

UNIT-IV

PLANNING AND CONTROLLING IN OPERATIONS

Planning and Controlling of operations

- ***Operational planning*** is an estimation of what needs to be done to ensure operational processes are efficient and effective-that supply always meets demand.
- ***Operational control*** is to ensure that operations conform with this estimation, and if they do not, adjustments can be made.
- operations design-----> Product to be produced
- Planning and control, often known as production planning and control, are management functions that seek to determine: first, what market demands are stating and second, reconcile how a company can fill those demands through planning and monitoring.

NEED

- 1) Effective utilization of the firm's resources.
- 2) To achieve the production objective concerning quality, quantity, cost, and timeliness of delivery.
- 3) To obtain the uninterrupted production flow to meet the customer demands concerning quality and committed delivery schedule.
- 4) To help the company to supply a good quality product to the customer continuously at company rates.

Typical activities in the planning and control process include...

- ***Setting Objectives***- so that you know what is to be achieved by your plans and by when
- ***Allocating Tasks And Responsibilities***-who is to be involved with the new product and service and how they are to be involved
- ***Scheduling***- work patterns, process scheduling, supply and demand scheduling
- ***Assessing Resource Requirements***-people and their skills, money (budgets), time, raw materials, plant and equipment, capacity
- ***Monitoring And Evaluating Performance***-the control part, involving control activities, measures and control techniques

*Stages or Steps
in...*

Production Planning and Control

First step relates to
Production Planning.

1. Routing.

Second step relates to
Production Planning.

2. Scheduling.

Third step relates to
Production Control.

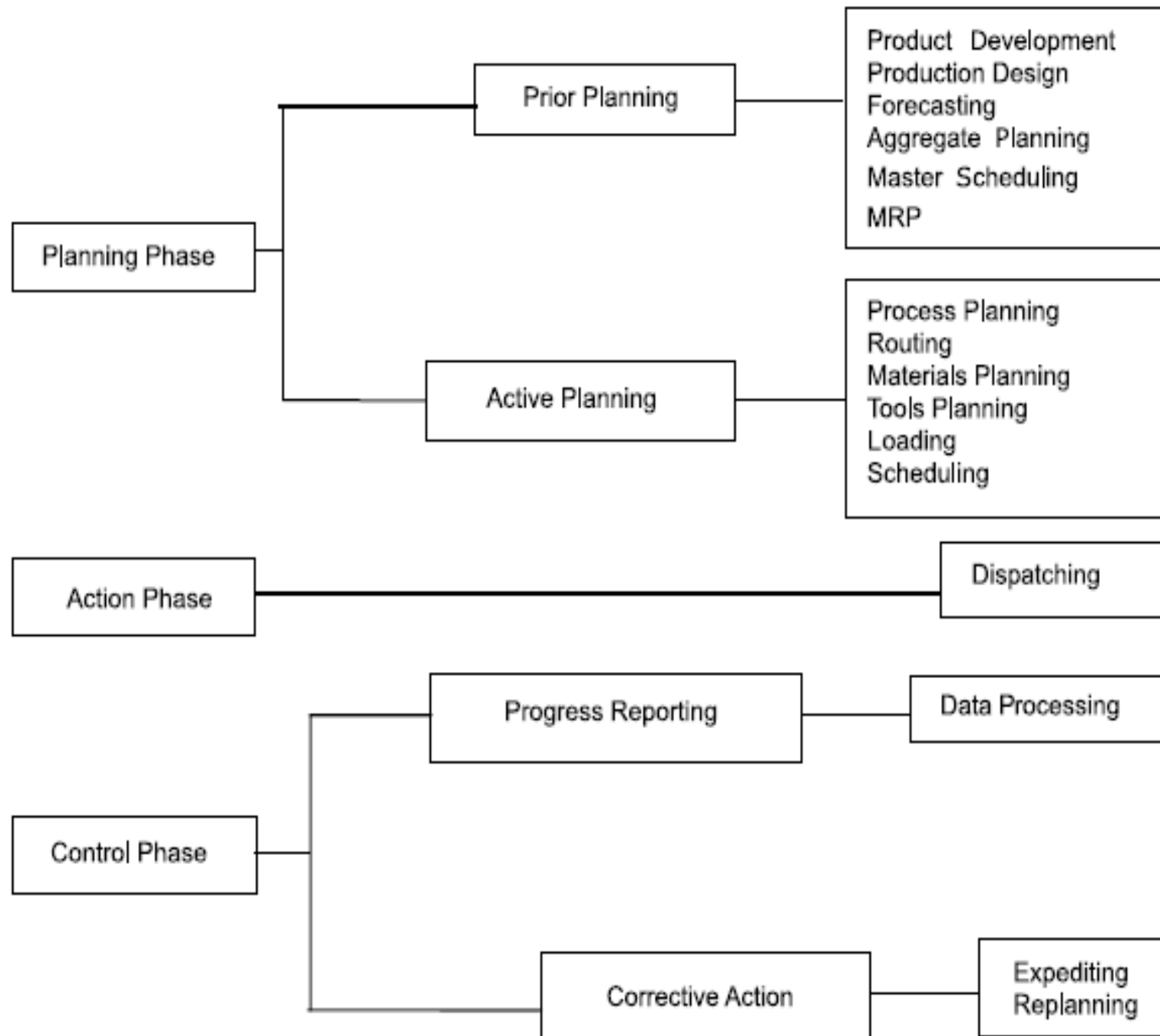
3. Despatching.

Fourth step relates to
Production Control.

4. Follow-up.

- to determine the path of production from raw materials to finished goods. Here, you will determine the equipment, resources, materials and sequence to be used.
- to determine when operations are scheduled. Here, the goals may be to increase throughput, reduce lead time, or increase profits. Many strategies can be used to create the most efficient schedule.
- starts when production is initiated. That is, when the scheduling plan is implemented, materials and work orders are released, and work is flowing down the production line.
- to determine whether there are any bottlenecks or inefficiencies in the process.

Stages/Phases of Production Planning and Control



PLANNING PHASE -To establish how an objective can be achieved or a need fulfilled in circumstances- production planning determines the optimal schedule and sequence of operations economic batch quantity, machine assignment and dispatching priorities for sequencing. It has two categories of planning namely

It includes two phases:

- **i) Pre-Planning :**

It comprises of the demand forecasting and resource planning, product planning and its development, planning of facilities, and planning for the plant location and layout.

- **ii) Active Planning :**

It comprises of quantity planning, routing and scheduling, product mix determination, process planning. material planning, tool planning and capacity planning.

Action Phase - Dispatching is the transition from planning phase to action phase

The tasks which are included in dispatching are job order, store issue order, tool order, time ticket, inspection order, move order etc.

- The **job order** number is the key item which is to be mentioned in all other reports/orders- will contain some testing and inspection to avoid rework
- **Stores issue order** gives instruction to stores to issue materials for manufacturing the product as per product specifications. As per tooling requirements for manufacturing the product, the **tool Order** instruct the tool room to issue necessary tools.
- **Time ticket** is nothing but a card which is designed to note down the actual time taken at various processes. This information is used for deciding the costs for future jobs of similar nature and also for performing variance analysis, which helps to exercise control.

Control Phase

Progress reporting and Corrective action.

- ***PROGRESS REPORTING***

- what is happening with the job is collected.
- make comparison with the present level of performance

- ***CORRECTIVE ACTION***

- The tasks under corrective action primarily make provisions for an unexpected event.
- Some examples of corrective actions are creating schedule flexibility, schedule modifications, capacity modifications, make or buy decisions, expediting the work, pre-planning, and so on.
- Due to unforeseen reasons such as, machine breakdown, labor absenteeism, too much rejection due to poor material quality etc., it may not be possible to realize the schedule as per the plan.
- Under such condition, it is better to reschedule the whole product mix so that we get a clear picture of the situation to progress further.- Under such situation, it is to be re-examined for selecting appropriate course of action.

Importance of Production Planning and Control

Following is the importance/advantages of the production planning and control :

- 1) Increase in Productivity
- 2) Removing the Hurdles
- 3) Better Quality
- 4) Consumer Satisfaction
- 5) Saving in Cost
- 6) Increase in Production
- 7) Optimum Utilization of Resources
- 8) Minimum Overtime
- 9) Better Industrial Relations
- 10) Better Profitability

Demand forecasting

- Demand forecasting is **the process of using predictive analysis of historical data to estimate and predict customers' future demand for a product or service**. Demand forecasting helps the business ***make better-informed supply decisions*** that estimate the total sales and revenue for a future period of time.
- ***People involved***-Sales managers, marketers and manufacturing, finance and production managers - demand planner and demand planning analyst.
- to have just the ***right amount of inventory to meet customer demand*** without incurring ***shortages or wasting money*** on making and storing surplus inventory.

Elements Of Demand Planning

Demand planning is a complex process that typically includes the following elements:

- **data collection** from internal and external sources on the factors known to predict or influence demand;
- **statistical analysis** of sales, inventory and other data;
- **modeling** the data to predict future demand; and
- **collaboration** with suppliers, manufacturers, salespeople and other stakeholders to gather information on events that could affect demand, such as promotions and production delays.

The above processes lead to the creation of the following:

- **demand forecast**, a prediction of demand based on the data model and analysis, followed by a **demand plan** that outlines the amount, type and location of inventory needed to satisfy the forecasted demand.

Types of Demand Forecasting

1.Active demand forecasting:

In-active demand forecasting, The forecasting is done on the assumption that the firm changes the course of its action. The prediction is done under the condition of favorable future changes in the operations by firms- **is ideal for newly established businesses or companies that are currently in a growth phase.**

2.Passive demand forecasting:

It is a rare type of forecasting and mostly done by the businesses which are stable and having very conservative growth plans. The forecast is based on the assumption that the firm doesn't change the course of its action. Small and local businesses prefer it for planning- it simply involves **using past sales data to predict future sales data.**

3.Short term demand forecasting:

In short term demand forecasting, forecasting is done for a shorter period of 3 months to 12 months. The demand pattern and the effect of the strategic decisions on customer demand are analyzed under this.

Types of Demand Forecasting

4.Long term demand forecasting:

When forecasting is carried out for a **period of more than 12 months**, such forecasting is known as long term demand forecasting. Long term forecasting is helpful in suitable **capital planning, business strategy planning, sales and management planning** etc.- or example, expansion of plant capacity, opening a new unit of business, etc.

5.External or National group forecasting:

The forecasting **carried out by a company's research wing or by outside consultants** is known as **external group forecasting**. It deals with the trends in general business.

6.Internal or Company group forecasting:

It refers to the forecasting **estimation by the operations of a particular enterprise** such as production group, sales group and financial group. It includes a forecast for annual sales, forecast of operating profit, forecast of cash resources and forecast of a number of employees etc.

Types of Demand Forecasting

7. *Macro-level forecasting:* (major uncontrollable, external forces)

In this, the broad market operations are analyzed and then forecasting is carried out in macro economic environment. It is measured by an appropriate index of industrial production, national income or expenditure.

8. *Industry-level forecasting:* (*Industry as whole or the product alone*)

This type of forecasting is prepared by different trade associations based on the survey of consumers' intention and analysis of statistical trends-For example demand for cement in India, demand for clothes in India, etc.

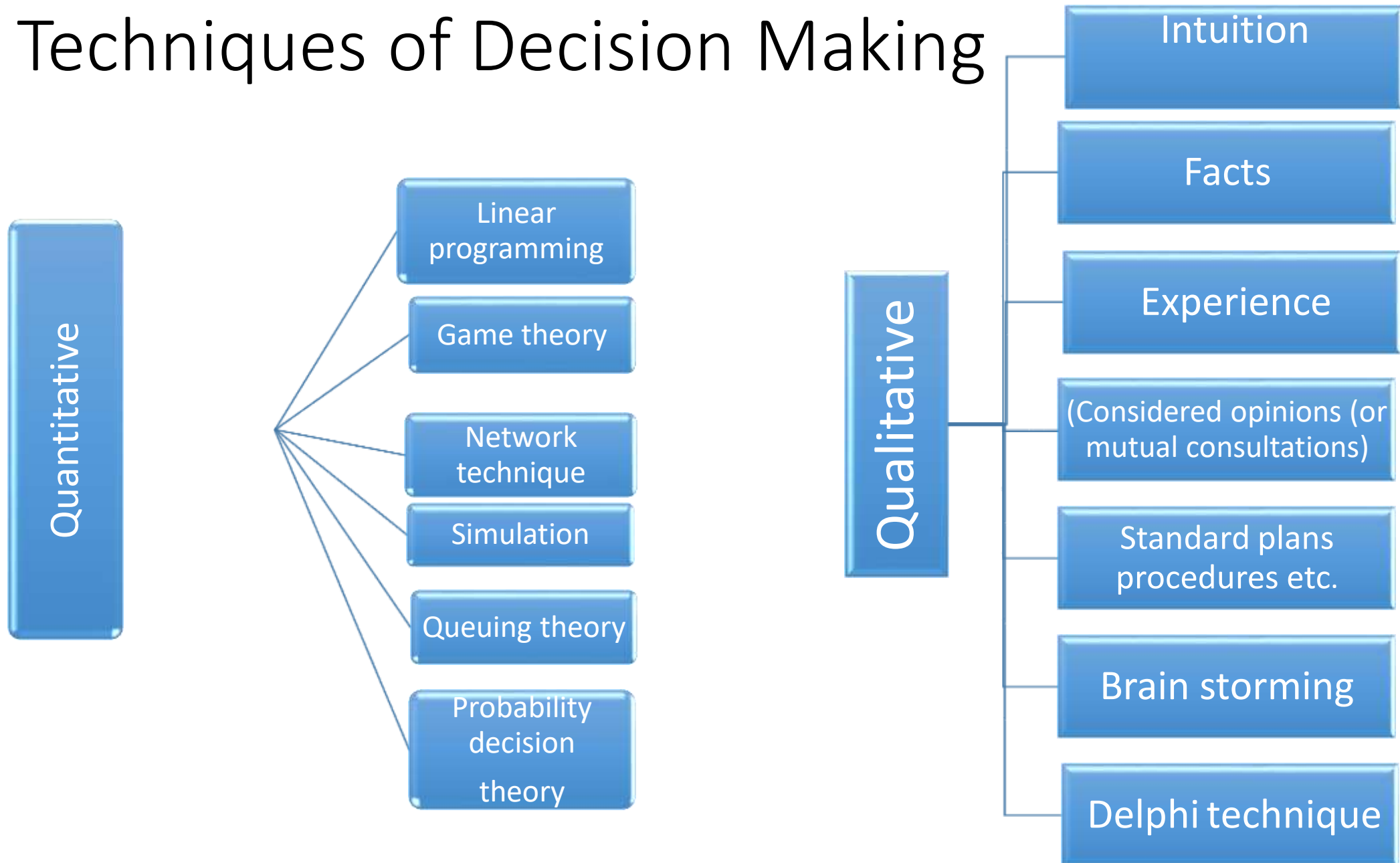
9. *Firm-level forecasting:*

This forecasting is prepared from the viewpoint of managers and is related to an individual firm-It means forecasting the demand for a particular firm's product. For example, demand for Birla cement, demand for Raymond clothes, etc.

10. *Product line forecasting:*

This forecasting is related to the product or products being produced by the firm. It helps the firm to decide which of the products should have priority in the allocation of the firm's limited resources.

Techniques of Decision Making



Techniques of Decision Making

Qualitative

- based on many algorithms like type and quality of data
- more in-depth evaluation of information taking into account
- comprehensive understanding of the analyst (active participant)

Quantitative

- based on statistical analysis of collected data
- the analyst is the mere dispassionate investigator of discrete variables.

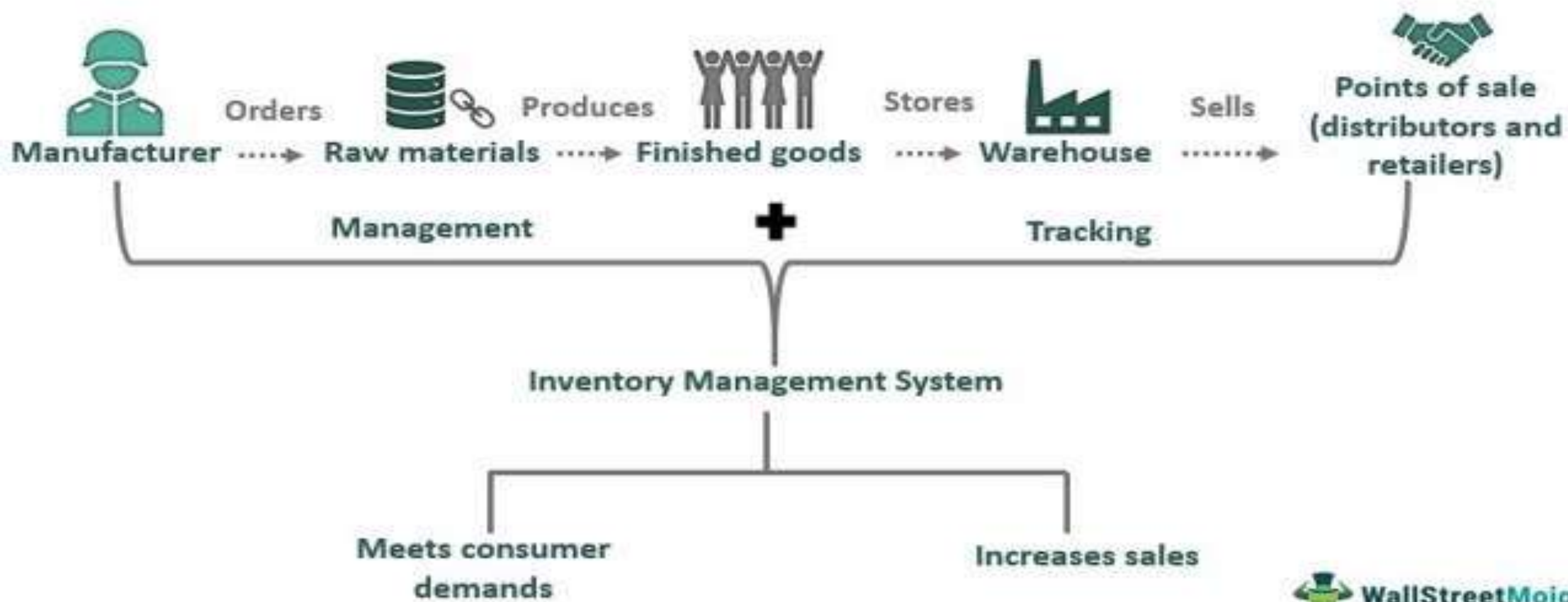
Inventory Planning and Control

Inventory generally refers to the materials in stock. It is also called the idle resource of an enterprise.

Inventory Planning

- Inventory planning involves [forecasting demand](#) and deciding exactly how much inventory and when to order. When done successfully, this helps companies meet demand whilst reducing expenditure.
- Inventory is a primary asset of any retail business. Efficient [inventory management](#) and control keep business on a profitable path, help to maximize profits, make the most of inventory use, avoid overstocks, and reduce write-offs

How Inventory Management Works?



Inventory Management Process

- 1 Goods are delivered



- 2 Goods are reviewed, sorted, and stored



- 3 Inventory levels are monitored



- 4 Stock orders are placed



- 5 Stock orders are approved



- 6 Goods are taken from stock



- 7 Inventory levels are updated



- 8 Low stock levels trigger purchasing



Objectives of Inventory management

- **Material Availability** (maintain a buffer stock of all critical goods in order to keep production on track)
- **Better Level of Customer Service** (maintain an adequate supply of completed items to guarantee that customers' orders are fulfilled- company's brand image.)
- **Keeping Wastage and Losses to a Minimum** (Inventory management attempts to minimize inventory waste at all stages, such as during storage in godowns or during production in the plant.)
- **Maintaining Sufficient Stock** (enough of the necessary material on hand to meet client demand-steady supply)
- **Cost-Effective Storage** (eliminates the possibility of keeping extra stock)
- **Cost Value of Inventories Can Be Reduced** (negotiate discounts and other incentives to lower the overall cost – on regular basis)
- **Optimizing Product Sales** (determine the volume of product sales- identify things that move at a slower rate, and remove them)

Types of Inventory

1) Movement Inventories

2) Buffer Inventories

3) Anticipation Inventories

4) Decoupling Inventories

5) Cycle Inventories



- **MOVEMENT INVENTORIES:** Pipeline inventory refers to **stock that is currently in transit between locations and has not yet been purchased by the consumer**. Pipeline inventory, also called Pipeline Stock, is important to consider as it helps build a picture of how much of your assets are tied up in stock.
- **BUFFER INVENTORY:** inventory is sometimes used to protect against the uncertainties of supply and demand, as well as unpredictable events such as poor delivery reliability or poor quality of a supplier's products- the higher the level of buffer inventory, the better the firm's customer service-Safety stocks
- **ANTICIPATION INVENTORY:** Oftentimes, firms will purchase and hold inventory that is in excess of their current need in anticipation of a possible future event (a price increase, a seasonal increase in demand, or even an impending labor strike. This tactic is commonly used by retailers. Ex: at Halloween, Christmas, or the back-to-school season)
- **DECOUPLING INVENTORY:** a decoupling inventory that serves as a shock absorber, cushioning the system against production irregularities. As such it "decouples" or disengages the plant's dependence upon the sequential requirements of the system (i.e., one machine feeds parts to the next machine).
- **CYCLE INVENTORY:** concept of economic order quantity (EOQ) - cycle inventory results from ordering in batches or lot sizes rather than ordering material strictly as needed (When large quantities are ordered or produced, inventory holding costs are increased, but ordering/setup costs decrease.

Benefits of Inventory Control

It is an established fact that through the practice of scientific inventory control, following are the benefits of inventory control:

- Improvement in customer's relationship because of the timely delivery of goods and service.
- Smooth and uninterrupted production and, hence, no stock out.
- Efficient utilization of working capital. Helps in minimizing loss due to deterioration, obsolescence damage and pilferage.
- Economy in purchasing.
- Eliminates the possibility of duplicate ordering.

INVENTORY MANAGEMENT TECHNIQUES THAT YOU NEED TO KNOW



Inventory System

facilitates the [organizational structure](#) and the operating policies- responsible for ordering and receipt of materials, timing the order placement and keeping record of what has been ordered, how much ordered and from whom the order placement has been done.

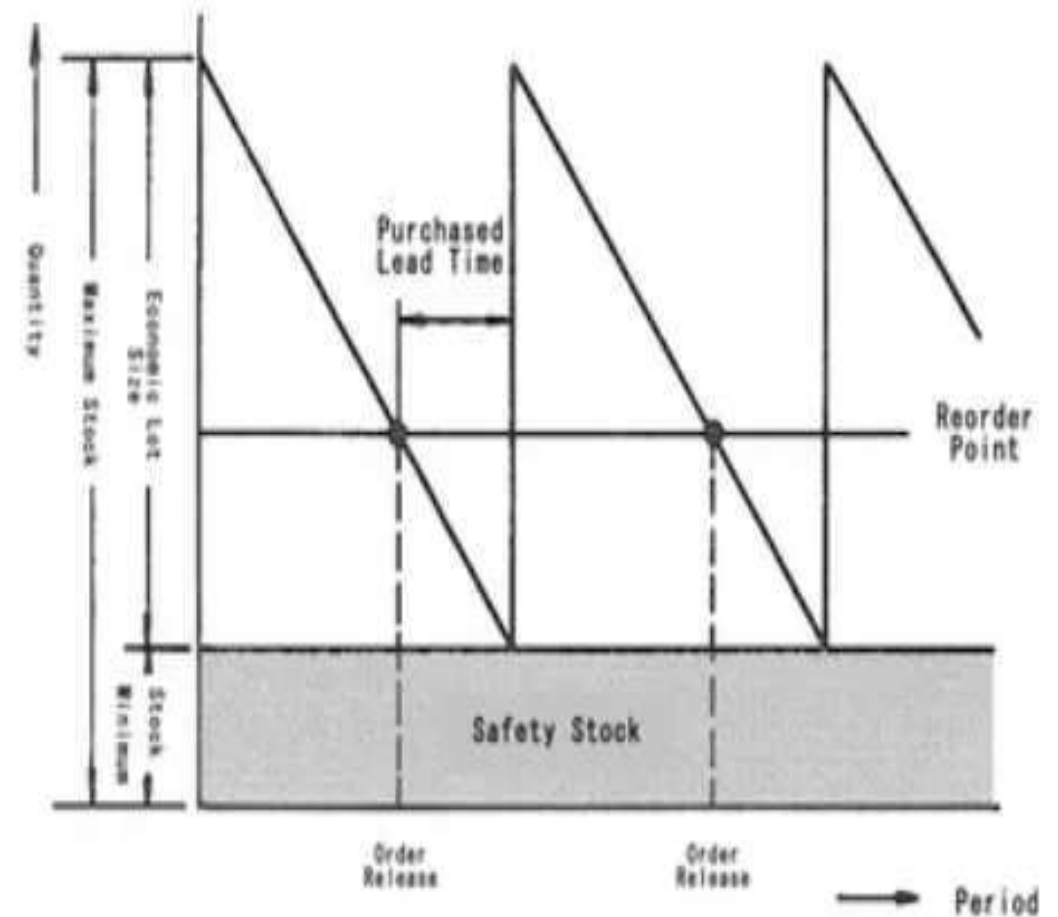
There are two models of inventory system:-

- The fixed order quantity system
- The fixed order periodic system

Inventory=French word inventaire and the Latin word inventariom, means a list of things which are found

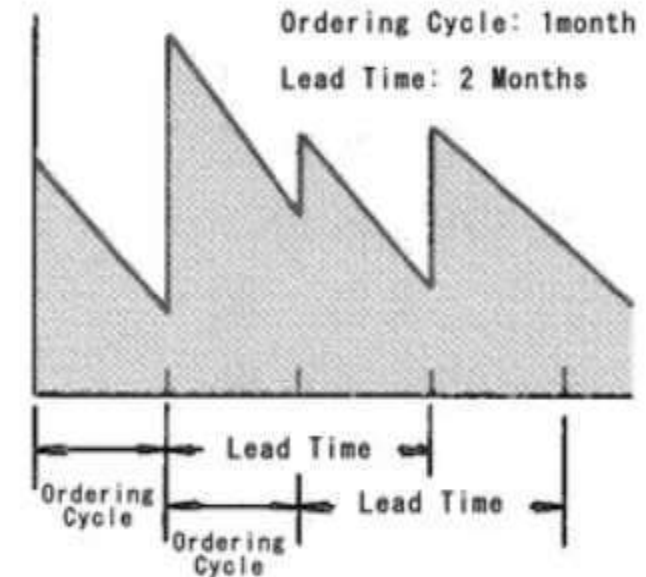
FIXED ORDER QUANTITY SYSTEM (Q SYSTEM)

- The fixed order quantity system is also known as **the Q system**.
- In this system, whenever the stock on hand reaches the reorder point, a fixed quantity of materials is ordered. The fixed quantity of material ordered each time is actually the **economic order quantity**.
- This method facilitates for a predetermined amount of a given material to be **ordered at a particular period of time**. This method helps to limit reorder mistakes, conserve space for the storage of the finished goods, and block those unnecessary expenditures that would tie up funds that could be better utilized elsewhere.
- an automatic reorder point



FIXED ORDER PERIOD SYSTEM (P SYSTEM)

- stock position-checked at regular intervals of time period.
- When the stock level of a given product is not sufficient to sustain the operation of production until the next scheduled tested, an order is placed destroying the supply.
- The frequency of reviews varies from organization to organization
- The order quantities vary for different materials.



$$\text{Order Quantity} = \text{Scheduled Demand of (Ordering Cycle + Lead Time)} + \text{Safety Stock} - \text{Inventory Quantity} - \text{Released Order}$$

Fixed-Order Quantity and Fixed-Time Period Differences

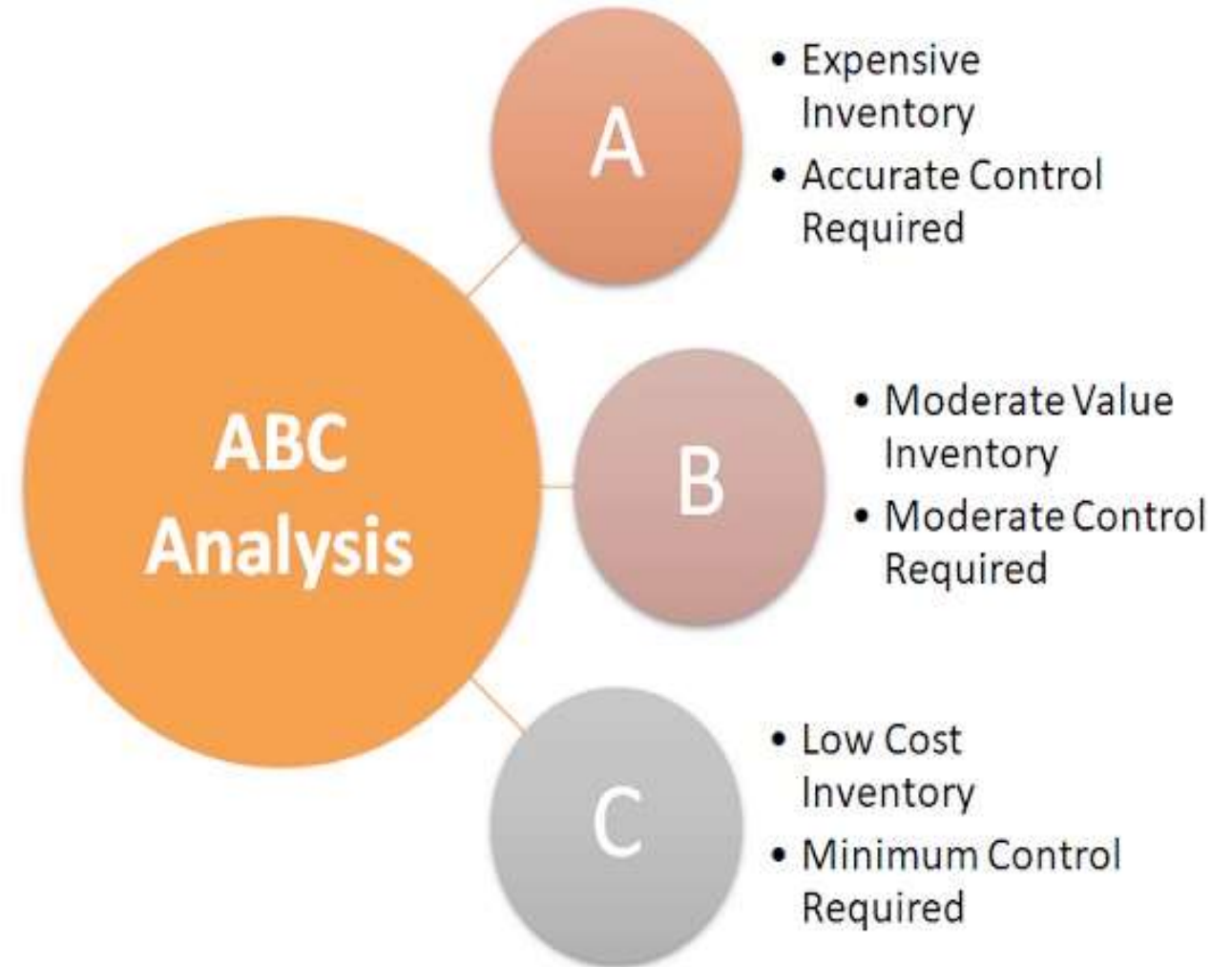
FEATURE	<i>Q-MODEL</i>	<i>P-MODEL</i>
	FIXED-ORDER QUANTITY MODEL	FIXED-TIME PERIOD MODEL
Order quantity	Q —constant (the same amount ordered each time)	q —variable (varies each time order is placed)
When to place order	R —when inventory position drops to the reorder level	T —when the review period arrives
Recordkeeping	Each time a withdrawal or addition is made	Counted only at review period
Size of inventory	Less than fixed-time period model	Larger than fixed-order quantity model
Time to maintain	Higher due to perpetual recordkeeping	
Type of items	Higher-priced, critical, or important items	

TOOLS & TECHNIQUES OF INVENTORY MANAGEMENT/ CONTROL

- ABC Analysis
- Economic Ordering Quantity (EOQ)
- Order Point Problem
- Two Bin Technique
- VED Classification
- HML Classification
- SDE Classification
- FSN Classification
- Order Cycling System
- Just In Time (JIT)

ABC Analysis- Always Better Control Analysis

- company can determine the items that hold more importance and high value and hence, need more considerable attention.
- Category A (70% Value 20% Volume)
- Category B (20% Value 30% Volume)
- Category C (10% Value 50% Volume)
- ABC Analysis allows you to focus and manage your time and resources on the essential items



Economic Order Quantity (EOQ) Model

Economic Order Quantity

$$EOQ = \sqrt{\frac{2 \times D \times S}{H}}$$

D = Annual demand (units)

S = Cost per order (\$)

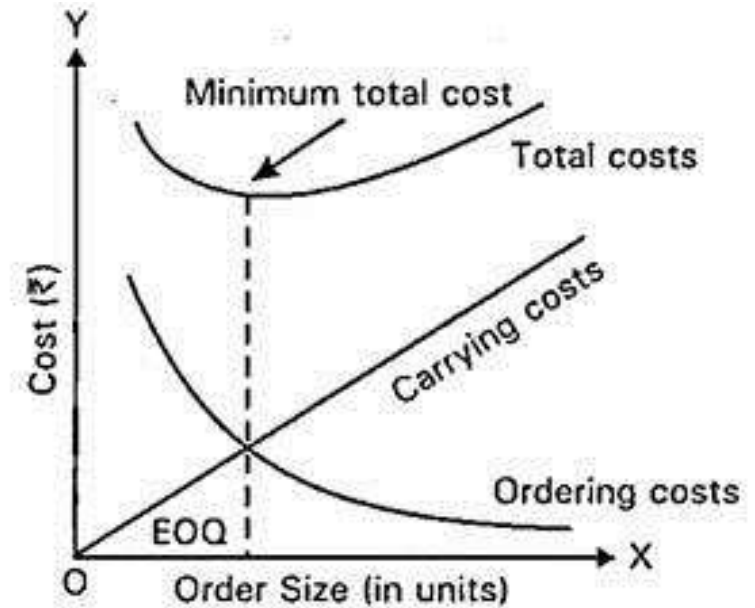
C = Cost per unit (\$)

I = Holding cost (%)

H = Holding cost (\$) = I x C

- how much quantity of inventory the company should order at any point in time and when they should place the order.(the store manager will reorder the inventory when it reaches the reordering level)
- to avoid over-spending in an item, minimize the ordering and the holding costs associated with the item
- the main aim is to minimize the total cost (from ordering to holding) for every order.
- Any order has two components: **the cost of the order and the cost of holding inventory.**
 - the number of units ordered or the volume of the order-Ordering Cost
 - It can be in the form of go down space or rentals for the storage area, electricity bills, and repairs and maintenance-Holding Cost or Carrying Cost

Calculation



EOQ can be determined by the following formula :

$$EOQ = \sqrt{\frac{2 \times A \times O}{C}}$$

where

- A = Annual purchase requirement in units
- O = Ordering cost per order
- C = Carrying cost per unit

Example: Sam's chairs

Sam decides to set up a business selling her handcrafted dining chairs. Each chair she makes requires 6 different sizes of wood, plus a cushion. She goes to her supplier and buys 10 planks of each size of wood she needs, plus 10 cushions. These are all now included in her business' inventory.

As she turns raw materials into chairs, then sells them, Sam's inventory levels will change. She'll need to keep track how much of each material she has at any one time, how many chairs she can make, how fast she can make them, where her materials are, how many chairs she is selling and much more. This is all inventory management.

Don't worry if that seems daunting — inventory management is much easier to digest once you break it down into the 5 key stages that your goods will go through.

Inventory management process:

5 key stages

The inventory management process involves tracking and controlling stock as it moves from your suppliers to your warehouse to your customers. There are five main stages to follow:

- **Purchasing:** This can mean buying raw materials to turn into products, or buying products to sell on with no assembly required
- **Production:** Making your finished product from its constituent parts. Not every company will get involved in manufacturing — wholesalers, for instance, might skip this step entirely
- **Holding stock:** Storing your raw materials before they're manufactured (if required), and your finished goods before they're sold
- **Sales:** Getting your stock into customers' hands, and taking payment
- **Reporting:** Businesses need to know how much it is selling, and how much money it makes on each sale

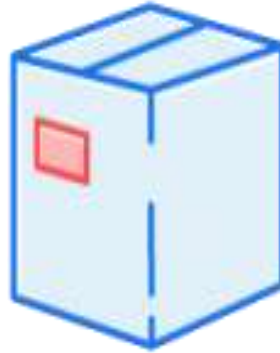
Continuing with our example from earlier, here's how Sam's company utilizes each stage of the process:



Sam buys the materials for her chairs



She manufactures those materials into her product



She'll need to store her materials — as well as the finished goods



She sells her chairs to customers



She keeps track of her profit from each sale, and how much she is selling

5) Modification in some items falling in category B could be very important.

Example 5: The store of an oil engine repair shop has 10 items whose details are shown in the following table. Apply ABC analysis to the store.

Component Code	Description	Price/Unit (₹)	Annual Demand Unit/Year
C01	Packing thread	100	100
C02	Tower bolt	200	300
C03	Hexagonal nut	50	700
C04	Bush	300	400
C05	Coupling	500	1000
C06	Bearings (Big)	3000	30
C07	Bearings (Small)	1000	100
C08	Fuel pump	7000	500
C09	Fixture	5000	105
C010	Drill bit	60	1000

Solution: The preliminary workings for ABC analysis with the annual consumption for various items are summarised in table 8.1.

Table 8.1: Preliminary Workings

Component Code	Description	Price/Unit (₹)	Units/Year	Annual Consumption ₹/Year
C01	Packing thread	100	100	10,000
C02	Tower bold	200	300	60,000
C03	Hexagonal nut	50	700	35,000
C04	Bush	300	400	1,20,000
C05	Coupling	500	1,000	5,00,000
C06	Bearing (Big)	3000	30	90,000
C07	Bearing (Small)	1000	100	1,00,000
C08	Fuel pump	7000	500	3,500,000
C09	Fixture	5000	105	5,25,000
C10	Drill bit	60	1000	60,000

Rearrange the rows of the table 8.1 as per the decreasing order of annual consumption (₹/yr) and compute the cumulative annual values as shown in table 8.2.

Table 8.2: Final Workings of ABC Analysis

Component Code	Price/Unit (₹)	Unit/Year (₹)	Annual Consumption ₹/Year	Cumulative Value of Annual Consumption (₹)	Class
C08	7000	500	35,00,000	35,00,000	A
C09	5000	105	5,25,000	40,25,000	B
C05	500	1000	5,00,000	45,25,000	
C04	300	400	1,20,000	46,45,000	C
C07	1000	100	1,00,000	47,45,000	
C06	3000	30	90,000	48,35,000	
C02	200	300	60,000	48,95,000	
C10	60	1000	60,000	49,55,000	
C03	50	700	35,000	49,90,000	
C01	100	100	10,000	50,00,000	

Example 6: Perform ABC analysis on the following sample of items in an inventory:

Item	Annual Consumption	Price/Unit in ₹
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In the figure 8.5, it can be observed that when the size of the order is large, the total number of orders will decrease and similarly the ordering cost will decrease. This is the result of large order size, the total number of orders will decrease and similarly the ordering cost will decrease. But at the same time, because of high inventory levels the carrying cost is bound to increase. The intersection results in EOQ and at this point both costs are equal and the Total Cost is at the lowest level.

EOQ may also be calculated with the help of the following formula:

$$EOQ(Q) = \sqrt{\frac{2DO}{h}}$$

where,

D = Demanded Annual quantity (in units)
O = Cost of ordering/placing (fixed cost)
h/c = Cost of holding one unit/Annual carrying cost per unit.

Calculation of Number of Orders

$$\text{Number of Order per Year} = \frac{\text{Annual Demand}}{EOQ \text{ or } Q}$$

Calculation of Total Inventory Cost

Particulars		₹
1) Cost of Material	$D \times P$	xxx
2) Ordering Cost per Annum	$\frac{D}{EOQ} \times O$	xxx
3) Carrying Cost per Annum	$\frac{EOQ}{2} \times h$	xxx
Total Inventory Cost		xxx

Example 1: A company annually uses 24,000 units of raw material costing ₹2.5 per unit. Considering ordering costs ₹30 and the carrying costs are 15% per year per unit of the average inventory. Find the EOQ.

$$\text{Solution: } EOQ = \sqrt{\frac{2DO}{h}}$$

Here, Annual Consumption (D) = 24,000 units,

Ordering Costs (O) = ₹30 per unit

Inventory Carrying Costs (h) = ₹2.5 per unit

Now, $h = ic = 15\%$ per year per unit of average inventory $= 0.15 \times 2.5 = 0.375$

$$EOQ = \sqrt{\frac{2 \times 24000 \times 30}{0.375}} = 1960 \text{ Units}$$

Example 2: Following information relating to a type of material is available:

1) Annual demand	4800 units
2) Unit price	₹2.40
3) Ordering cost per order	₹8.00
4) Storage cost	2% p.a.
5) Interest rate	10% per annum
6) Lead time	Half month

Calculate EOQ and total annual inventory cost from the above information.

$$\text{Solution: } EOQ = \sqrt{\frac{2DO}{h}}$$

Where, Annual Demand (D) = 4800 units

Ordering Cost (O) = ₹8 per order

Operations, Resource & Inventory Planning (Chapter 8)

$$\text{Carrying Cost (h)} = \left(2.40 \times \frac{2}{100}\right) + \left(2.40 \times \frac{10}{100}\right) = 0.048 + 0.24 = 0.288$$

$$\text{EOQ} = \sqrt{\frac{2 \times 4800 \times 8}{0.288}} = 516 \text{ units}$$

$$\text{Number of Orders} = \frac{\text{Annual Demand}}{\text{EOQ}} = \frac{4800}{516} = 9.30$$

$$\begin{aligned} \text{Total Inventory Cost} &= \text{Cost of Material} + \text{Ordering Cost} + \text{Carrying Cost} \\ &= (4800 \times 2.40) + \left(\frac{4800}{516} \times 8\right) + \left(\frac{516}{2} \times 0.288\right) = 11,520 + 74 + 74 = ₹11,668 \end{aligned}$$

8.5.7.1.1. Assumptions of EOQ Model

Following assumptions are made while calculating EOQ:

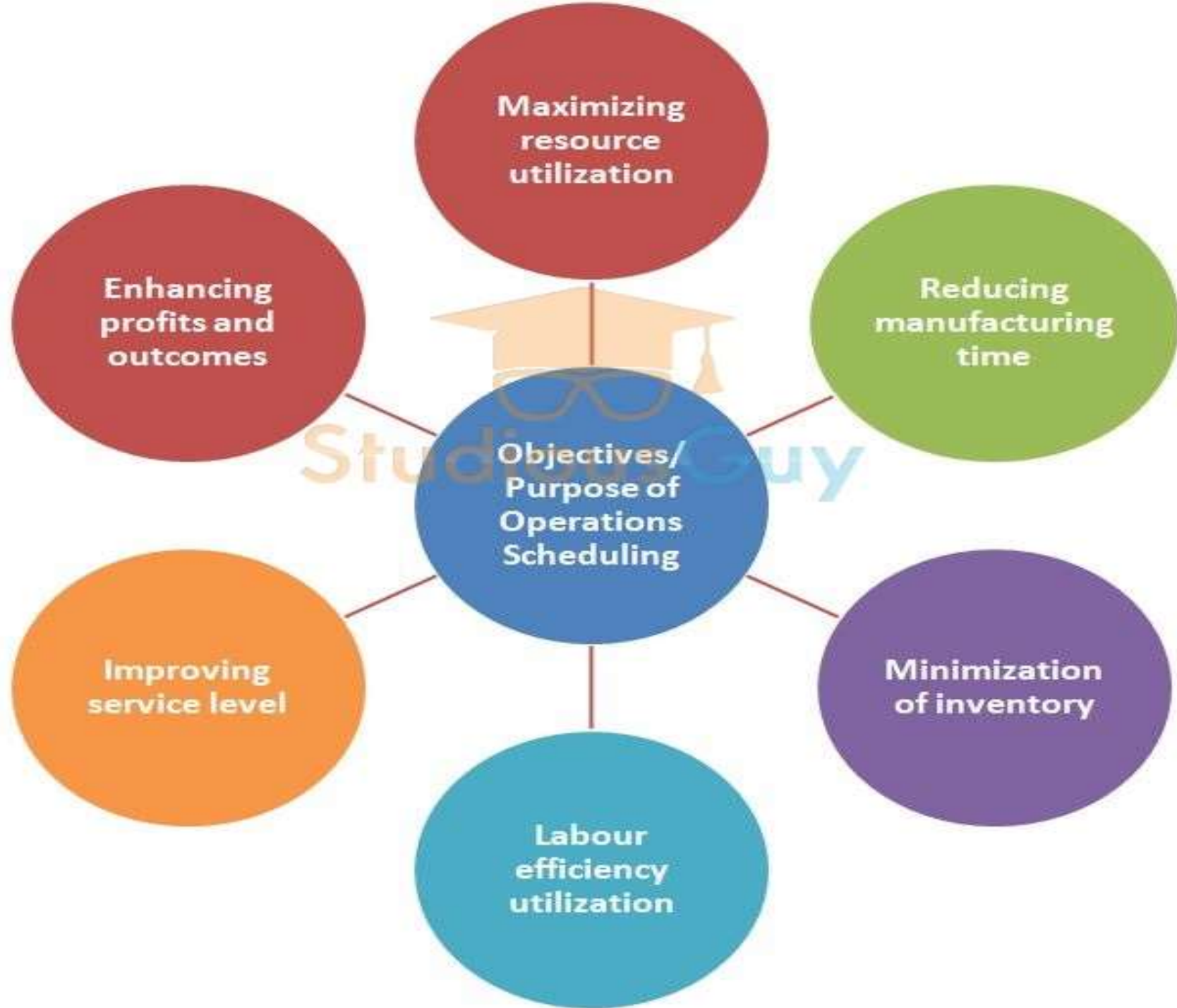
- 1) Supply is available in the market and goods can be procured as and when required.
- 2) The quantity to be procured is pre-decided.

Operations Scheduling

Scheduling pertains to establishing both the timing and use of resources within an organization. Under the operations function (both manufacturing and services), scheduling relates to use of equipment and facilities, the scheduling of human activities, and receipt of materials.

Objectives of the Operations Scheduling

Increasing the profit. Increasing the output. Improving the service level. Maximizing the delivery performance i.e. meeting the delivery dates.



Why your eCommerce company needs demand forecasting

- **Reveal seasonal trends.** (dip in sales –offer discount)
- **Rationalize your cash flow.**(when you will have the cash on hand to invest in inventory)
- **Plan your supply chain.** (you plan ahead to have inventory on hand when customer demand spikes)
- **Understand how outside factors will influence your sales.** (data about industry trends, the state of the economy, and projections for your market sector)
- **Prepare for the future.** (natural disaster or a new competitor that eats into your market share)

