proposals. The purchasing department cannot order the material until the MRP controller has checked and converted the order proposal. If a purchase requisition is created, it is immediately available to the purchasing department, which then takes over the responsibility for material availability and warehouse stocks.

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Planning at plant level or for MRP areas

As materials planning is usually carried out at plant level, all available stock in the plant (from now on described as available warehouse stock) is taken into account during planning. However, stocks from individual storage locations can be excluded from requirements planning or they can be planned independently. These stocks are then not included in material requirements planning at plant level. On the other hand, consignment stocks from the vendor are always included in MRP.

You can also carry out MRP for individual MRP areas. You can define the MRP areas. This means, for example, that you can group several storage locations into one MRP area and carry out MRP for this MRP area.

Lot-sizing procedures

The standard lot-sizing procedures are available in the R/3 System. However, you can quite easily integrate your own formulas without much effort.

Automatic planning run

The automatic planning run determines shortages and creates the appropriate procurement elements. The system creates notes for critical parts and exceptional situations providing you with the necessary information for processing the planning results.

LOT SIZING TECHNIQUES

In order to take advantage of quantity price discounts, reduce shipping and setup costs, or address similar considerations, items are manufactured or purchased in quantities greater than needed immediately. Since it is more economical to produce or purchase less frequently and in larger quantity, inventory is established to cover needs in periods when items are not replenished. Lot-size inventory depletes gradually as customer orders come in and is replenished cyclically when suppliers' orders are received.
A lot-sizing technique that generates planned orders in quantities equal to the net requirements in each period. In MRP logic, planned order releases are equal to net requirements for LFL lot sizing rule.

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 Lot-For-Lot (LFL)
A lot-sizing technique that generates planned orders in quantities equal to the net requirements in each period. In MRP logic, planned order releases are equal to net requirements for LFL lot sizing rule.

 Periodic Review System (PRS)
A periodic reordering system where the time interval between orders is fixed, but the size of the order is variable. An order is placed every n time periods. The time interval is determined arbitrarily. This approach as well as the next approach (POQ) is also known as fixed reorder cycle inventory models. Table 11 is an example of PRS. The size of the order is the total GR in the ordering time intervals. The total cost is 57.27.

 Least Unit Cost (LUC)
A dynamic lot-sizing technique that chooses the lot size with the lowest unit cost by adding ordering cost and inventory carrying cost for each trial lot size and dividing by the number of units in lot size. The unit cost is calculated from the period next to a period with a planned order receipt, until the lowest unit is found. In Table 14, a lot size covering the GR from period 3 to period 6 is of the least unit cost, as shown in Table 15. The total cost of this example is 48.99.

 Part Period Balancing (PPB)
One part-period of an item means one unit of that item is carried in inventory for one period. Economic part-period (EPP) is the quantity of an item which, if carried in inventory for one period, would result in a carrying cost equal to setup cost. Therefore,

EPP = Ordering Cost / Unit Carrying Cost

PPB is a dynamic lot-sizing technique that uses the same logic as LTC method
The result is the same as in LTC.
An adjustment procedure called “look ahead/look back” is frequently added to the PPB technique to improve the schedule. Look-forward/look-back features adjust the schedule by including the requirement next to or excluding the requirement prior to the period covered by current lot size. This technique is used to prevent stock covering peak requirements from being carried for long periods of time and to keep orders from

being brought in too early in periods with very low requirements. When the look ahead/look back feature is used, a lot quantity is calculated and the next or the previous periods' demands are evaluated to determine whether it would be economical to include them in the current lot before the quantity is firmed up.

Cushions

The environment of operations planning and control is uncertain. The best way to solve the uncertainty problem is to eliminate the uncertainty, i.e., to make the environment more stable through the efforts such as increasing the similarity of product and process design, shortening the setup time, decreasing the lot sizes, decreasing the manufacturing lead-times, smoothing the supply channels, etc. Before the uncertainties are removed, we have to face them. The consideration of safety is crucial to reduce the influences of manufacturing environment's uncertainties. Three safety considerations are frequently applied.

 Safety Stock

The safety stock is used to cover the random uncertainties caused by unknown factors. When the source of an uncertainty is known, such as suppliers' late delivery, approaches other than safety stock should be used to resolve it. Masking the source of the problem causing an uncertainty with safety stock will prevent the actual cause of the problem from being addressed.

 Safety Time

If a supplier's delivery tends to be late, increasing the lead-time will not be an effective method of smoothing production. Suppliers tend to ignore orders with long lead-times in favor of urgent orders placed by other buyers. Longer lead-times may therefore result in more serious late deliveries. Safety time in the MRP logic moves both the planned order receipt and the planned order release to an earlier period. To the suppliers, the lead times remain the same, but the due dates are earlier than when are actually needed.

 Safety Capacity

In priority planning, sometimes scheduled quantities require available capacity that exceeds current productive capacity (see chapter five). Safety capacity provides protection from planned activities, such as resource contention and preventive maintenance, and unplanned activities, such as additional requirement, resource breakdown, poor quality, rework, or lateness.

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{**Consolidation, Breakbulk, Crossdocking, Mixing, Assembly – competitive advantage, production support warehouse} Notes already available in Unit 4**

Inventory Management Systems

Modern day inventory is managed by sophisticated system applications that are designed to manage complex inventory plans and to a large extent contain processes that initiate and streamline the operations and inventory management. In the wake of improvements in the communication technology, companies are deploying one single ERP system across all factories, offices, departments and locations, thereby ensuring seamless transactions, visibility and controls.

Inventory in the earlier days used to be managed by a system known as cardex system. Bin cards were printed and kept in every bin location. Whenever inventory was put into the bin or removed, the card had to be updated. Apart from the bin cards, books or registers were maintained to note down the transactions and reports were prepared manually. The system was basic and did not provide flexibility to manage warehouse locations as dynamic locations. The operations being manual were time consuming.

In the next phase come the basic inventory management systems, which were a replica of the accounting books containing debit and credit entries along with the balance and the **Cardex System** continued to be used to manage the shop floor operations.

With the **ERP System** introduction, MM modules are deployed which work in tandem with procurement and other modules. Inventory modules contain intelligent applications that manage the inventory, help in analysis, categorization and to a large extent initiate actions and processes based on auto inputs derived from other sources.

ERP systems do contain WMS modules, which can be deployed along with the inventory module to manage the warehouse operations. Basic inventory modules in ERP do contain location management of inventory but do not support warehousing operations in detail. **WMS System** applications are designed to work like an extension of the inventory system but are stand alone applications that help in warehousing, control, direct and manage inventory and operations.

In fact a robust system suite comprising of ERP and WMS with interfaces built in between the two systems can play a major role in managing inventory efficiencies.

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Both the systems need to be robust, strong and built to suit the business operations requirement as well as logistics operations requirements. While the inventory management efficiencies depend upon the ERP functioning and features, the inventory operations management is heavily dependant upon WMS System.

WMS system is different from an ERP based inventory system in the sense that WMS manages inventory but manages inventory operations and warehouse operations. Though it mirrors the inventory that lies in ERP, the rest of the operations that are carried out through WMS are different and operations intensive.

Until a few years ago the inventory operations used to be carried out with basic WMS where most of the operations were manual. Put away lists and pick lists had to be printed and issued to the operators, who had to note down the bin location and the pallet ID etc on the slip and give it back to the operator to do the data entry into the WMS and update the systems. With the introduction of scanning technology things became a lot more easier where barcodes labels could be pasted on the inventory which could then be scanned via hand held or wire less scanners and the data could get uploaded into the WMS. This was further replaced by RF scanners, which work in real time basis. Today most of the warehouse operations are carried on through RF Scanners, which are like the extension of the WMS and are connected to the system on real time basis. The operators can now download tasks, carry out the tasks and upload confirmation of task completion into the system through RF scanners. This has not only improved operations efficiencies and ensure better house keeping but has greatly improved the inventory as well as data efficiency.

Both ERP and WMS systems along with RF technology have helped improve inventory visibility, accuracy and operations efficiency, resulting in faster operations, leaner inventory and good warehouse management practices.

RF Tag IDs have made an entry into the inventory and supply chain arena and are currently being adapted by retail and textile industries as well as aero spares industry etc. Tag IDs will provide inventory visibility at all times through out the supply chain and thereby ensure inventory accuracy. They are expected to help cut down and ease a lot of operational processes too. However exorbitant cost of the RF tag IDS has been the entry barrier that kept the industries from adapting this technology. The rates are dropping fast making it viable for all industries to adopt these into the inventory management and operations systems.

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