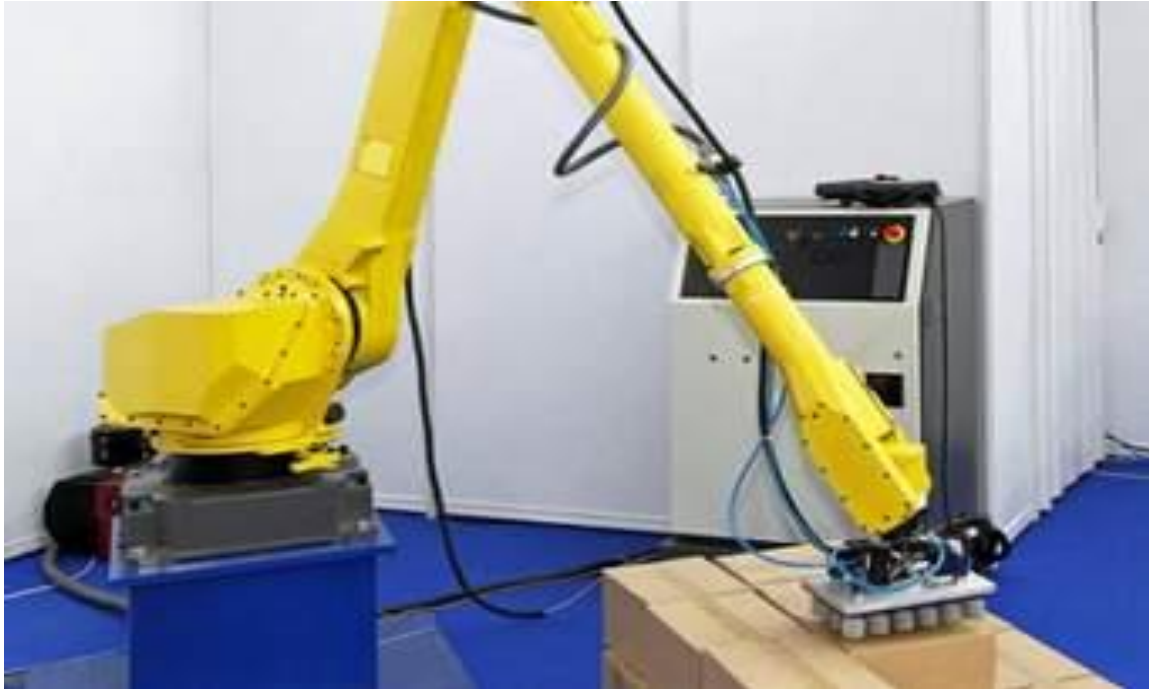


Notes on

## Production Operations and Supply Chain Management



**NEHRU GRAM BHARTI (DEEMED TO BE UNIVERSITY)**

By-

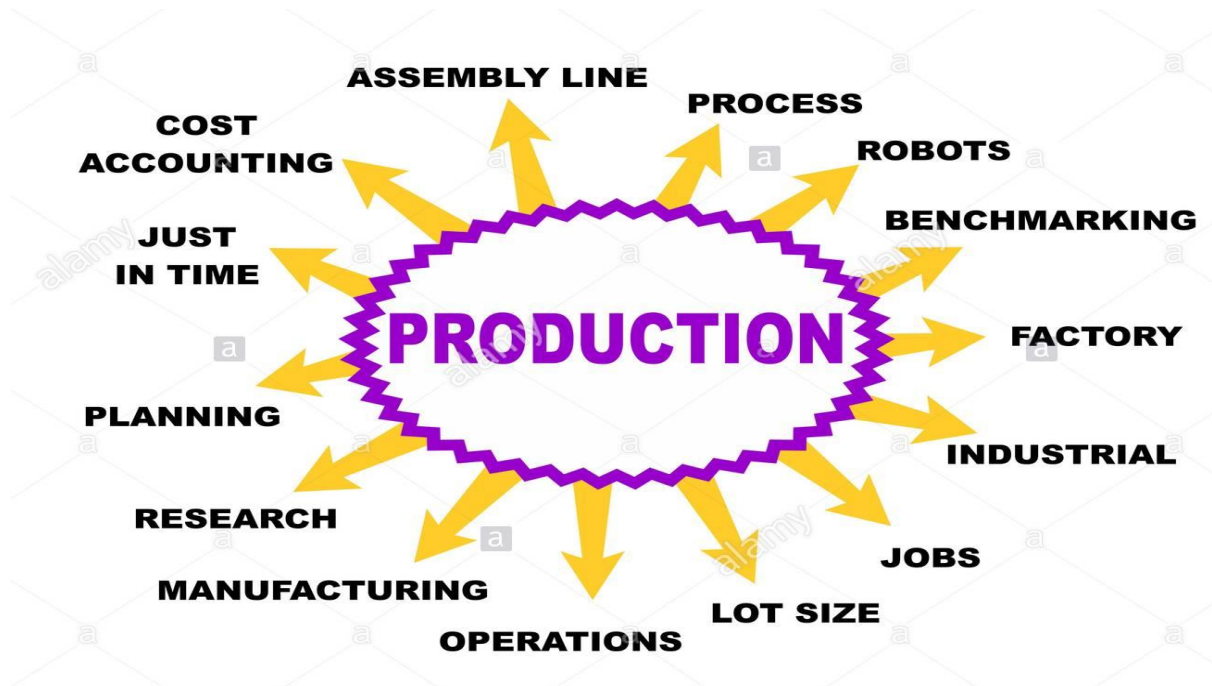
**UJJWAL SHUKLA**

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## UNIT- I

**Production Concept:** is the understanding of the dynamics of the product in order to showcase the best qualities and maximum features of the product. A product concept is a verbal statement of what is going to be changed and how the customer stands to gain or lose.



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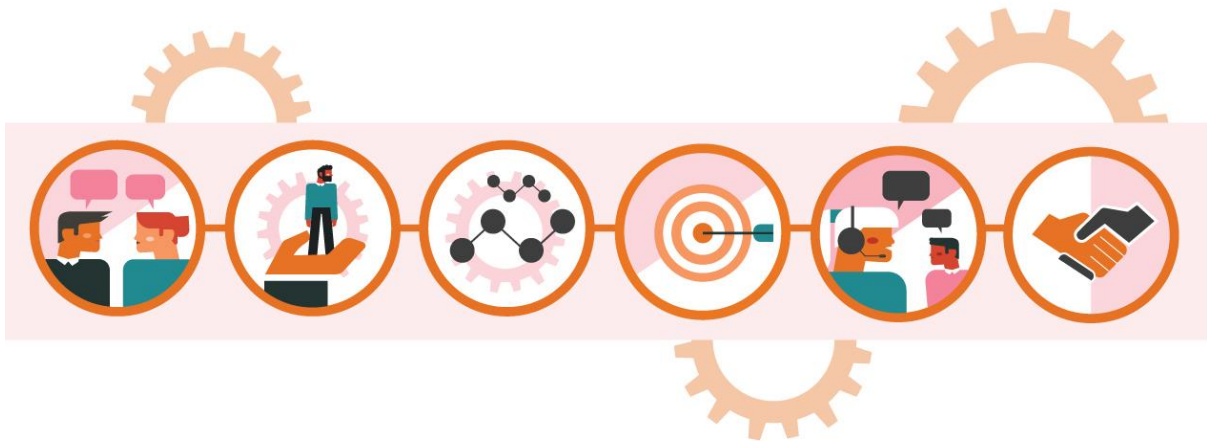
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### Difference between Product Management & Operations Management

Basis	Production Management	Operation Management
Meaning	Production Management connotes the management of the selection belonging to the production of products	Operations Management identifies the part of management involved with the creation and delivery of products and services
Decision Making	Linked to the aspects of production	Linked to the normal business activities
Found In	Enterprises where production is undertaken	Banks, Hospitals, Companies including production companies, Agencies etc.

Objectives	To produce right quality goods in quantity at right time and at least cost	To utilize resources, to the extent possible so as to satisfy customer wants
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**Productivity:** describes various measures of the efficiency and production. Often, productivity measure is expressed as the ratio of an aggregate output to a single input or an aggregate input used in production process.



### Types of Productivity:

1. **Partial Productivity:** measures that use one class of inputs or factors, but not multiple factors, are called partial productivity
2. **Labour Productivity:** A common partial productivity measure is labour productivity. Labour productivity is a revealing indicator of several economic indicators of dynamic measures of Economic Growth, Competitiveness and living standards within an economy.
3. **Multifactor Productivity:** When multiple inputs are considered, the measure is called multifactor productivity or MFP. Multifactor Productivity is typically estimated using growth accounting.
4. **Total Productivity:** When all outputs and inputs are included in the productivity measure it is called total productivity. A valid measurement of total productivity necessitates considering all production inputs.

**Productivity Measurement:** Productivity measurement needs focused attention because it is the most vital element in the success of a business organization.

1. **Aggregate Basis (Total Productivity):** On aggregate basis, output is compared with all inputs taken (added) together. This is called Total Productivity.

Total Productivity Index: Total Output/ Total Input

Where Total Output= Total Production of Goods and Services

& Total Input= Labour + Material + Capital + Energy

Examples: 10000 units produced, Sold for \$10/unit, 500 labour Hours, Labour Rate \$9/hour, Raw Material Cost: \$30000, Overhead: \$15500

Total Productivity= Output/Labour + Material + Overhead

$$= 10000*10/4500 + 45500$$

$$= 2.0$$

2. **Individual basis (Partial Productivity):** Output is compared with anyone of the input factor and this is called as Partial Productivity/ Factor Productivity. **Types of Partial Productivity:**

- a. **Labour Productivity:** is simply defined as the ratio of total output to the Labour Input. i.e.

Labour Productivity depends on how labours are utilized.

Labour Productivity can be higher/lower depending on factors like availability of work load, working tools, availability of power, work efficiency, level of training, working condition.

**Example:** 10000 units produced, Sold for \$10/unit, 500 labours hours, Labour Rate: \$9/hour

$$10000/500 = 20\text{units/hour}$$

$$10000*10/500 = \$200/\text{hour}$$

$$10000/500*9/\text{hour} = 2.2\text{unit}/\$$$

- b. **Material Productivity:** Total Output/Material input, OR

No. of Units Produced/Total Material Cost

- Material Produced can be increased by using skilled workers, adequate machine tools, good design of product etc.
- Material Productivity depends upon how material is effectively utilized in its conversion into finished goods

c. **Machine Productivity:** Production System converts raw material into finished product through mechanical or chemical process with the help of machines and equipments.

**M.P.** = Total Output/Machine Input, OR

**M.P.** = Output in Standard Hours/Actual Machine Hours

- Machine Productivity depends upon availability of raw materials, power, skill of workers, etc.

d. **Capital Productivity:** For any production set-up facilities of machines, tools, land etc. are required which are assets of organization. Capital is need for such assets.

**Capital Productivity:** Total Output/Capital Employed/Input

- Capital Productivity depends on how effectively assets are utilized.

## Factors Affecting Productivity

1. **Training:** Without proper training productivity cannot be increased because training enhances not just skills but also increases willingness and efficiency to work.
2. **Methods:** If need for increase in productivity is felt then there is need to adopt the best method of production be it Manual, Semi-Scientific or Scientific Method. After training method of production plays vital role in enhancing productivity.
3. **Technology:** When method mixes with technology then it creates wonder. Technology is growing leaps and bounds every year so need is for coping up with the changing environment.
4. **Management:** means managing overall resources which associate to produce desired output at stipulated time.

## Production Technology

- **Automated Assembly Line:** Style mass production represents the apex of modern industrial production, & is the driving force behind industrial titans. The higher the degree of mechanization & use of robotics in the assembly line process, the fewer human workers are required to produce a product.
- **Manual:** (Large & Small Both)

- **Semi-Automated:** (Small & Large) At small business, this means a workshop at the very least, with more elaborate operations making use of machines and humans.



### **Types of Manufacturing Processes:**

1. **Repetitive Manufacturing:** is comprised of dedicated production lines that produce the same or a paraphernalia of items, 24/7 (24\*7), all year round (Eg: Parle-G Biscuit)
2. **Discrete Manufacturing:** In discrete manufacturing utilizes an assembly are production line. This process is extremely diverse, with a variation of set-ups and changeover frequencies. (Eg: Seasonal Product)
3. **Job Shop Manufacturing:** makes use of production areas rather than assembly lines. This is because, this process will produce smaller batches of custom products which can be either made to order and made to stock. (Stocking products for smaller period)
4. **Process Manufacturing (Continuous):** is similar to repetitive manufacturing as it too also runs 24\*7. The difference is that this manufacturing process productions raw materials are gases, liquids, powders, etc.

5. **Process Manufacturing (Batch)**: Shares similarities with discrete and job shop processes. Depending on consumer demand, one batch could be enough to meet that demand.

## Unit- II

**Operation Concept:** is a document the characteristics of a proposed system from the viewpoint of an individual who will use that system such as a business requirements specifications. It is used to communicate the quantitative and qualitative system characteristics to all stakeholders.

### **Concept of Operations Management**

- Important concept of Operations Management is how well the Products & Services are produced to:
  - **Compete with the competitors,**
  - **Effective & Efficient Manufacturing** in terms of cost & Quality
  - How does the process is allowing to **generate profits** for the Organization

Dr. Prashant B. Kalaskar

### Difference between Product and Service

<b>Product</b>	<b>Service</b>
Products are tangible	Services are intangible
Products can be stored	Services are perishable
Products quality can be controlled with the help of data	Service's quality can be defined by experience
Product's output can be measured	Outcome of Service can be measured through the benefits enjoyed and derived
Repetition of Product is possible	Services are very difficult to repeat
Products can be patented	Services are very difficult to patent

## Difference between Product Design and Service Design

Product Design	Service Design
Defines the appearance of product	Specifies what physical needs can and cannot be served by the service
Sets standards for performance	Defines the sensual and psychological benefits that customer are to receive from the service
Determines dimensions and Tolerances	Defines the environment in which the service will take place.

## Characteristics of Services:

1. **Lack of Ownership:** Service cannot be owned. Only the means through which that service is provided can be owned but not service.
2. **Intangibility:** Services don't have any physical presence in the world. They can be only felt and one can only enjoy the benefits of service.
3. **Inseparability:** Service cannot be separated from the point of origin as like physical products, they can be only felt and enjoyed. They remain constant at the place they are, and the place from where they are offered.
4. **Variability:** Service are provided to each every person of each and every corner of the country, state or region. If we take the example of mobile service then we can say that mobile services vary from region to region, state to state and etc. as per the availability of tower and other physical needs required to avail that service.
5. **Perishability:** Services are frequently perishable in nature in comparison to products. Once they are utilized they cannot be retrieved back as like products.
6. **User Participation:** Services stay in touch with the user through online survey and feedback. But products don't.

## Classification of Services:

1. Business Services
2. Communication Services
3. Construction and Related Engineering Services
4. Distribution Services
5. Educational Services
6. Environmental Services
7. Financial Services



8. Tourism and Travel-Related Services
9. Health-Related and Social Services
10. Transport Services

### **Factors Affecting Service Operations:**

1. **Extraversion:** Extraverted people are sociable assertive, talkative and active. Extraverts also have a higher degree to excel. They perform better in service and sales jobs.
2. **Conscientiousness:** Conscientious people are dependable, responsible, work hard, and strive for achievements. Besides being related to Onsuperior customer service, conscientiousness is also related to superior job performance in general.
3. **Cognitive Abilities:** Employees with a higher cognitive ability (often measured in IQ) tend to provide better customer service. People with greater cognitive abilities will learn faster, absorb more information and generalize knowledge more effectively.
4. **Employee Training:** Training increases the speed at which employees learn specific knowledge. Training is aimed to improve the employee's skills.
5. **On-the-job Experience:** is another customer service performance, as more experienced employees are better equipped for their job and thus provide better service.

### **Service Capacity Planning:**

It is the process of determining the service production capacity needed by an organization to meet changing demands for its services.

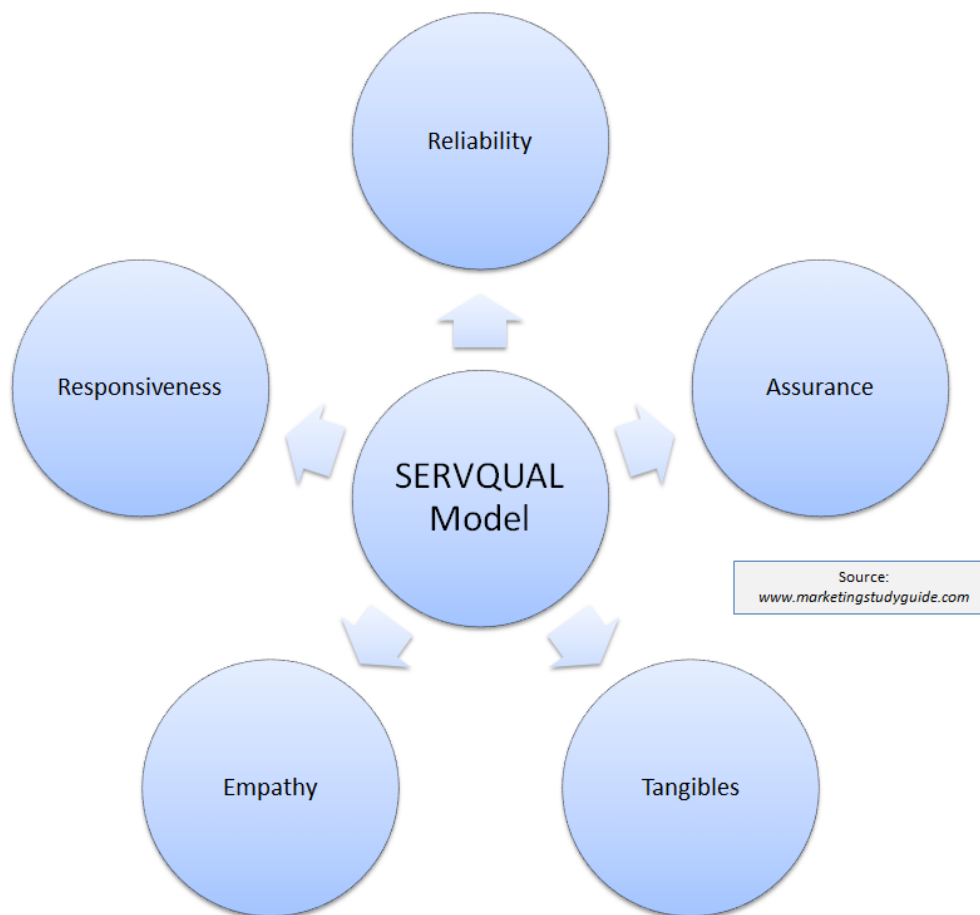
In the context of capacity planning, design capacity is the maximum amount of work that an organization is capable of completing in a given period.



### Strategies of Service Capacity Planning:

- **Lead Strategy:** is adding capacity in anticipation of an increase in demand. Lead Strategy is an aggressive strategy with the goal of living customers away from the company's competitors by improving the service level and reducing lead time.
- **Lag Strategy:** refers to adding capacity only after the organization is running at full capacity or beyond due to increase in demand. This is a more conservative strategy and opposite of a lead capacity strategy. It decreases the risk of waste, but it may result in the loss of possible customers either by stock-out or low service levels.
- **Match Strategy:** is adding capacity in small amounts in response to changing demand in the market. This is a more moderate strategy.
- **Adjustment Strategy:** is adding or reducing capacity in small/large amounts due to consumer's demand shift, or due to major changes to product or system.

### SERVQUAL Model of Measuring Service Quality:



**SERVQUAL (SERV+QUAL)** is a multi-dimensional research equipment, designed to capture consumer expectations and perceptions of a service along with the 5 dimensions that are believed to represent service quality. SERVQUAL is built on the expectancy-disconfirmation paradigm, which in simple terms means that service quality is understood as the extent to which The consumer's pre-consumption expectations of quality are confirmed or disconfirmed by their perceptions.

SERVQUAL Method/Model questionnaire was found and published in 1985 by a team of academic researchers and American authors **A. Parasuraman, Valarie Zeithaml, & Leonard Len Berry** to measure quality in the service.

SERVQUAL is a multidimensional research instrument, designed to measure service quality by capturing respondent's expectations and perceptions along with the 5 dimensions of SERVQUAL.

The questionnaire consists of matched pair of items= 22 perceptions and 22 expectations organized into 5 dimensions.

Tangibles= 4 items

Reliability= 5 items

Responsiveness= 4 items

Assurance= 4 items

Empathy= 5 items

SERVQUAL model is based on 5 dimensions which are acronymed as:

R= Reliability

A=Assurance

T=Tangible

E= Empathy

R= Responsiveness

Thus SERVQUAL can be conceptualised as a simple equation:

$S.Q. = P - E$

Where, S.Q. = Service Quality

P= Individuals perceptions of given service delivery

E= is the individual's expectations of given service delivery.

### Unit- III

**Material and Inventory Management:** refers to the process of ordering, storing, and using a company's inventory. These include the management of raw materials, components and finished products, as well as warehousing and processing such items.



Material Management is the planning, directing, controlling, and co-ordinating those activities which are concerned with materials and inventory management. It begins with the determination of materials quality and quantity and ends with its issuance to production to meet the customer demand as per schedule and at the lowest cost.

# CONTENTS -

## • MATERIALS MANAGEMENT FUNCTIONS :

- Standardization
- Simplification
- Purchasing
- INVENTORY CONTROL :
  - Static & Dynamic models
  - Selective Control
  - Inventory control under constraints
  - Store functions & records
  - Spares parts and in- process inventory
  - Fundamental of supply chain management

### Types of Production Planning:

**Job Method:** This method includes the task of manufacturing a product that is handled either by a single worker or by a group. The type of jobs that may utilize this method may be either small scale or complex. This method is usually incorporated when customer specifications are essential in the production.

**Flow Method:** Very similar to the batch method, the aim is to improve material and work flow, reduce labour cost and ultimately complete the work much quicker. Differing from the batch method, work progresses as a flow, hence the name the flow method.

**Mass Production Method:** Within this method, goods are usually produced utilizing standard techniques such as balance production and product wise layout.

**Batch Method:** This method usually falls under business that are growing that also have growing production volumes as well. It requires a division of work into parts.

**Process Method:** This method includes the product being produced utilizing a uniform and standardised sequence. Very specific and sophisticated machinery is utilized here and production is continuous.

## Steps/Processes of Production Planning and Control:

1. **Routing:** can be defined as the process of deciding the path (route) of work and the sequence of operations. Routing fixes in advance:
  - The quantity and quality of the product.
  - The men, machines, materials, etc. to be used
  - The type, number and sequence of manufacturing operations, and
  - The place of production.

Routing gives a very systematic method of converting raw materials into finished goods. It leads to smooth and efficient work.

2. **Scheduling:** means to:
  - Fix the amount of work to do.
  - Arrange the different manufacturing operations in order of priority.
  - Fix the starting and completing, date and time, for each operation.

Scheduling is also done for materials, parts, machines, etc. So, it is like a time-table of production. It is similar to the time-table, prepared by the railways. There are different types of Schedules:

Master Schedule

Operation Schedule

Daily Schedule

Schedule helps to make optimum use of time.

3. **Dispatching:** It is the action, doing or implementation stage. Dispatching means starting the process of production. It provides the necessary authority to start the work. Dispatching includes the following:
  - Issuing of materials, tools, fixtures, etc.

## Types of Inventory:

1. **Raw Materials:** are necessary to the life of any business. They are made up of materials your business uses to produces its own goods. If your company does not have a system in place to track its supply of raw materials.
2. **Work-in-Progress:** is made up of the different parts that are being processed in a system, including all:
  - Necessary materials
  - Parts (Components)

- Assembles
- Subassemblies

Work-in-Progress usually includes raw materials that have been released for initial processing. It also covers the enPackatire process of a production. Eg: You own an auto repair company. Brake pads would be part of your work-in-progress.

3. **Finished Goods:** inventory includes any complete products that are now ready to be marketed and sold. Eg: The packaged and boxed ice-cream cones would be finished goods inventory.
4. **Packaging Materials:** As the name suggests, packing material is the inventory you use to pack and ship your finished goods.
5. **Cycle Inventory:** is a by-product of economic order quantity theory (EOQ). EOQ attempts to balance inventory costs and machine setup costs.
6. **MRO Goods:** Maintenance, Repairs and Operating supplies-or MRO goods-are items put in place to maintain tasks in the production process. Egs of MRO Goods include Gloves, Packing Materials, Tools, etc.

### Inventory Control Techniques:

**Just-In-Time (JIT) Method:** In JIT Method, of Inventory Control, the company keeps only as much inventory as it needs during the production process. With no excess inventory in hand the company saves the cost of storage and insurance. The company orders further inventory when the old stock of inventory is close to replenishment. This is a little risky method of inventory management because a little delay in ordering new inventory can lead to stock out situation. Thus this method requires proper planning so that new orders can be timely placed.

**EOQ= Economic Order Quantity Model:** EOQ Technique focuses on taking a decision regarding how much quantity of inventory should the company order at any point of time and when should they place the order. In this model, the store manager, will reorder the inventory when it reaches the minimum level. EOQ Model helps to save the ordering cost and carrying cost incurred while placing the order. With the EOQ Model, the organization is able to place the right quantity of inventory. The orders are placed in batch. The cost of its inventory include holding and setup costs.



The EOQ Model seeks to ensure that the right amount of inventory is ordered per batch so a company does not have to make orders too frequently and there is not an excess of inventory setting on hand.

**Formula:  $EOQ = \sqrt{2 \cdot S \cdot D / H}$ , Where:**

**S**= Setup Costs (per order, generally shipping and handling)

**D**= Demand Rate (quantity sold per hour)

**H**= Holding Costs (per year, per unit)

**VED Analysis:** VED stands for **Vital, Essential and Desirable**- Organizations mainly use this technique for controlling spare parts of inventory. Like, a higher level of inventory is required for vital parts that are very costly and essential for production. Others are essential spare parts, whose absence may slow down the production process, hence it is necessary to maintain such inventory.

### **Factors Affecting Plant Location:**

- 1. Law and Order Situation:** Plant Location be at that place where law and order situation is in control. Entrepreneurs give a lot of importance to this factor while locating a business unit in any state or region.
- 2. Availability of Infrastructure Facilities:** Plant Location which is selected must have proper infrastructure facilities. Without good infrastructure facilities, it will be difficult to do a business efficiently. Crucial infrastructure:
  - Transport and Communications
  - Banking and Insurance Services
  - Regular Fuel Supply
  - Continuous Supply of electricity and water etc.
- 3. Good Industrial Relations:** Plant Location must be at those places where good industrial relations are maintained. Industrial Relations become bad, because of militant and selfish trade unions. Entrepreneurs do not want to locate their business at places where anti-social elements are rampant.
- 4. Availability of Skilled Work Force:** Plant Location must be convenient and easily accessible to skilled workforce. Most businesses require skilled labour force such as engineers, management experts, computer programmers, etc.
- 5. Social Infrastructure:** Plant Location must have a good social infrastructure there is a need for social infrastructure not only for

employees but also for the development of their families. Social Infrastructure:

- Education Institutions
- Hospital and Health Centres
- Community Centres like worship place, garden, meditation centre, etc.
- Recreation facilities like theatres, clubs, communication facilities, etc.

**6. Nearness to Market:** Plant Location must be near a market. Every business unit depends on a market for selling its goods and services. The goods and services must reach the market on time, and it must be available to the consumers at a low price.

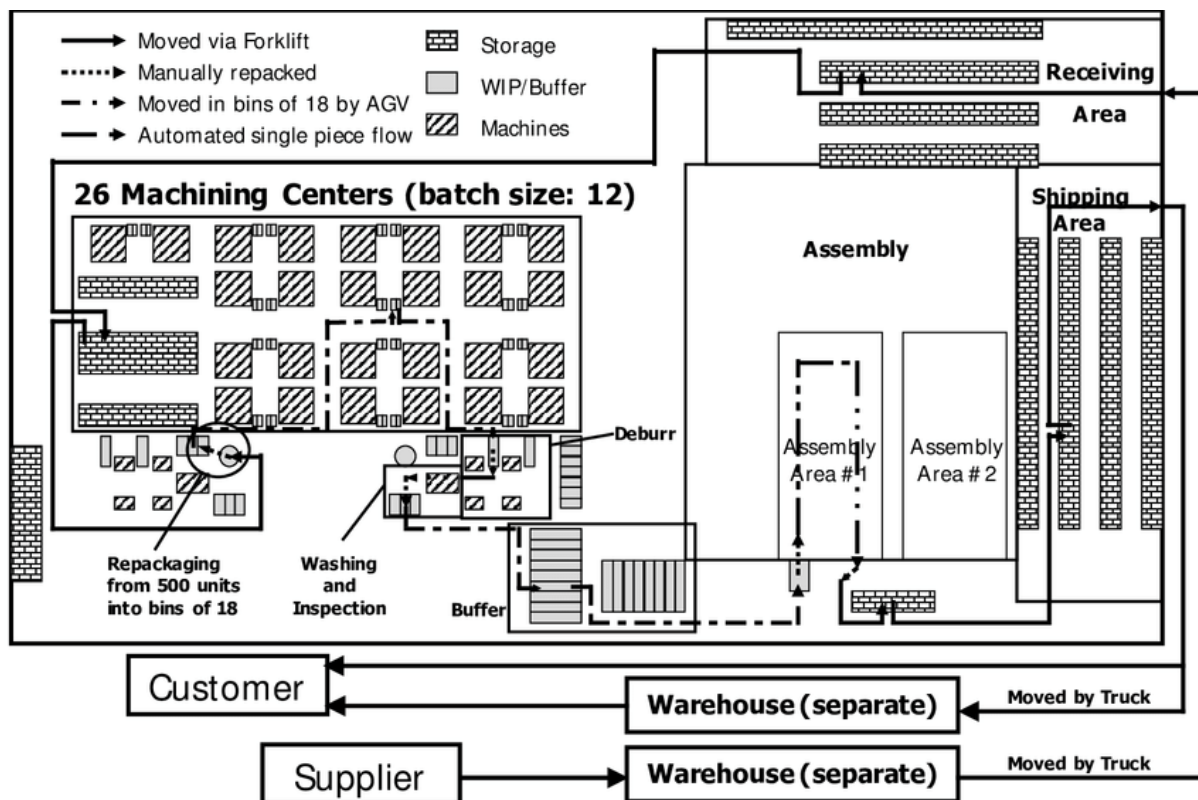
**7. Nearness to Raw-Materials Source:** Plant Location must be usually near to the source of raw-materials. Raw Material's costs are about 50% of the total cost. So it is important in the business to get the raw materials in time and at a reasonable price.

**Gross Materials:** are those which lose weight in the production process. Examples of Gross Materials are sugarcane, iron ore, limestone, so on.

**Pure Materials:** are those which add their weight to the finished product. Examples of Pure Materials are Cotton, Textiles, Bakeries, Silk fabrics, etc.

### **Types of Plant Layout:**

**Plant Layout:** means the disposition of the various facilities (equipment, material, manpower, etc.) and services of the plant within the area of the site selected previously.



Plant Layout begins with the design of the factory building and goes up to the location and movement of a work table. All the facilities like equipment, raw materials, machinery, tools, fixtures, workers etc. are given a proper place.

**Process Layout:** It is also known as functional layout and is characterised by keeping similar machines or similar operations at one location (place). In other words, all lathes will be at one place, all nulling machines at another and so on that is machines have been arranged according to their functions. This type of layout is generally employed for industries engaged in job order production.

**Product Layout:** It is also known as line (type) layout. It implies that various operations on raw material are performed in a sequence and the machines are placed along the product flow line, i.e. machines are arranged in the sequence in which the raw material will be operated soon. This type of layout is preferred for continuous production i.e. involving a continuous flow of process material towards the finished product stage.

**Combination Layout:** A combination of process and product layouts combines the advantages of the both types of layouts. A Combination Layout is possible where an item is being made in different types and sizes. A combination layout is also useful when a number of items are produced in same sequence but none of the items are to be produced in bulk and thus no item justifies for an individual and independent production line.

**Fixed Position Layout:** Layout by fixed position of the product is inherent in

Ship building, aircraft, manufacture and big pressure vessels fabrication. In other types of layouts discussed earlier, the product moves past stationary production equipment, where in this case the reverse applies, men and equipment are moved to the material which remains at one place. In this layout, it is possible to assign one or more skilled worker to a project from start to finish in order to ensure continuity of work at one place.

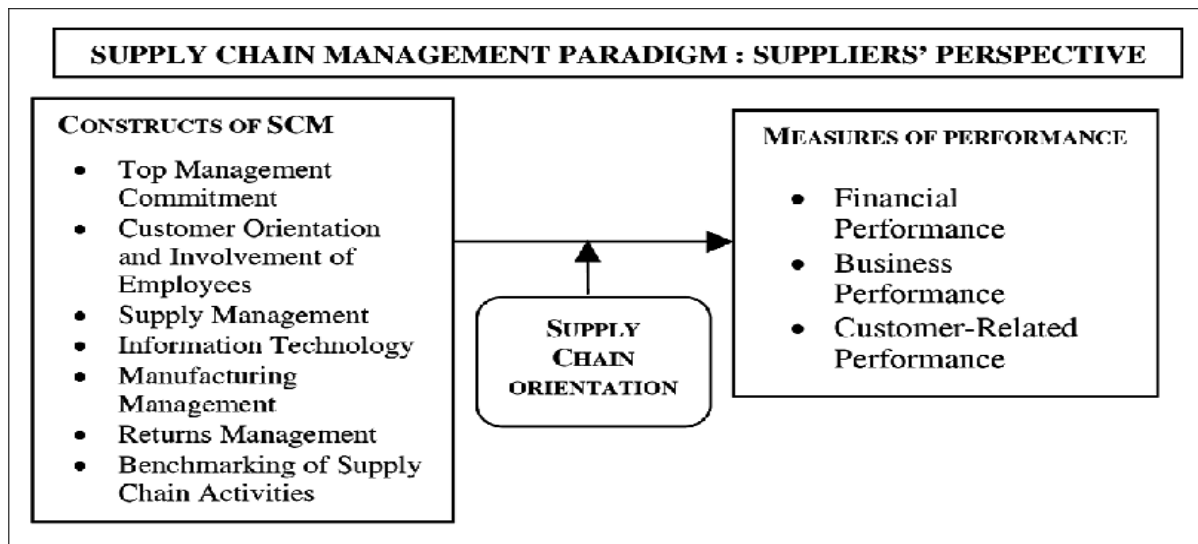
## Unit- IV

**Supply Chain Management:** The management of the flow of goods and services, involves the movement and storage of raw materials of work-in-progress inventory, and of finished goods from point of origin to point of consumption.

**Conceptual Model of Supply Chain Management:** Supply chain acts as a connecting chain of materials from the suppliers to the manufacturer to the distributor to the retailer to the ultimate customers/consumers.

Supply Chain Management can be seen as the process of strategically managing the procurement, movement and storage of materials, parts and finished inventory and related information flows through the organization and its marketing channels in such a way that current and future profitability are maximize through the cost effective fulfilment of orders.

Supply Chain Management coordinates and integrates all the supply chain activities into a seamless process and links all of the partners in the chain, including departments within an organization as well as the external suppliers transporters, and information system.



In sum, we can say that Supply Chain Management works in a demand driven situation, encourages flow type production with small batches, reduces idle inventory and idle time in any business by improving overall customer-centric approach.

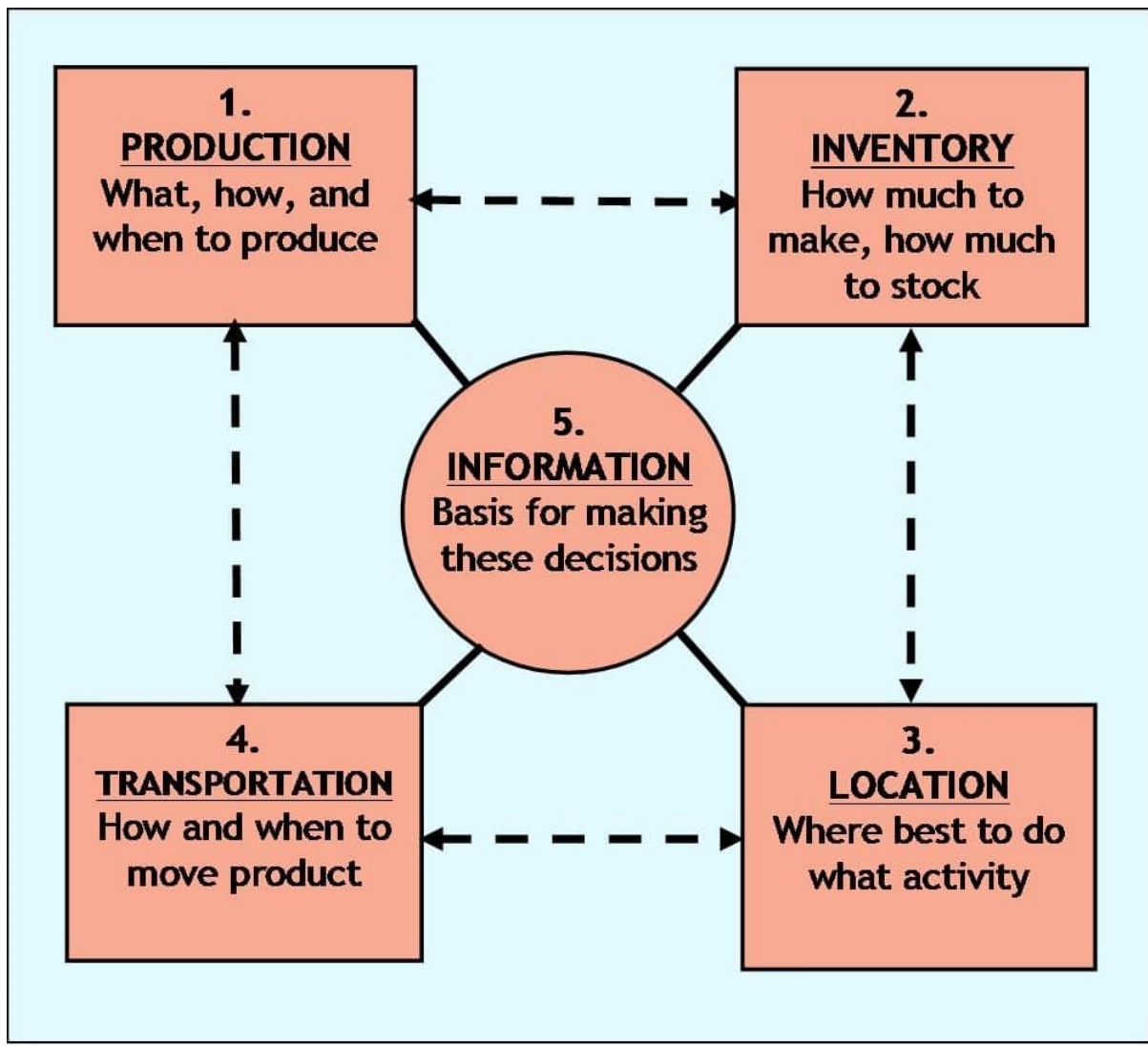
The conceptual model of Supply Chain Management is based on the 5 basic elements called Pillars of SCM:

- Customization Philosophy
- Outsourcing of items in which the supplier has competency
- Multi-tier supplier partnership
- 3<sup>rd</sup> or 4<sup>th</sup> party logistics
- Use of modern IT Systems

### Supply Chain Drivers:

Supply Chain capabilities are guided by the decisions you make regarding the 5 supply chain drivers.

1. **PRODUCTION:** This driver can be made very responsive by building factories that have a lot of excess capacity and use flexible manufacturing techniques to produce a wide range of items. To be even more responsive a company could do their production in many smaller plants that are close to major groups of customers to shorten delivery time.
2. **INVENTORY:** Responsiveness can be had by stocking high levels of inventory for a wide range of products. Additional responsiveness can be gained by stocking products at many locations so as to have the inventory close to customers and available to them immediately.



3. **LOCATION**: A location decision that emphasizes responsiveness would be one where a company establishes many locations that are close to its customer base. For Eg: Fast food chains use location to be very responsive to their customers by opening up lots of stores in high volume markets.
4. **TRANSPORTATION**: Responsiveness can be achieved by a transportation mode that is fast and flexible such as trucks and airplanes. Many companies that sell products through catalogues or on the internet are able to provide high levels of responsiveness by using transportation to deliver their products often within 48 hours or less. Amazon is expanding and operating its own transportation services in high volume markets to be more responsive to customer desires.
5. **INFORMATION**: The power of this driver grows stronger every year as the technology for collecting and sharing information becomes more wide spread, easier to use, and less expensive. Information, much like money,

is a very useful commodity because it can be applied directly to enhance the performance of the other four supply chain drivers.

**Demand Forecasting in Supply Chain:** Demand Forecasting facilitates critical business activities like budgeting, financial planning, sales and marketing plans/raw materials planning, production planning, risk assessment and formulating mitigation plans. Outlined below are the impacts of demand forecasting in Supply Chain Management.

1. **Improved Supplier Relations and Purchasing Terms:** Demand Forecasting drives the raw material planning process which facilitates the purchasing managers to release timely purchase plan to suppliers.
2. **Better Capacity Utilization and Allocation of Resources:** Based on the current inventory levels, raw materials availability and expected customer orders, production can be scheduled effectively. This leads to improved capacity utilization and judicious allocation of manufacturing resources.
3. **Optimization of Inventory Levels:** A proper demand forecast provides vital information for driving the desired raw material, work-in-progress and finished goods inventory levels.
4. **Improved Distribution Planning and Logistics:** Apart from small business, this is particularly evident in business dealing with multiple skills and wide distribution networks. Distribution and Logistics Managers are enabled to balance inventory across the network and negotiate favourable terms with transporters.
5. **Increase in Customer Service Levels:** With optimized inventory levels and improved Distribution Planning and Logistics, customer service metrics like on-time delivery (OTD) on-time in full (OTIF) are improved due to right sizing and right positioning of inventory.
6. **Facilitates Performance Management:** Management can set targets for various functions like Sales, Finance, Purchase, Manufacturing, Logistics, etc. based on the medium to Long range plans derived from the Demand Forecasting process.

### **Demand Forecasting in Simple Moving Average:**

A simple moving average is formed by computing the average price of a security over a specific number of periods. Most moving averages are based on closing prices.

The simple moving average (SMA) calculates an average of the last n prices, where n represents the number of periods for which you want the average.

Simple Moving Average:  $(P1+P2+P3+P4+Pn)/n$

For Eg: A 4 period SMA with prices of (1.2640+1.2641+1.2642+1.2641) gives a moving average of 1.2641 using the calculation  $[1.2640+1.2641+1.2642+1.2641/4]= 1.2641$

A simple moving average (SMA) is an arithmetic moving averages calculated by adding recent prices and then dividing that by the number of time periods in the calculation average. For Eg: one could add the closing price of the security for a number of time periods and then dividing this total by that same number of periods. Short term averages respond quickly to changes in the price of the underlying while long-term averages are slower to react.

Week 1 (5 days) - 20, 22, 24, 25, 23

Week 2 (5 days) - 26, 28, 26, 29, 27

Week 3 (5 days) - 28, 30, 27, 29, 28

**Weighted Moving Average:** Assign a heavier weighting to more current data points since they are more relevant than data points in the distant past. The sum of the weighting should add up to 1 (or 100%)

<b><u>Date:</u></b>	<b><u>Closing Price</u></b>	<b><u>Weighting</u></b>
June 26	\$ 90-90	5/15
June 25	\$ 90-36	4/15
June 24	\$ 90-28	3/15
June 23	\$ 90-23	2/15
June 22	\$ 90-21	1/15

The weighted average is calculated by multiplying the given price by its associated weighting and totalling the values. Formula:

$$WMA= \text{Price } 1 * n + \text{Price } 2 * (n-1) \dots \text{Price } n / n * (n+1) / 2$$

Where, n= time period

**Exponential Moving Averages:** are also weighted towards the most recent prices, but the rate of decrease between one price and its preceding price is not



consistent. The difference in the decrease is exponential. This method of sales forecasting is a modification of the moving average method or in better words it is an improvement over the moving average method of forecasting. This method tries to eliminate the limitations of moving averages and remove the necessity of keeping extensive past data it also tries to remove the irregularities in demand pattern.

This method represents a weightage average of the past observations. In this case most recent observations is assigned the highest weightage. This method keeps a running average of demand and adjusts it for each period in proportion to the difference between the latest actual demand figure and the latest value of the average.

**Supply Chain Efficiency:** is a measure of how a company's processes harness resources in the best way possible, whether or not those resources are financial, human, technological or physical.

**Core Supply Chain:** activities cover everything from product development, sourcing, production, and logistics, as well as the information systems needed to coordinate these activities.

- **Sourcing and Procurement:** We set-up or improve the sourcing and procurement processes for direct and indirect goods, focusing on long term savings and synergies between product categories. We build and transform purchasing teams for global organizations with a focus on risk management, process efficiency, metrics, roles and responsibilities.
- **Manufacturing and Service Operations:** Having a very strong background in industrial operations we assess and improve manufacturing and service operations from the shop floor to the back-office functions. We can apply a broad set of methodologies and tools to perform assessments or audits and provide practical recommendations on improvement tracks with guaranteed return on investment.
- **Shipment and Transportation:** We provide comprehensive decision-making support in building shipment and transportation networks through distribution centres (DC), warehouses (WH), and point of sale (POS). Cost Analysis and lead-time forecasting are part of our core advisory services.
- **Business Process Outsourcing (BPO):** Shared Services (SS) or Shared Operational Services (SOP) are frequently deployed as a mean for our clients to address the Total Cost of Ownership (TCO) and Make-or-Buy

Decisions. Outsourcing improves productivity, reduce cost, generate additional competitive advantage.

- **Business Process Optimization:** Manufacturing and service systems typically have random components to their behaviour such as the demand for products and services. Part of SEED supply chain optimization service, our experts provide rigorous analysis of production and service systems using advanced quantitative methods.

**Reverse Supply Chain:** refers to the movement of goods from customer to vendor. This is the reverse of the traditional supply chain movement of goods from vendor to customer. Reverse logistics is the process of planning implementing and controlling.

It is the series of activities required to retrieve a used product from a customer and either dispose of it or reuse it.

In some cases, companies are being forced to set-up reverse supply chains because of environmental regulations or consumer pressures.

Whether a company is establishing a reverse supply chain by choice or necessity it will face many challenges. It will have to educate customers and then decide which activities to outsource and which to do itself.

- **Product Acquisitions:** Our research suggests that this risk-retrieving the used product is key to creating a profitable chain. The quality, quantity and timing of product returns need to be carefully managed. Companies often will need to work closely with retailers and other distributors to coordinate collection.
- **Reverse Logistics:** Once collected products need to be transported to facilities for inspection, sorting and disposition. There is no one best design for a reverse logistics network each has to be tailored to the products involved and the economies of their reuse.
- **Inspection and Disposition:** The testing, sorting, and grading of returned products are labour intensive and time consuming tasks. But the process can be streamlined if a company subjects the returns to quality standards and uses sensors, bar codes, and other technologies to automate tracking and testing. In general, a business should seek to make disposition decisions based on quality, product configuration, or other variables at the earliest possible stage in the returns process.

- **Reconditioning:** Companies may capture value from returned products by extracting and reconditioning components for reuse or by completely remanufacturing the products for resale. Reconditioning and Remanufacturing processes tend to be much less predictable than traditional manufacturing because there can be a large degree of uncertainty in the timing and quality of returned products.
- **Distribution and Sales:** If a company plans to sell a recycled product, it first needs to determine whether there is demand for it or whether a new market must be created. If it's the latter, the company should expect to make heavy investment in consumer education and other marketing efforts.

**International Supply Chain:** A Global Supply Chain is a dynamic worldwide network when a company purchases or uses goods or services from overseas. It involves people, information, processes and resources involved in the production, handling and distribution of materials and finished products or providing a service to the customer.

Essentially, global supply chain management is the same as supply chain management, but it focuses on companies and organizations that are trans-national.

### **Area of Concentration in Global Supply Chain Management:**

**Marketing:** should be emphasized by global supply chain managers to create customer value, satisfaction, and loyalty lead to improved profit margins which in turn leads to overall corporate growth.

**Logistics:** When managing a global supply chain, it is important to place emphasis on logistics performance as there has been an increase in business-to-business international marketing. Logistics is inherently difficult and complex for a global supply chain as it deals with trade regulations, shipping distances and across-currency issues. Companies and/or organizations who place an emphasis on logistics management can find themselves with a serious competitive advantage as it has a clear visible impact on customers.

**Supply Management:** deals with the development and management of the critical business and supplier relationship. As the market becomes progressively global, the strategy of outsourcing suppliers has increasingly used.

**Aggregate Planning:** is a marketing activity that does an aggregate plan for the production process, in advance of 6 to 18 months to give an idea to management as to what quantity of materials and other resources are to be procured and when, so that the total cost of operations of the organizations is kept to the minimum over that period.

Aggregate planning has certain pre-required inputs which are inevitable. They include:

- Information about the resources and the facilities available
- Cost of various alternatives and resources: This includes cost of holding inventory, ordering cost, cost of production through various production alternatives like subcontracting, back ordering and overtime.
- Demand forecast for the period for which the planning has to be done.

Aggregate Planning is concerned with matching supply and demand of output over the medium time range, up to approximately 12 months into the future. The term aggregate implies that the planning is done for a single overall measure of output. The aim of aggregate planning is to set overall outputs levels in the near to medium future in the face of fluctuating or uncertain demands. Aggregate planning might seek to influence demand as well as supply.

**Inbound Supply Chain Management:** can be defined as the process by which companies acquire raw materials, parts, components different products and services from various suppliers in order to carry-out their operations, such a process is also called as procurement. Supply scoring and assessment mean rating the suppliers.

### **Inbound Supply Chain Management Planning and Analysing:**

In order to make future sourcing decisions, each firm must analyse its procurement spending and supplier performance. It is important to aggregate the spending across and within categories and suppliers. Aggregate provides visibility of what a company is purchasing and from whom.

### **Outbound Supply Chain Management:**

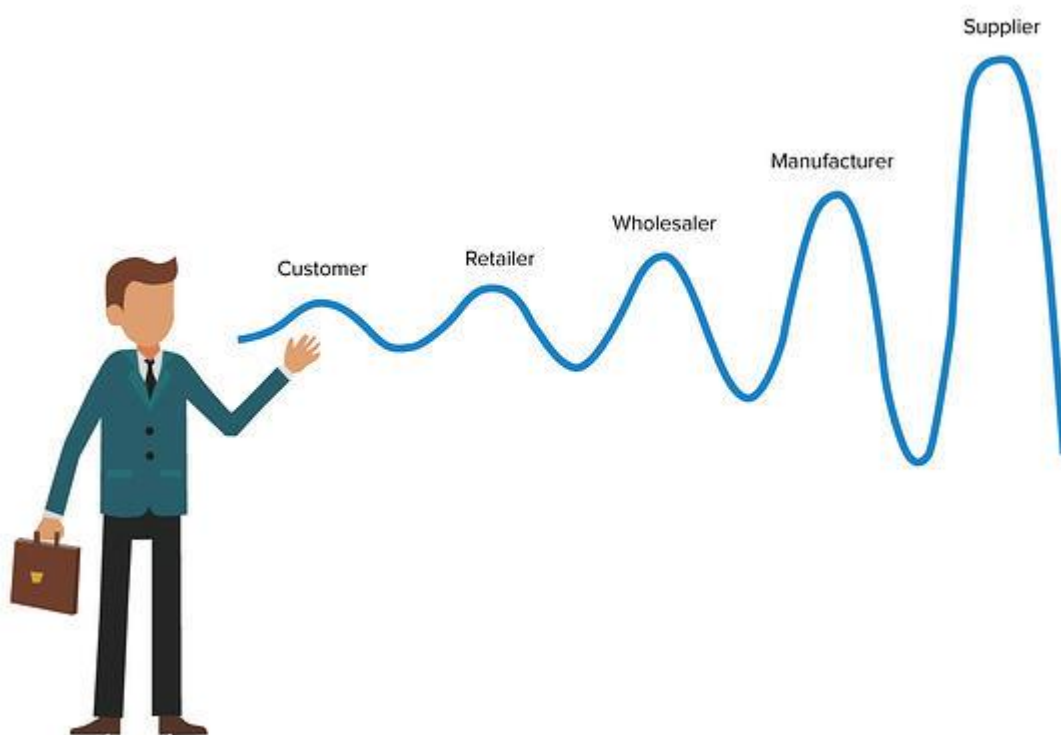
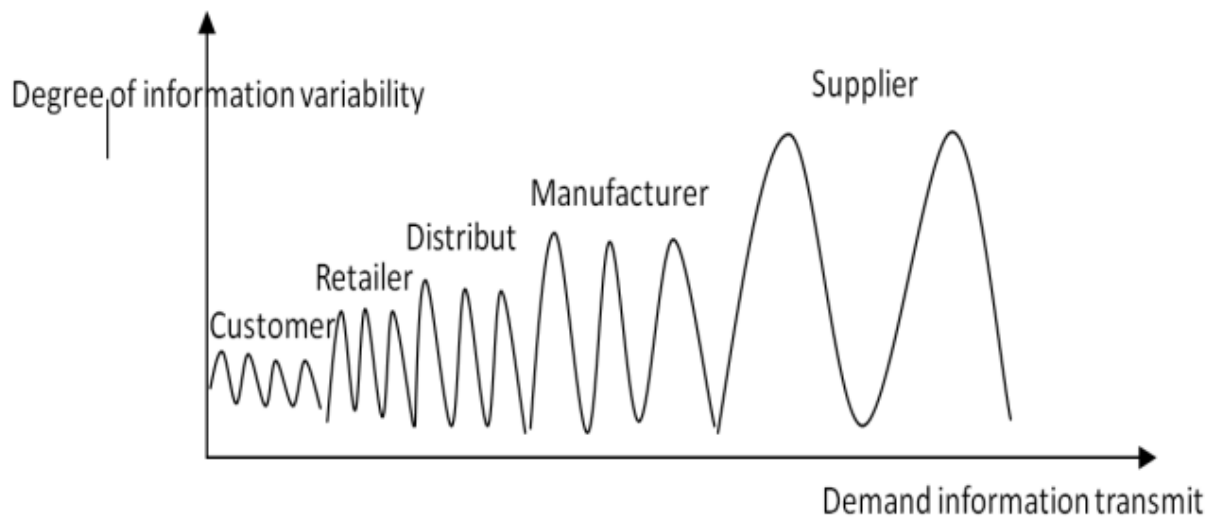
Outbound logistics is the process of storing, transporting and distributing goods to customers. The outbound logistics process starts with a customer sales order, moves on to warehouse packing and ends with product. To make outbound logistics run smoothly, business must pick the right distribution channels, maintain a sensible inventory stocking system and optimize delivery options.

- **Channels of Distribution:** stores the product, promotes the product and arranges for its sale. Part of outbound logistics is choosing channels that will maximize revenue. This means choosing distributors that promote the product in line with branding, have good logistics systems themselves and cater to the right type of customer.
- **Inventory Systems:** In order to make the outbound process run smoothly, businesses have to have a functioning inventory system. If a business overstocks inventory, product may become antiquated or obsolete. If a business does not stock enough inventory, it runs the risk of losing customers.
- **Delivery Optimization:** An important component of outbound logistics is optimizing shipping and delivery. A system of barcode scanning and inventory tracking allows the business to continually update the customer on the status of the order.

### **Bullwhip Effect in Supply Chain Management:**

The bullwhip effect is a distribution channel phenomenon in which forecasts yield supply chain inefficiencies. It refers to increasing swings in inventory in response to shifts in customer demand as one moves further up the supply chain. The Bullwhip effect was named for the way the amplitude of a whip increases down its length.

The further from the originating signal, the greater the distortion of the wave pattern. In a similar manner, forecast accuracy decreases as one moves upstream along the supply chain. For Eg: Many consumer goods have fairly consistent consumption at retail but this signal becomes more chaotic and unpredictable as the focus moves away from consumer purchasing behaviour.



Research indicates a fluctuation in point-of-sale demand of  $\pm 5\%$  will be interpreted by supply chain participants as a change in demand of upto  $\pm 40\%$ .

### **Behavioural Causes:**

- Misuse of base-stock policies
- Misperceptions of feedback and time delays
- Panic ordering reactions after unmet demand

- Perceived risk of other player's bounded rationality

**Base-Stock Policy:** (places a replenishment order to restore the base stock  $s$ .) Inventory management when the leftover inventory is not salvaged but kept for the next season/period.

### **Operational Causes:**

- Dependant demand processing
  - Forecast errors
  - Adjustment of inventory control parameters with each demand observation.
- Lead time variability (forecast error during replenishment lead time)
- Lot-sizing/order synchronization
  - Consolidation of demands
  - Transaction Motive
  - Quantity discounts
- Trade promotion and forward buying
- Anticipation of shortages
  - Allocation rule of suppliers
  - Shortage gaming

**Lean Manufacturing:** is a methodology that focuses on minimising waste within manufacturing systems while simultaneously maximising productivity. Waste is seen as anything that customers do not believe adds value and are not willing to pay for some of the benefits of lean manufacturing can include reduced lead times, reduced operating costs and improved product quality.

Lean manufacturing, also known as lean production, or lean is a practice that organizations from numerous fields can enable.

The term Lean was coined in **1988** by **John Krafcik** and defined in **1996** by **James Womack and Daniel Jones**.

### **5 Principles of Lean Manufacturing:**

- 1. Identify Value from the Customer's Perspective:** Value is created by the producer, but it is defined by the customer. Companies need to understand the value the customer places on their products and services, which in turn help company determine how much money the customer is willing to pay.

- 2. Map the Value System:** This principle involves recording and analysing the flow of information or materials required to produce a specific product/service with the intent of identifying waste and methods of improvement. Value stream mapping encompasses the products entire life cycle from raw materials through to disposal.

Company must examine each stage of the cycle for waste. Anything that does not add value must be eliminated.

- 3. Create Flow:** Eliminate functional barriers and identifying ways to improve lead time. This aids in ensuring the processes are smooth from the time an order is received through to delivery. Flow is critical to the elimination of waste. Lean manufacturing relies on preventing interruptions in the productions process and enabling a harmonized and integrated set of processes in which activities move in a constant stream.

- 4. Establish a Pull System:** This means you only start new work when there is demand for it. Lean manufacturing uses a pull system instead of a push system.

Push systems are used in manufacturing resource planning (MRP) systems. With a push system, inventory needs are determined in advance, and the product is manufactured to meet that forecast.

In contrast to MRP, lean manufacturing is based on a pull system in which nothing is bought or made until there is demand. Pull relies on flexibility and communication.

- 5. Pursue Perfection with Continual process improvement, or Kaizen:** Lean manufacturing rests on the concept of continually striving for perfection, which entails targeting the root causes of quality issues and forecasting out and eliminating waste across the value stream.

**Agile Manufacturing:** is a term applied to an organization that has created the processes, tools and training to enable it to respond quickly to customer needs and market changes while still controlling costs and quality. It's mostly related to lean manufacturing.

Agile manufacturing is an approach to manufacturing which is focused on meeting the needs of customers while maintaining high standards of quality and controlling the overall costs involved in the production of a particular product. This approach is geared towards companies working in a highly competitive environment, where small variations in performance and product delivery can make a huge difference in the long term to a company's survival and reputation among consumers. This concept is closely related to



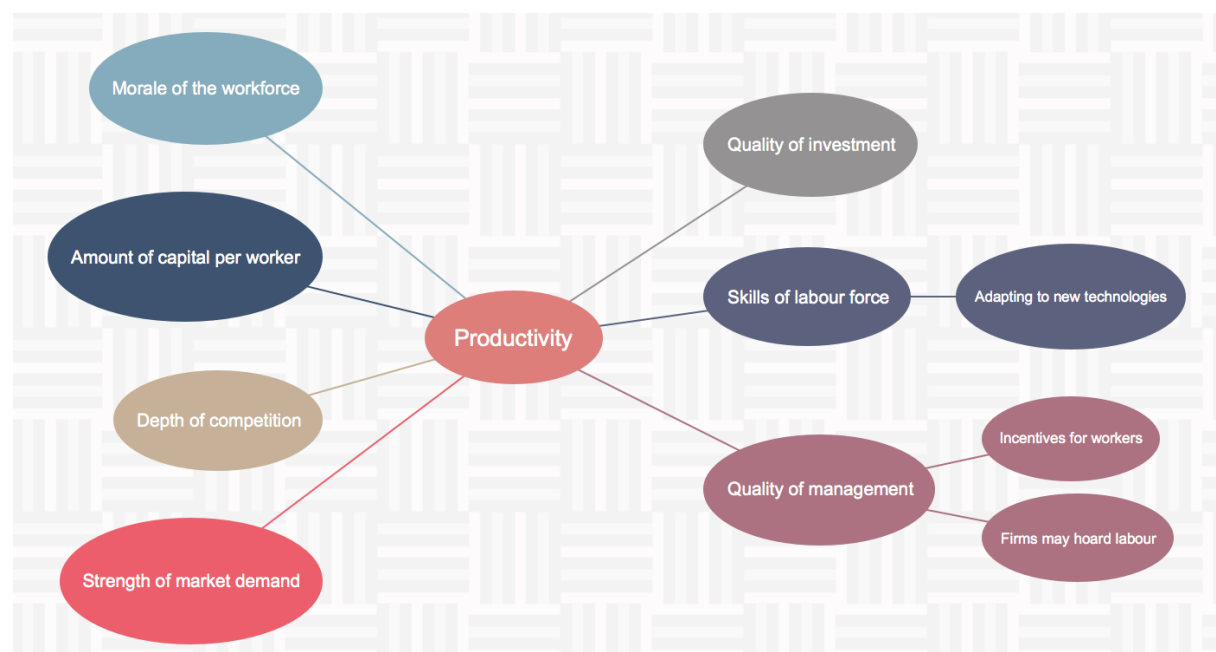
lean manufacturing, in which the goal is to reduce waste as much as possible. In lean manufacturing the company aims to cut all costs which are not actually related to the production of a product for the consumer. Agile manufacturing can include this concept, but it also adds an additional dimensions, the idea that customer demands need to be met rapidly and effectively.

## Unit- V

### Productivity and Quality:

Productivity can be defined as the ratio of total output to total input (raw material, man hour, capital cost, etc.)

Quality is a measure of excellence and can be defined as the overall performance (reliability, durability, serviceability, etc.) as compared to customer expectations.



### Total Quality Management (T.Q.M.)

Total Quality Management refers to meeting the requirements of customers consistently by continuous improvements in the quality of work of all employees. For achieving Total Quality, three things are essential:

- Meeting customer's requirements.
- Continuous improvements through management process.
- Involvement of all employees

Total Quality Management is a dynamic concept as the quality standards do not remain the same forever.

**Features:**

The key concepts in the TQM effort undertaken by the Navy in the 1980s include:

- Quality is defined by customer’s requirements
- Top management has direct responsibility for quality improvement.
- Increased quality comes from systematic analysis and improvement of work processes.
- Quality improvement is a continuous effort and conducted throughout the organization.

**Deming’s 14 Principles:**

Deming’s 14 Principles was propounded by **William Edwards Deming (October 14, 1900- Dec 20, 1993)** was an **American engineer, statistician, professor, author, and management consultant.**

01	CREATE PURPOSE FOR IMPROVEMENT	08	DRIVE OUT FEAR
02	ADOPT THE NEW PHILOSOPHY	09	BREAK DOWN SILOS
03	CEASE DEPENDENCE ON INSPECTION TO ACHIEVE QUALITY	10	NO SLOGANS
04	WORK WITH ONE SUPPLIER TO REDUCE COST	11	NO QUOTAS OR NUMERICAL GOALS
05	CONTINUOUS IMPROVEMENT	12	REMOVE ANNUAL RATINGS OR MERIT SYSTEM
06	ON-THE-JOB TRAINING	13	INSTITUTE EDUCATION AND SELF-IMPROVEMENT PROGRAMS
07	LEADERSHIP	14	INVOLVE ALL WORKERS IN THE TRANSFORMATION

 <b>Total Quality Management (TQM)</b> <b>Deming’s 14 Point Plan for TQM</b>			
1	Create constancy of purpose	8	Drive out fear
2	Adopt the new philosophy	9	Eliminate boundaries
3	Cease inspection, require evidence	10	Eliminate the use of slogans
4	Improve the quality of supplies	11	Eliminate numerical standards
5	Continuously improve production	12	Let people be proud of their work
6	Train and educate all employees	13	Encourage self-improvement
7	Supervisors must help people	14	Commit to ever-improving quality

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Deming is best known in the United States for his 14 points and they are as follows:

### **William Edwards Deming's 14 Points:**

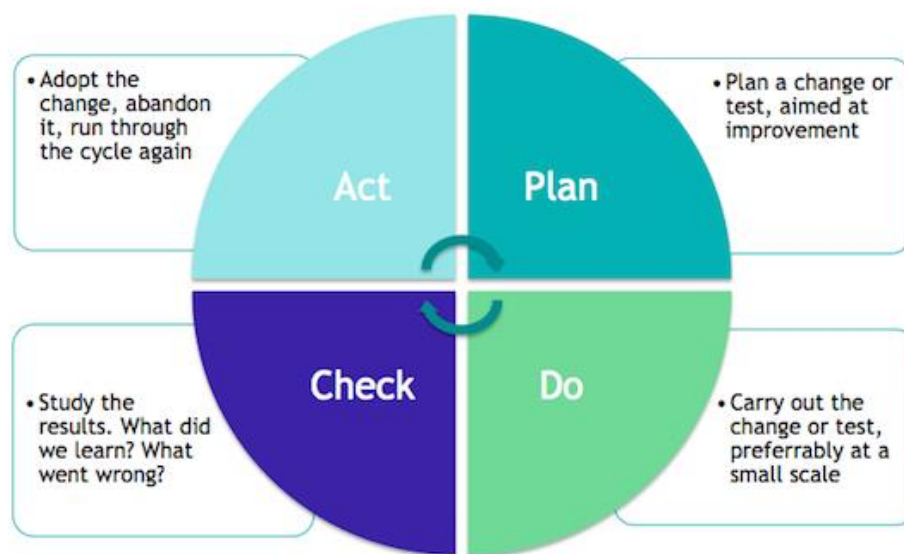
- 1. Create constancy of purpose for improving products and services:** with the aim to become competitive and to stay in business and to provide jobs.
- 2. Adopt the new philosophy:** We are in a new economic age. Western management must awaken to the challenge, must learn their responsibilities.
- 3. Cease dependence on inspection to achieve quality:** Eliminate the need for inspection on a mass basis by building quality into the product in the first place.
- 4. End the practice of awarding business on the basis of Price tag:** Instead, minimise total cost. Move towards a single supplier for working.
- 5. Improve constantly and forever the system of production and service:** to improve quality, quantity and productivity, and thus constantly decrease costs.
- 6. Institute:** training on the job.
- 7. Adopt and Institute Leadership:** The aim of supervision should be to help people and machines and gadgets to do a better job.
- 8. Drive out fear:** so that everyone may work effectively for the company.
- 9. Break down barriers between departments:** People in research, design, sales, and production must work as a team, to foresee problems of production.
- 10. Eliminate Slogans, Exhortations, and targets for the workforce:** asking for zero defects and new levels of productivity. Such exhortations only create adversarial relationships, as the bulk of causes of low quality and low productivity belong to the system.
- 11.(a) Eliminate work standards, quotas (numerical):** on the factory floor. Substitute leadership.  
**(b) Eliminate management by objective:** eliminate management by numbers, numerical goals. Substitute leadership.
- 12.(a) Remove barriers:** that rob the hourly paid worker of his right to pride in workmanship. The responsibility of supervisors must be changed from sheer numbers to quality.

**(b) Remove barriers:** that rob people in management and engineering of their right to pride in workmanship. This means, inter alia, abolishment of the annual or merit rating and MBO (Management by Objectives)

**13. Institute a vigorous:** program of education and self-improvement.

**14. Put everybody in the company to work to accomplish the transformation:** The transformation is everybody's job.

### PDCA (PLAN, DO, CHECK, ACT,) CYCLE:



PDCA (Plan-Do-Check-Act) or (Plan-Do-Check-Adjust) is an iterative 4 step management method used in business for the control and continuous improvement of processes and products.

Another version of this PDCA cycle is OPDCA. The added 'O' stands for 'Observation' or as some versions say "observe the current condition".

**Plan:** Establish objectives and processes required to deliver the desired results.

**Do:** The Do phase allows the plan from the previous step to be done. Small changes are usually tested, and data is gathered to see how effective the change is.

**Check:** During the check phase. The data and results gathered from Do phase are evaluated. Data are compared to the expected outcomes to see any similarities and differences.

**Act:** Also called "Adjust", this act phase is where a process is improved. Records from the "Do" and "Check" phases help identify issues with the process. These

issues may include problems, non-conformities, opportunities for improvement, inefficiencies and other issues.

## **KAIZEN**

Kaizen involves identifying issues and opportunities, creating solutions and rolling them out and then cycling through the process again for inadequately addressed issues or problems.

Kaizen is a concept referring to business activities that continuously improve all functions and involve all employees from the CEO to the assembly line workers. Kaizen also applies to processes, such as purchasing and logistics that cross organizational boundaries into the supply chain.



## **Types of Kaizen:**

**Point Kaizen:** It is one of the most commonly implemented types of Kaizen. It happens very quickly and usually without much planning. As soon as something is found broken or incorrect, quick and immediate measures are taken to correct the issues. Example of point kaizen could be a shop inspection by a supervisor and he finds broken materials or other small issues, and then asks the owner of the shop to perform a quick kaizen (5s) to rectify those issues.

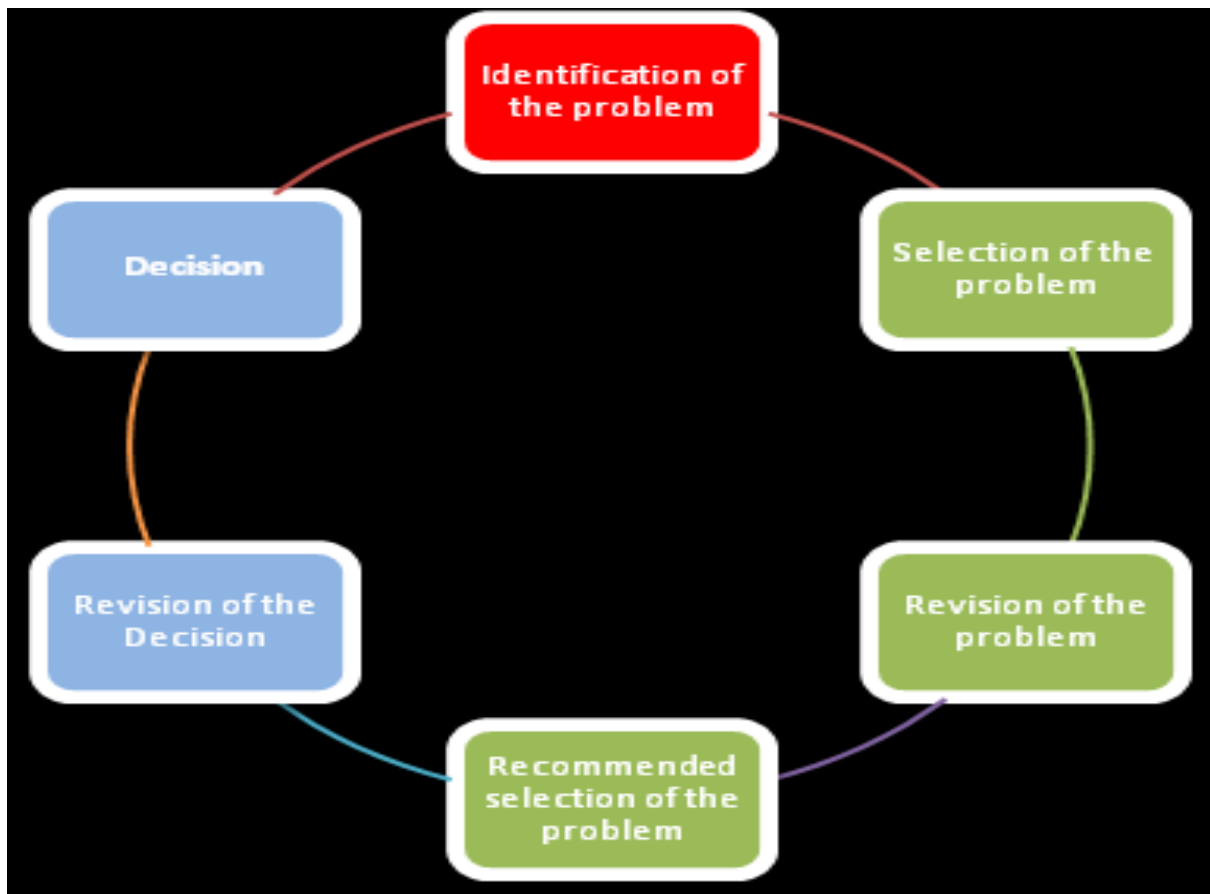
**System Kaizen:** is accomplished in an organized manner and is devised to address system level problems in an organization. It is an upper level strategic planning method which results in a number of planned kaizen events over a long period of time.

**Line Kaizen:** Line in this context refers to a structured spreading of Lean from point or discrete to the line. Example: Kaizen might be applied to a process (point); but also to the downstream process. These 2 points constitute a line kaizen.

**Plane Kaizen:** It is the next upper level of line kaizen, in that several lines are connected together. In modern terminologies, this can also be described as a value stream, where instead of traditional departments the organization is structured into product lines or families and value streams.

**Cube Kaizen:** describes the situation where all the points of the planes are connected to each other and no point is disjointed from any other. This would resemble a situation where Lean has spread across the entire organization.

### **Quality Circle:**



A Quality Circle or Quality Control Circle is a group of workers who do the same or similar work, who meet regularly to identify, analyse and solve work-related problems. It consist of minimum 3 and maximum 12 members in number. Normally small in size, the group is usually led by a supervisor or manager and presents its solutions to management, where possible, workers implement the solutions themselves in order to improve the performance of the organization and motivate employees.

Typical topics for the attention of quality circles are improving occupational safety and health, improving product design, and improvement in the workplace and manufacturing processes.

Quality Circle are typically more formal groups. They meet regularly on company time and are trained by competent persons (usually designated as facilitators) who may be personnel and industrial relations specialists trained in human factors and the basic skills of problem identification, information gathering and analysis, basic statistics and solution generation. Quality Circles are generally free to select any topic they wish (other than those related to salary and terms and conditions)

Quality circles have the advantage of continuity; the circle remains intact from project to project.

## 7 QC TOOLS

The seven basic tools of quality is a designation given to a fixed set of graphical techniques identified as being most helpful in trouble shooting issues related to quality. They are called basic because they are suitable for people with little formal training in statistics and because they can be used to solve the vast majority of quality-related issues.

The seven tools are:

### 1. Check Sheet:

Name of the operator -

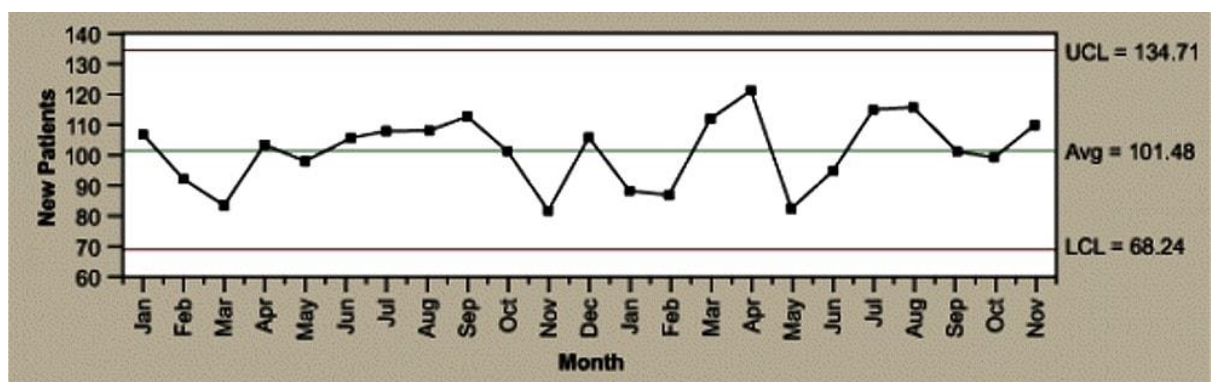
Date -

Location -

Section -

Defect Types	No of occurrences					Total
	Mon	Tue	Wed	Thu	Fri	
Bottles broken	II				III	5
Cap loose		II		I		3
Missing label	III		II		I	6
Dirt	I		II	II		5
Wrong order		III	I	II		6
Damage while packaging	II		II		II	6
<b>Total</b>	8	5	7	5	6	31

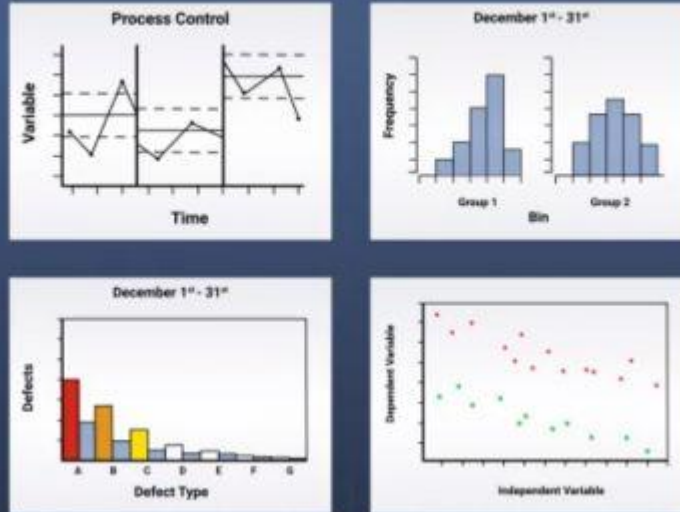
### 2. Control Chart:



### 3. Stratification (alternatively, flow chart or run chart):



# Stratification

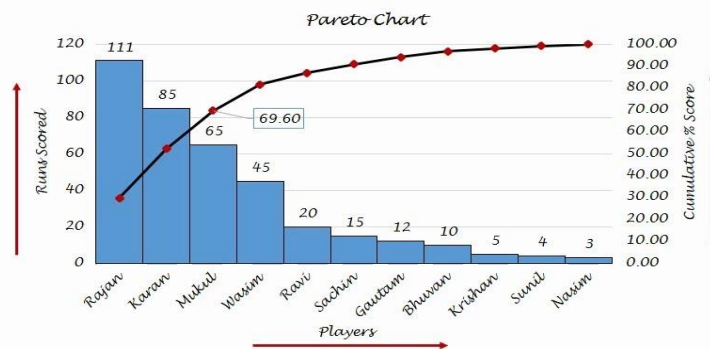


## 4. Pareto Chart:

### Pareto Chart

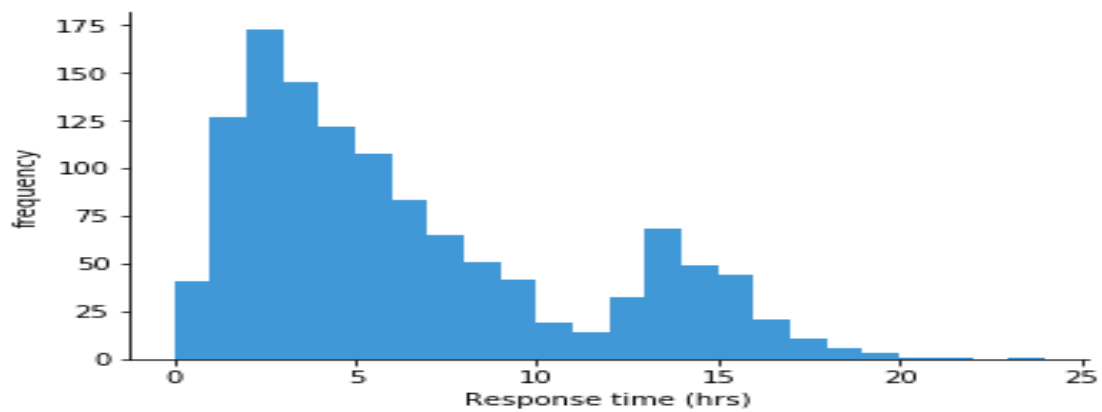
Player	Sachin	Rajan	Mukul	Gautam	Karan	Bhuvan	Ravi	Wasim	Krishan	Nasim	Sunil	Total
Runs Scored	15	111	65	12	85	10	20	45	5	3	4	375

Player	Runs Scored	Cumulative Score	Cum:% Score
Rajan	111	111	29.60
Karan	85	196	52.27
Mukul	65	261	69.60
Wasim	45	306	81.60
Ravi	20	326	86.93
Sachin	15	341	90.93
Gautam	12	353	94.13
Bhuvan	10	363	96.80
Krishan	5	368	98.13
Sunil	4	372	99.20
Nasim	3	375	100.00



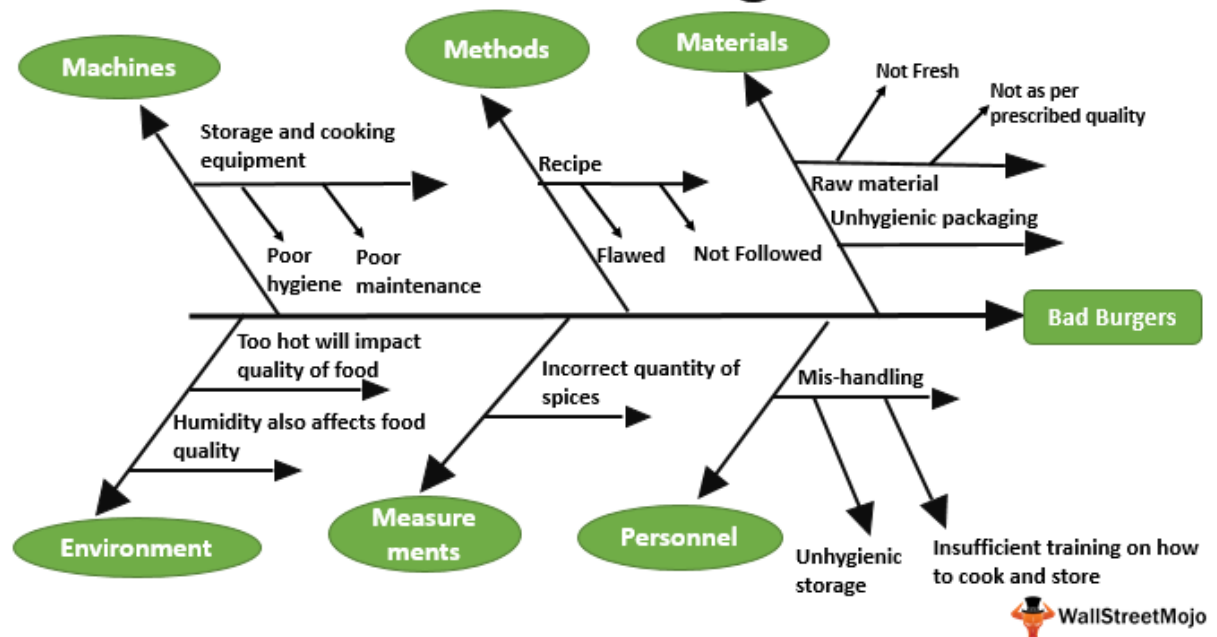
[www.shakehandwithlife.in](http://www.shakehandwithlife.in)

## 5. Histogram:

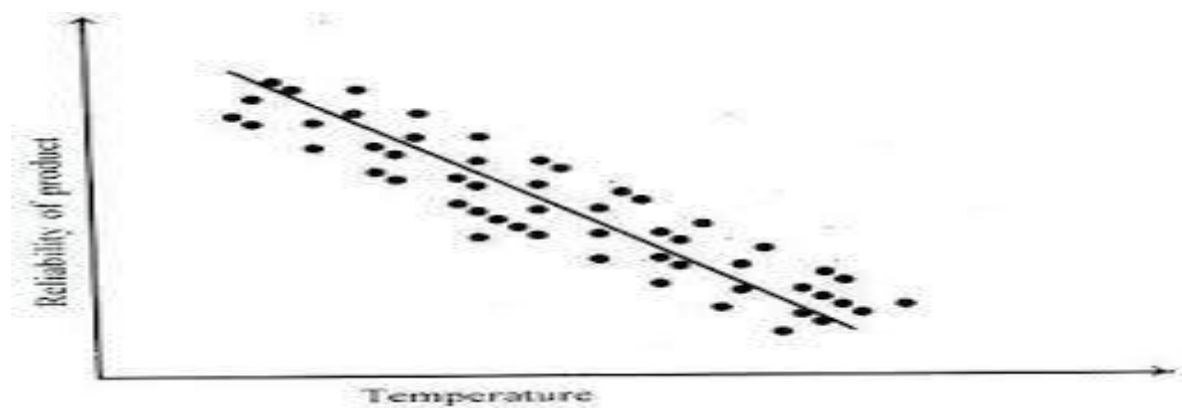


6. Cause and Effect Diagram (also known as the “fishbone diagram” or ishikawa diagram):

## Fishbone Diagram



7. Scatter Diagram:



The seven basic tools stand in contrast to more advanced statistical methods such as **survey, sampling, acceptance sampling, statistical hypothesis testing, design of experiments, multivariate analysis**, and various methods developed in the field of operations research.

In the measure phase, the first three of the 7 QC Tools are relevant: Fishbone Diagram, Pareto Chart, and Control Charts.

In the analyze phase, the Scatter Diagram, Histogram, and Checklist are relevant. The Control Chart is also relevant in the improve phase.

**ISO 9000-2000 CLAUSES:**

International Standard Organization. It is a specialised international agency for standardisation of system and its certification. It is an attempt to bring in uniformity in quality standard of different countries.

ISO is a non-governmental organization and represents a network of national standard organizations of 150 countries (one member/country)

BIS (Bureau of Indian Standard) is a member of ISO.

ISO is the world's largest developer of standards of various types. ISO was born on February, 1947.

### **ISO 9000**

Is a series of international quality standards that serves as a guidance to suppliers and purchasers about the minimum requirements of a quality system. The first edition of 9000 standards was completed in 1986 by ISO technical committee and published in 1987. **RALLI WOLF was the first company in India to get ISO 9000 certified in 1988 by BIS.**

### **ISO 2000**

Quality System Standards adopted in 1987 by International Organization for Standardisation, revised in 1994 and 2000.

Technical specifications and criteria to be used as rules, guidelines, or definitions of characteristics to ensure that materials, products, processes, and services are fit for their purpose.

### **ISO 9000-2000 CLAUSES:**

- 1. Quality Management System:** The general requirements are concerning whether the organization a well quality management system or not. QMS ensures that a long term strategy with respect to quality management. It provides the framework for ensuring quality in every sphere of activity.
- 2. Management Responsibility:** The top management conducts management reviews at regular interval of time. Management determines the requirement and expectations of customer and take appropriate measures to satisfy these. Management appoints management representative for matters related to quality.
- 3. Resource Management:** Resources requires that the organization should determine and provide the resources required to implement, maintain and improve the QMS. The human resource seeks the attention of the organisation towards identifying whether the personnel, who directly affect the quality of product are competent enough in terms of qualifications, skills. Experience etc.
- 4. Product Realization:** It demands for planning and developing processes for product realization and maintaining the relevant records.

## SIX SIGMA

Is a set of techniques and tools for process improvement. **It was introduced by American Engineer Bill Smith while working at Motorola in 1986. A Six Sigma process is one in which 99.9966% of all opportunities** to produce some feature of a part are statistically expected to be free of defects.

Six Sigma strategies seek to improve the quality of the output of a process by identifying and removing the causes of defects and minimising impact variability in manufacturing and business processes. It uses a set of quality management methods, mainly empirical statistical methods, and creates a special infrastructure of people within the organization who are experts in these methods.

### Methodologies of Six Sigma:

- **DMAIC:** is used for projects aimed at improving an **existing business process**.
- **DMADV:** is used for projects aimed at creating **new product or process designs**.

**DMAIC** has 5 phases:

- **Define the System:** The voice of the customer and their requirements, and the project goals specifically.
- **Measure Key Aspects:** of the current process and collect relevant data.
- **Analyse the data:** to investigate and verify cause and effect relationships. Determine what the relationships are, and attempt to ensure that all factors have been considered.
- **Improve or Optimize:** the current process based upon data analyses using techniques such as design of experiments, or mistakes proofing and standard work to create a new, future state process.
- **Control the Future:** state process to ensure that any deviations from the target are connected before they result in defects. Implement control systems, such as statistical process control, production board, visual workplaces.

**DMADV** has 5 phases:

- **Define Design Goals:** that are consistent with customer demands and the enterprise strategy.
- **Measure and Identify CTQs** (Characteristics that are Critical to Quality): Measure product capabilities, production process capability, and measure risks.
- **Analyse** to develop and design alternatives.
- **Design** an improved alternative, best suited per analysis in the previous step.
- **Verify the Design:** set up pilot runs, implement the production process and hand it over to the process owner(s)
- Six Sigma is a data-driven process that seeks to reduce product defects down to **3.4 defective parts per million**, or **99.9966% defects-free products** over the long-term.
- In other words, the goal is to produce nearly perfect products for your customers. In all Six Sigma projects, there are 2 main methods of achieving the same defect-free goals.

## **TOTAL PRODUCTIVE MANAGEMENT (T.P.M.)**

Total Productive Maintenance (TPM) is a system of maintaining and improving the integrity of production, safety and quality systems through the machines, equipment, processes, and employees that add business value to an organization.

**T.P.M.:** focuses on keeping all equipment in top working condition to avoid breakdowns and delays in manufacturing processes.

**Objectives:** The goal of TPM is the continuous improvement of equipment effectiveness through engaging those that impact on it in small group improvement activities.

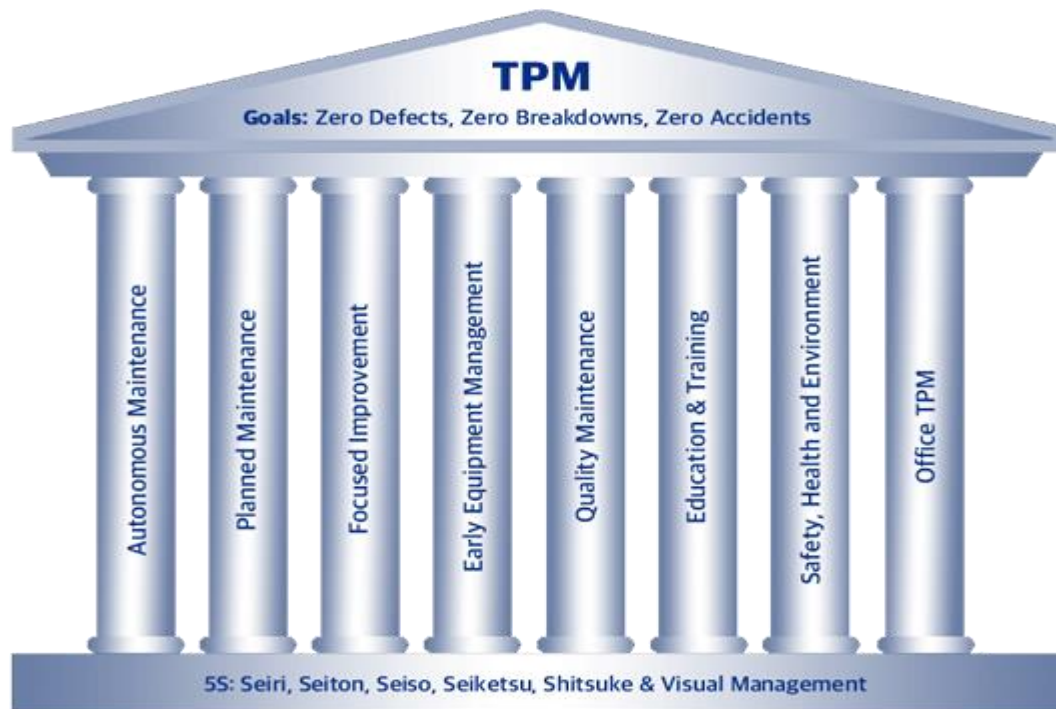
The main objective of TPM is to increase the **Overall Equipment Effectiveness (OEE)** of plant equipment. TPM addresses the causes for accelerated deteriorated while creating the correct environment between operators and equipment to create ownership.

### **Principles of TPM:**

The 9 pillars of TPM are mostly focused on proactive and preventive techniques for improving equipment reliability:

1. Autonomous Maintenance.

2. Focused Improvement.
3. Planned Maintenance.
4. Quality Management.
5. Early Equipment Management.
6. Education and Training.
7. Administrative and Office TPM.
8. Safety Health Environmental Conditions.
9. Routine Maintenance.



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## **Implementations:**

Following steps are involved in the implementation of TPM in an organization:

1. Initial evaluation of Total Productive Maintenance level.
2. Introductory Education and Propaganda (IEP) for TPM.
3. Formation of Total Productive Maintenance Committee.
4. Development of a master plan for TPM implementation.
5. Stage by Stage training to the employees and stakeholders on all 9 pillars of TPM.
6. Implementation preparation process.
7. Establishing the TPM policies and goals and development of a road map for TPM implementation.