OPERATIONS MANAGEMENT (18MBA205)

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Course Objectives:

1. **Operations management involves a wide range of areas as well as redesigning business operations in the production of goods or services.**
2. **Known about the various industries which were implanting operation management in competitive advantages**.
3. **To develop strategies which are as capacity planning, facilities location is planning, aggregate planning and scheduling, as well as inventory management techniques and quality management.**
4. **To demonstrate ability to identify strengths and weaknesses of alternative solutions and obtain relevant managerial insights.**

Syllabus:

Module-1: Overview of Operations Management and Capacity Planning:

Operations in Manufacturing and services, Responsibility of Operations Manager, Operations Strategy and Competitiveness, Process Analysis, Job Design and Work Measurement; Capacity Planning-Concept, Types of capacity; Aggregate Planning- Relevant cost and strategies.

Module-II: Facility Location and Layout, Inventory Management: Facility Location-Factors, Techniques (Single facility and multi-facility), Factor Rating Method, Centroid Method; Facility Layout- Concept, Types of Layout and Line Balancing, Inventory Management-concept, EOQ,MRP.

Module-III: Scheduling, Project Management and Quality Management: Scheduling; Gantt chart; Project Management-concept and technique PERT and CPM; Basis of supply chain management; Quality management-concept, quality design, control chart (X.R.P.) TQM introduction to ISO 9000 and 14000 series


Operations Management
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(Overview of Operation Management & Capacity Planning)

Module- 1

Operation in Manufacturing and Service

What is Manufacturing?

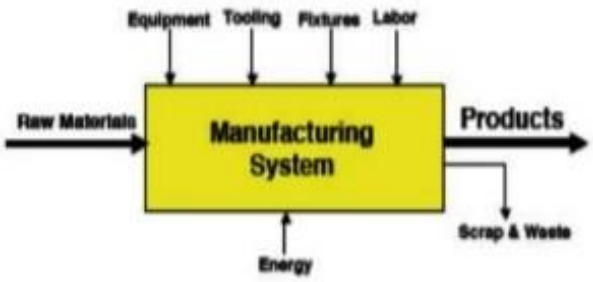
i. Manufacturing is derived from latin word **menu factus** which means made by hand.
ii. The process of converting raw materials, components or parts into finished goods that meet a customer's expectation or specifications.
iii. Manufacturing is the making of goods by hand or by machine that upon completion the business sells to a customer.
iv. Manufacturing in the transformation materials in goods or products.
v. Manufacturing is to plan and deploy an optimum way of transformation of material into goods by integrating people , capital, process system and enterprises to deliver product of value to the society.
vi. Manufacturing is value added process where direct and indirect values are associated to produce finished goods or products.



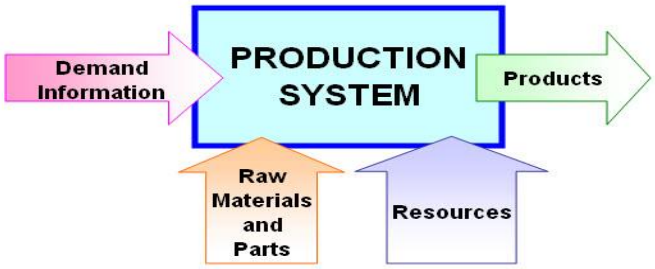
Figure: Manufacturing

Manufacturing and Production are often used as same terms but there is a big difference between them.

Manufacturing is the process to convert raw material to a ready to sale finished product that is tangible. The manufactured product can be directly sold to end customer. Manufacturing involves many processes to convert procured raw material to a finished product. Almost all the processes add value to material but also consume some material for adding value. A lot of planning goes into this. Mostly men, machine and material is required as resource.



On the other hand, Production is process to convert any type of inputs to output, tangible or intangible. Mainly Production is creation of utility. Utility includes both goods and services. Productivity is measure of production that is defined as following way:



Difference between Manufacturing and Production

BASIS FOR COMPARISON	MANUFACTURING	PRODUCTION
Meaning	The process of producing merchandise by using resources like labor, machines, tools, raw materials, chemicals and others is known as a Manufacturing.	Production is a process of making something used for consumption by combining various resources.
Concept	A process in which raw material is used to generate output.	A process of converting inputs into outputs.
Compulsory resources	Men and Machine	Men
Form of input	Tangible	Tangible and Intangible
Form of Output	Goods only	Goods and Services
Creation of	Goods that are suitable for use	Utility

Manufacturing Operations:

Manufacturing operations convert inputs like materials, labour and capital into some tangible outputs.

Manufacturing processes are the primary processes and can be grouped under three basic categories, namely forming, machining and assembly. The objective of each process is to change the shape or physical characteristics of the raw materials.

1) **Machining processes:** Involve basically metal removal, by turning, drilling, milling, grinding, shaping, boring etc., it also includes chip less machining processes such as electro discharge machining (EMD), electrochemical machining(ECM), chemical milling, laser drilling etc.

2) **Assembly processes:** Involve the joining of component or piece parts to produce a single component that has a specific function. Some of the common assembly processes are welding, brazing, soldering, riveting, fastening with bolts and nuts and joining by use of adhesives.

3) **Forming processes:** Include casting forging, stamping embossing, spinning etc. these processes change the shape of the work piece without necessarily removing or adding material.

Selection of a Process:

The selection of a manufacturing process is influenced by several factors such as the desired product quality, labor cost to be achieved and the volume of production needed. While there can be several manufacturing methods or processes to produce an item, there is usually one best method for a given set of variables. Some of the common manufacturing processes are briefly described in the following paragraphs.

Forming Processes:

1) **Casting:** The casting process consists of pouring of molten metal into a mould and allowing sufficient time for the metal to solidify and retain the shape of the molded cavity. The various casting methods are sand casting, shell molding, gravity die casting, pressure die casting centrifugal casting, investment casting etc. Casting of plastics is done by compression molding, injection molding, transfer molding extrusion, vacuum forming and blowing.

2) **Embossing and Coining:** In embossing the metal is stretched or formed as per the configuration in the dies. Coining is performed in an enclosed die and the metal flow is restricted in a lateral direction. An impact or compressive force causes the metal to flow in the shallow configurations of the blank being coined.

3) **Extrusion:** Extrusion process consists of forcing the metal through dies so that the metal obtains cross section of the same shape as the die. Extrusion process can be direct or forward extrusion, inverted or backward extrusion and impact extrusion.

4) **Forging:** In forging process the metal is heated to a plastic state and then formed to the desired shape by pressure or impact. The various types of forging processes are flat die forging, drop forging, upset forging, press forging and roll forging.

5) **Stamping:** In the stamping process, force is applied on the metal to cause plastic flow and to alter the size and shape of the metal part to the desired size and shape. It is a cold working process.
6) **Spinning:** Also known as spin forming; it is a process of shaping a metal by pressing it against a form or mandrel while it is rotating on a high speed lathe.

Machining Processes:

1) **Turning:** In turning operation, the work piece is held in the lathe and rotated while the cutting tool or cutter removes the metal from the work piece. The various kinds of operations that can be performed on lathe are cylindrical turning, taper turning, facing, reaming, drilling, boring thread cutting, grinding and knurling.

2) **Drilling and boring:** In drilling operation, a hold is produced on the work piece by forcing a rotating cutter known as drill bit through the work piece. In boring operation, an existing drilled hold is enlarged by using a cutter known as boring bit. Reaming is the finishing of a drilled hole to an accurate size using a fluted tool called a reamer.

3) **Milling:** Milling operation removes metal by feeding the work piece against a rotating multi-point cutting tool called milling cutter.

4) **Grinding:** Grinding process refers to the abrading or wearing away by friction of a material. It is accomplished by forcing the work piece against a rotating grinding wheel made of abrasive material. Extremely hard metals or metals hardened by heat treatment processes can be machined only by the grinding process.

5) **Shaping and planning:** In shaping or planning, plane surfaces are produced with the use of single point cutting tools. Work pieces, castings or forgings of smaller sizes are machined by shaping process, where planning process is used for machining work pieces, castings or forgings of larger sizes.

Assembly Processes:

1) **Welding processes:** In welding process, two pieces of metal are joined into a single piece by fusion due to heat or combination of heat and pressure. Various types of welding processes are gas welding arc welding, resistance welding (spot welding and seam welding), plasma arc welding, electron beam welding and laser welding.
2) **Brazing:** Brazing is a metal joining process used for joining nonferrous alloys(either similar or dissimilar metals).The brazing alloy melts at a lower temperature than the melting point of the

base metals to be joined and fills the joint between the base metals by capillary action and then solidifies on cooling.

3) **Soldering:** Soldering process is similar to brazing except that the soldering alloy is different from brazing alloy and melts at a lower temperature as compared to brazing alloy. The lead-tin base solder alloys melt and flow throughout the solder joint by the heat of the joint itself.
4) **Riveting:** It is the process of placing the river in a hole drilled through the overlapping surfaces of the work pieces to be joined and upsetting the head of the rivet using a riveting tool.
5) **Fastening by bolts and nuts:** When work pieces or parts of an assembly must be disassembled and reassembled, the best method of assembly is by fastening using screws, bolts and nuts.
6) **Assembling using adhesives:** Adhesives are used to bond almost all materials such as wood, rubber, plastics and metals.

Production & Operation Management:

Operation Management:

1) Operation management is the process in which resources/ inputs are converted into more useful products.
2) Operation is purposefully actions or activities which are done methodically as part of a plan of work by a process that is designed to achieve the pre-decided objectives.
3) Its consists of scheduling work, assigning resources including people, equipment, managing inventories, assessing quality standards, process type decision and sequence for making individual items.
4) Operation management as the process whereby resources or input are converted into more useful products.



Scope of Operation Management:

Operations management concern with the conversion of inputs into outputs, using physical resources, so as to provide the desired utilities to the customer while meeting the other organizational objectives of effectiveness, efficiency and adoptability. Following are the activities which are listed under production and operations management functions:

1) Location of facilities
2) Plant layouts and material handling
3) Product design
4) Process design
5) Production and planning control
6) Quality control
7) Materials management
8) Maintenance management.

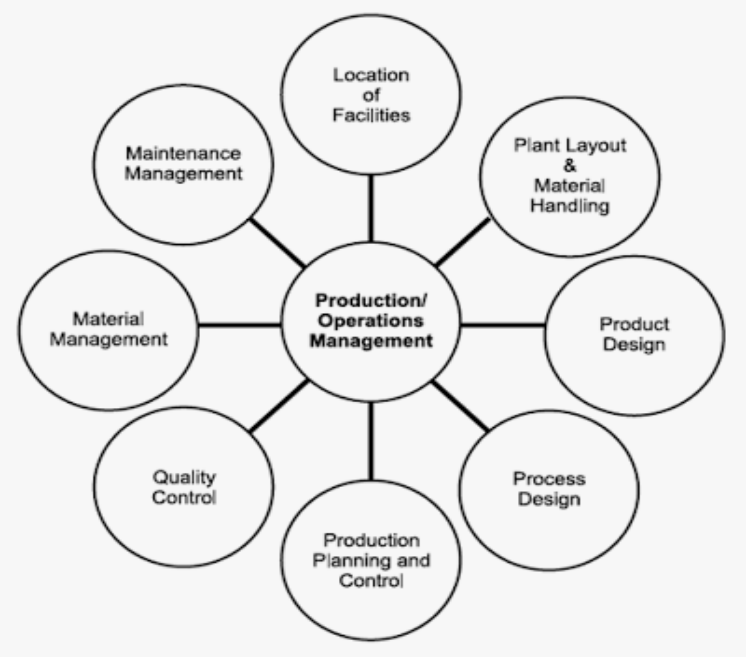


Figure: Scope of Production & Operation Management

Location of Facilities:

Location of facilities for operations is a long-term capacity decision which involves a long term commitment about the geographically static factors that affect a business organization. It is an important strategic level decision-making for an organization. It deals with the questions such as 'where our main operations should be based?' The selection of location is a key-decision as large investment is made in building plant and machinery.

Plant Layout and Material Handling:

Plant layout refers to the physical arrangement of facilities. It is the configuration of departments, work centers and equipment in the conversion process. The overall objective of the plant layout is to design a physical arrangement that meets the required output quality and quantity most economically.

Product Design:

Product design deals with conversion of ideas into reality. Every business organization has to design, develop and introduce new products as a survival and growth strategy. Developing the new products and

launching them in the market is the biggest challenge faced by the organizations. Product design and development provides link between marketing, customer needs and expectations and the activities required to manufacture the product.

Process Design:
Process design is a macroscopic decision-making of an overall process route for converting the raw material into finished goods. These decisions encompass the selection of a process, choice of technology, process flow analysis and layout of the facilities. Hence, the important decisions in process design are to analyze the workflow for converting raw material into finished product and to select the workstation for each included in the workflow.

Production Planning and Control:
Production planning and control can be defined as the process of planning the production in advance, setting the exact route of each item, fixing the starting and finishing dates for each item, to give production orders to shops and to follow up the progress of products according to orders. The principle of production planning and control lies in the statement 'First Plan Your Work and then Work on Your Plan'. Main functions of production planning and control includes planning, routing, scheduling, dispatching and follow-up.

Quality Control:
Quality Control (QC) may be defined as 'a system that is used to maintain a desired level of quality in a product or service'. It is a systematic control of various factors that affect the quality of the product. Quality control aims at prevention of defects at the source, relies on effective feedback system and corrective action procedure. Quality control can also be defined as 'that industrial management technique by means of which product of uniform acceptable quality is manufactured'. It is the entire collection of activities which ensures that the operation will produce the optimum quality products at minimum cost.

Materials Management:
Materials management is that aspect of management function which is primarily concerned with the acquisition, control and use of materials needed and flow of goods and services connected with the production process having some predetermined objectives in view.

Maintenance Management:
In modern industry, equipment and machinery are a very important part of the total productive effort. Therefore, their idleness or downtime becomes are very expensive. Hence, it is very important that the plant machinery should be properly maintained.

Characteristics of Modern Operation Management:

Specially, today's production system is characteristics by at least four features;

1) Manufacturing as competitive Advantages
2) Service Orientation

3) Disappearance of Smokestacks
4) Small has Become Beautiful

Manufacturing as competitive Advantages:

1) Plant have excess capacities, competition is mounting and firms look and gain competitive advantages to survive and success.
2) The production system offers vast scope to gain competitive edge and firms intend to exploit the potential.
3) Employing some managerial philosophy & technology to gain competitive advantages which includes;
- Total Quality Management
- Time based competition
- Business process re-engineering
- Just in time
- Flexible manufacturing system
- Computer integrated manufacturing

Service Orientation:

1) Production system needs to organize for requirement of service components.
2) The manufacturing need to serve;
- Intangible & perishable nature of services
- Constant interaction with customer
- Small volume of production to serve local markets
- Need to locate facilities to serve local mark

Disappearance of Smokestacks:

1) Smokestacks represent the smoke polluting the environment around.(bad smell, generated dust, noisy sound etc.)
2) Protective labour legislation (Law), Environment movement, knowledge based organization brought total transformation in the production system.

Small has Become Beautiful:

1) Small has Become Beautiful opposed big organization & increased specialization.
2) The concept based on smaller working units, community ownership & regional workplaces utilized local labour & resources

Production System-Examples:

The production system of an organization is that part, which produces products of an organization. It is that activity whereby resources, flowing within a defined system, are combined and transformed in a controlled manner to add value in accordance with the policies communicated by management. A simplified production system is shown below.

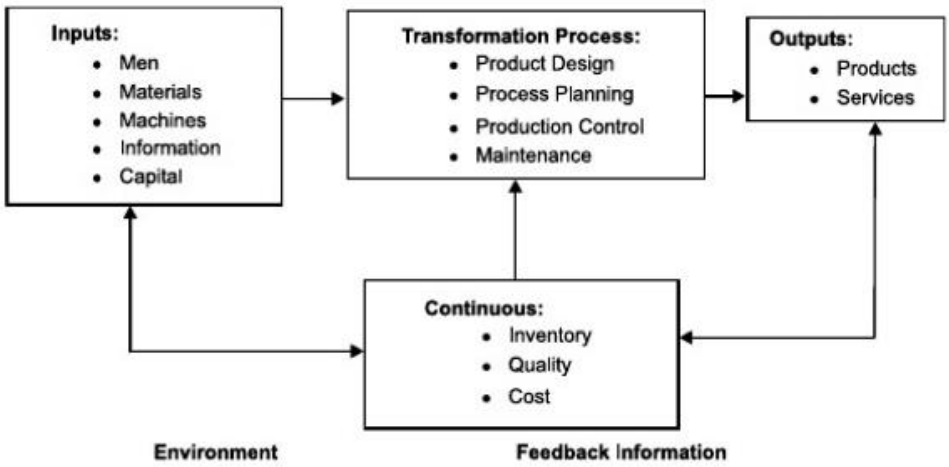


Figure: Production System

The production system has the following characteristics:

1) Production is an organized activity, so every production system has an objective.
2) The system transforms the various inputs to useful outputs.
3) It does not operate in isolation from the other organization system.
4) There exists a feedback about the activities, which is essential to control and improve system performance.

Table: Example of Production System

System	Inputs	Conversion	Output (desired)
Hospital	Patients MDs, Nurses Medical Supplies Equipment	Health Care	Healthy Individuals
Restaurant	Hungry Customers Food, Chef Servers Atmosphere	Prepare Food Serve Food	Satisfied Customers
Automobile Plant	Sheet Steel Engine Parts Tools, Equipment Workers	Fabrication and Assembly of Cars	High Quality Automobiles
University	High School Grads Teachers, Books Classroom	Transferring of Knowledge and Skills	Educated Individuals

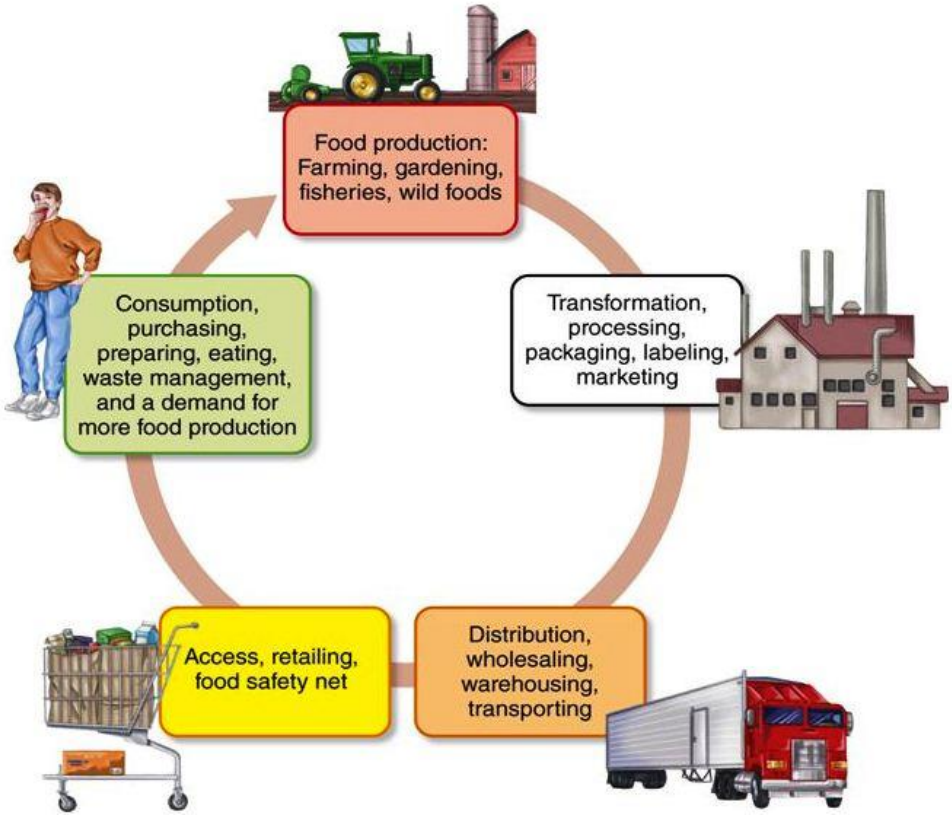


Figure: Example Food Production System

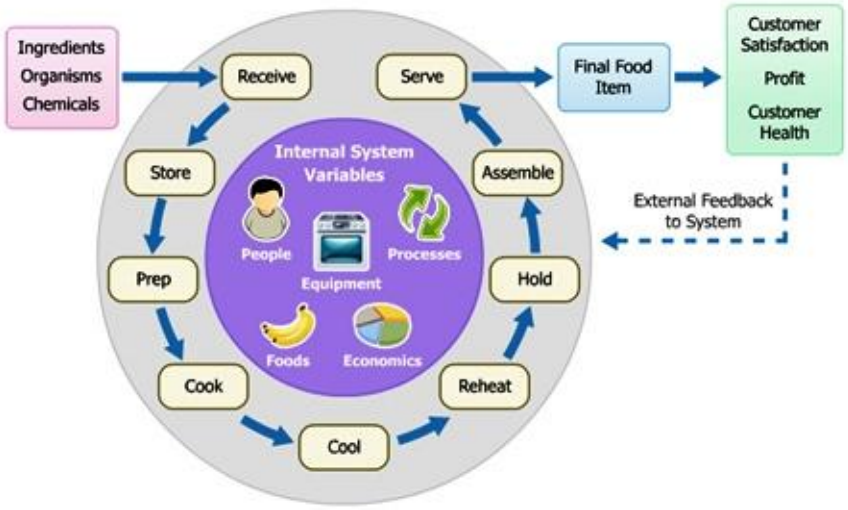


Figure: Example Restaurant Production System

Manufacturing System:

i. A manufacturing system is a collection of integrated equipment and human resources, whose function is to perform one or more processing and/or assembly operations on a starting raw material, part, or set of parts.

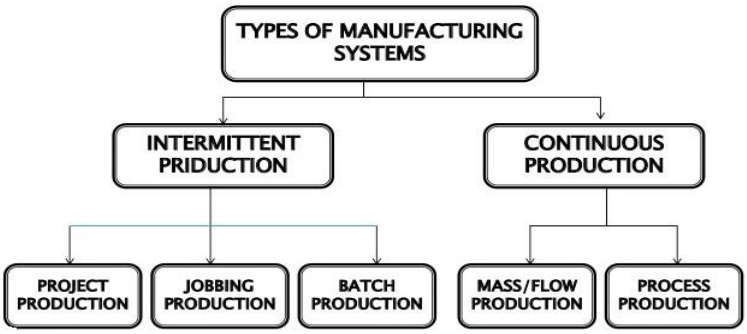
ii. Manufacturing system may be defined as the arrangement and operation of machine, tool, materials, people information to produce value-added physical, informational or service product whose success and cost is characterized by measurable parameters.

iii. Manufacturing system is an approach to making products that is based upon several factors. These includes how much of the product is needed, how quickly the product must be produced and how unique the product must be to ensure sufficient sales.

iv. Manufacturing system includes custom, assembly, flexible, intermittent, reconfigurable, just in time, and lean manufacturing system.

Types of Manufacturing System:

The manufacturing systems differ in structure or physical arrangement. According to the physical arrangement, there are four kinds of classical manufacturing systems and two modern manufacturing systems that is rapidly gaining acceptance in industries.



The classical systems are;

1. **Job Shop**
2. **Flow Shop**
3. **Project Shop**
4. **Continuous Process**

The modern manufacturing systems are

1. **Linked Cell System (Cellular Manufacturing System)**
2. **Flexible Manufacturing System (FMS)**

Job Shop: In a Job shop, varieties of products are manufactured in small lot sizes to a specific customer order. To perform a wide variety of manufacturing processes, general purpose production equipment is required. Workers must have relatively high skill levels to perform a range of different work arrangements**.**

Flow Shop: The flow shops have a "product oriented layout" composed mainly of flow lines. This system can have high production rates. The plant may be designed to produce the particular product or family, using "Special purpose machines" rather than general purpose equipment**.**

Project Shop: In this type, a product must remain in a fixed position or location because of its size and weight. The materials, machines and people in fabrication are brought to site. The layout is also called as fixed position layout.

Continuous Process: In this continuous process, the product seems to flow physically. This system is sometimes called as flow production when referring to the manufacture of either complex single parts, such as a canning operation, or assembled products such as TVs. However, this is not a continuous process, but high volume flow lines. In continuous process, the products really do flow because they are liquids, gases, or powers.

Linked Cell Manufacturing (CM) System: Cellular manufacturing (CM) is a hybrid system for linking the advantages of both job shops (flexibility in producing a wide variety of products) and flow lines (efficient flow and high production rate). A cellular manufacturing system (CMS) is composed of "linked cells". In cells, the workstations are arranged like a flow shop. The machines can be modified, retooled and regrouped for different product lines within the same "family" of parts. This system has

some degree of automatic control for loading and unloading of raw materials and work pieces, changing of tools, transferring of work pieces and tools between workstations.

Flexible Manufacturing System (FMS) : A FMS integrates all major elements of manufacturing into a highly automated system. The flexibility of FMS is such that it can handle a variety of part configurations and produce them in any order. The basic elements of FMS are a) works station b) automated material handling and automated storage and retrieval systems c) control systems. Because of major capital investment; efficient machine utilization is essential. Consequently proper scheduling and process planning are crucial, that are complex in nature. Because of the flexibility in FMS, no setup time is wasted in switching between manufacturing operations; the system is capable of different operations in different orders and on different machines.

Other Types of Manufacturing System:

Manufacturing is a very simple business, the owner buys the raw materials or component parts to manufacture a finished product. To function as a business the manufacture needs to cover costs, meet demand and make a product to supply the market. There are three types of manufacturing processes which are

A. **Make –to-Stock (MTS)**
B. **Make –to-Order (MTO)**
C. **Make –to-Assemble (MTA)**

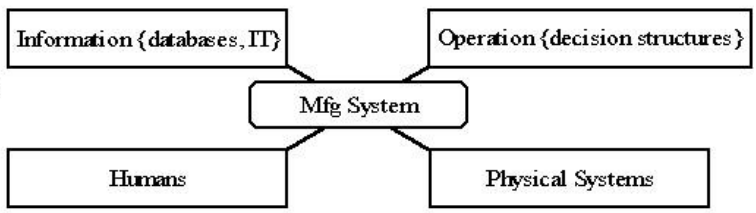
Make –to-Stock (MTS): A factory produces goods to stock stores and showrooms. By predicting the market for their goods, the manufacture will plan productivity in advance.

Make –to-Order (MTO): The producer waits for order before manufacturing stock. Inventory is easier to control and the owner doesn't need to rely as much on market demand. Customer waiting time is longer and the manufacturer needs a constant stream of order to keep the factory in production.

Make –to-Assemble (MTA): The factory produces component parts in anticipation of order for assembly. The manufacturer is ready to fulfill customer orders don't materialize, the producer will have a stock of unwanted parts.

Components Of Manufacturing System

- Production Machines
- Material handling system
- Computer systems
- Human Resources



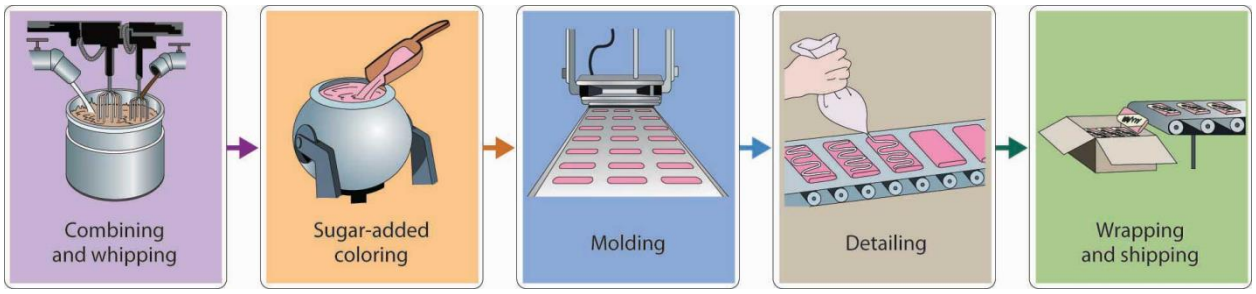
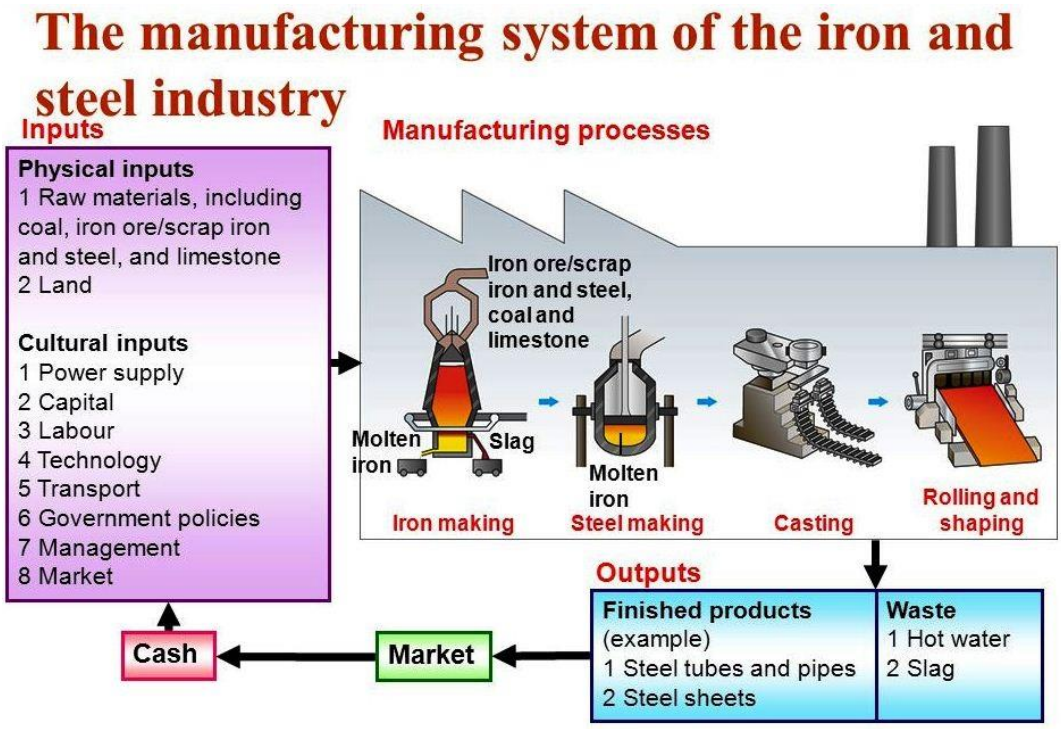


Figure: Operations Management in Manufacturing Example of Chocolate Making Company



What is Service?

a) "Services are deeds, processes and performances". They elaborate their definition as- all economic activities whose output is not a physical product and construction, is usually consumed at the time it is produced, and provides added value in forms that are essentially intangible concerns of its first purchaser.

b) 'A service is a time perishable, intangible experience performed for a customer acting in the role of co-producer.'

c) 'Service is any act and performance that one party can offer to another that is essentially intangible and does not result in the ownership of anything'.

d) Services are economic activities offered by one party to another, commonly employing time-based performance to bring about the desired results for which purchasers have responsibility.

e) A service system is a value coproduction configuration of people, technology, other internal & external service system and shared information (such as languages, processes, metrics, prices, policies and laws)

f) From the customer's perspective, service is the combination of customer's experience and their perception of the outcomes of the service.

Service = Experience + Outcome

The Objectives of Service Operation:

a) The main objective of service operation is to coordinate and carry out the activities and processes required to deliver and manage services at agreed levels to business users and customers.

b) Service operation is also responsible for ongoing management of the technology that is used to deliver and support services.

c) Well designed and well implemented processes will be of little value if day to day operation of those processes is not properly conducted, controlled and managed; nor will service improvements be possible if day to day activities to monitor performance, assess metrics and gather data are not systematically conducted during service operation.

d) Other objectives include:

- Responsive stable services
- Robust end to end operational practices
- Business as usual – day to day
- Execution of processes and services
- Responsive and operational validation
- Realizing value
- Achieving service excellence

The Scope of Service Operation

Services: All activities associated with operational services regardless of whether they are executed by the service provider, a third party supplier or by users and customers.

Service Management Processes: Operational aspects of all processes whatever part of the lifecycle they originate from (e.g. operational aspects of capacity and availability management).

Technology: Management of the technology delivering the services.

People: The people managing the services, processes and technology



Difference between Manufacturing and Service Operation:

Sl. No.	Manufacturing	Service
1	Manufacturing operations convert inputs like materials, labour etc. into tangible outputs	Service Operations also transform inputs into outputs but outputs are intangible.
2	Manufacturing Operation allow Separation between Production and Consumption.	Customer receives service as it is performed. Thus, there is production as well as consumption of service at the same time.
3	Productivity is easily measured in manufacturing operations because manufacturing operations produce tangible products.	Productivity is not easily measured in service operations because the outputs of service operations are intangible.
4	Expenses required for material handling is more in manufacturing operations.	Expenses required for material handling are less as compared to manufacturing operations.
5	Customers have less contact with people who provide manufacturing operations.	Customers have more contact with persons who provide services.
6	Quality standards are relatively simple and easy to establish in manufacturing operations.	Quality standards are difficult to establish and product quality is difficult to evaluate in service operations.
7	Manufacturing operations depend on maintenance and repair work.	Service operations do not depend on maintenance and repair work.
8	Manufacturing operations are flexible in manufacturing work, methods, scheduling work.	Service operations are inflexible because services are in direct contact with customers and customers are part of service system.

9	Manufacturing operations can standardized and less customized.	Service operations cannot produce outputs that can be stored.
10	Higher amounts are required to be invested an assets like equipment , building, etc.	High amounts are not required to invested since most of they are labour performance.
11	Quality assurance is relatively easy and controllable variation. In inputs can be controlled and defects can be rectified in output before they reach the customer.	Quality assurance in services is challenging. There is high level of variation in input in case of services. This affects service quality.
12	Manufacturing operations usually are larger in size and operation.	Service operations meet direct contact with customer and hence they are relatively smaller in size and operation.

Products vs Services

Criteria	Product (product manufacturer)	Service (service provider)
Durability	A physical, durable product	Intangible, perishable product
Inventory	Output can be inventoried	Output cannot be inventoried
Customer involvement	Low contact with customers	High contact with clients
Operation facility	Large production facility	Small service facility
Resource intensity	Capital intensive	Labour intensive
Quality	The quality of the product is easily measured	The quality of the service is not easily measured
Re-usability	The product can be resold	The service cannot be resold
Patents	A product can be patented	A service can only be patented with difficulty

Service Operation Characteristics:

In service, distinction must be made between input & resources. For services, inputs are the customer themselves and resources are the facilitating goods, employee labour and capital at the command of the services manager.

So the service system must interact with the customer as participants in the service process.

Because customer typically arrives at their own discretion and with unique demand on the service system, matching service capacity with demand is a challenge.

There are so many unique characteristics of services, such as;

A. Customer participation in the service process
B. Simultaneity
C. Perishability
D. Intangibility
E. Heterogeneity

Customer Participation in the Service Process:

a) The presence of the customer as a participant in the service process requires attention to the physical surrounding of the service facility or facility design that is not necessary for the factory as well as manufacturing operation.

b) The knowledge, experience, motivation and even honesty of the customer all directly affect the performance of service system;

i. The popularity of supermarket and discount stores is predicted on the idea that customer are willing to assume an active role in the relating process.

ii. The accuracy of patient's medical records can greatly influence the effectiveness of the attending physicians.

iii. The education of a student is determined largely by the student's own effort and contribution.

Simultaneity:

a) In fact services are crated and consumed simultaneously and it cannot be stored is a critical features in the management of services.

b) This inability to inventory services precludes (make impossible) using the traditional manufacturing strategy of relying on inventory as a buffer to absorb fluctuations in demand.

c) The Simultaneous production and consumption in service also eliminate many opportunities for quality control intervention.

d) A product can be inspected before delivery, but services must rely on other measures to ensure the quality of service delivered.

Perishability:

1) A service is a perishable commodity. For example empty airline seat, an unoccupied hospital or hotel room etc. which means a lost opportunity has occurred.
2) So full utilization of service capacity becomes a management challenges, because customer demand exhibits considerable variation and building inventory to absorb these fluctuation is not an option.
3) Faced with variable demand and a time-perishable capacity to provide the service, the manager had three basic option;

a) Smooth demand
b) Adjusting Service Capacity
c) Allow Customer to Wait

Intangibility:

1) Services are ideas and concept, product are things, to ensure the benefits of a novel service concept, the firm must expand extremely rapidly and present any competitors.

2) The Intangible nature of service also presents a problem for customer. Customer is able to see, feel & test performance of the product before purchase of a product.

3) Example:

a) Public construction plan approved by Registered Engineer.
b) Doctor licensed to practice medicine
c) Lawyer licensed to practice laws

d) Power Company is a regulated utility.

Heterogeneity:

1) The combination of the intangible nature of services and the customer as participant in the service delivery system results in variation of service from customer to customer.

2) The interaction between customer and employee in service which creates the possibility of a more satisfying human work experience.

3) In service work activity generally is oriented towards people rather than towards things, however for services that process information or customer's property.

Service Operation Management:

1) Service operation management is the term that is used to cover the activities, decision and responsibilities of operation manager in service organization.

2) Example:

- Managing partner in consultancy firm
- Nursing manager in hospitals
- Head master in school
- Restaurant manager etc.

3) From customer perspective, service is the combination of customer experience and their perception of the outcomes of the service.

4) So the service product or service package is formed by two major elements such as;

i. **Service Experience**
ii. **Service Outcome**

Service Experience:

a) The service experience is the customer's direct experience of the service process and concern the way the customer is deal by the service provider.

b) It contains aspect of how customer facing staff interact with customers and also the customer's experience of the organization and its facilities.

c) The aspect of service experience includes;

- The extent of Personalization of the process
- The Responsive service organization
- The Flexibility customer facing the staff
- Customer intimacy
- Ease to access to service personnel or information system
- The extent to which the customer feels valued by the organization
- The courtesy and competence of customer facing the staffs
- Customer feels valued by the organization
- Interaction with other customer.

Service Outcome:

1) The term service outcome to describe the results for the customer of service delivery.

2) The key & most obvious output is the expected and often tangible output of the service.

3) Example:

- Ability of software trainee to constructed a software
- For a patient in a hospital to enjoy mobility after a operation.

4) There are some less tangible outcomes such as value, emotion, judgments & intentions.
5) Value is the customer's assessment of the benefits of service weighted against all the costs involved.
6) Emotions are strong mental or instinctive feeling such as pleasure or frustration, delight or disgust, it may concern with the tangible output and /or the way the customer was treated.
7) Judgment is opinions that form as a result of customer's feeling about their experience and output. It includes views about fairness, satisfaction or loyalty.
8) If the judgment is good/ bad or indifferent, will result in intentions such as the intention to repurchase or not, the intention to tell friends and relatives hoe bad the service was or the intention to complain or not.

Role & Responsibilities of Operation Manager:

An Operations Manager has a broad role, and the specific responsibilities will vary between different companies, but generally it includes;

1) Planning and controlling change.
2) Managing quality assurance programs.
3) Researching new technologies and alternative methods of efficiency.
4) Setting and reviewing budgets and managing cost.
5) Overseeing inventory, distribution of goods and facility layout
6) Operations managers need good communication and interpersonal skills to help the different parts of an organization work together.
7) Operations managers play a key role in budgeting, controlling costs and keeping the organization on track financially.
8) Operations managers play a leading role in managing both raw materials and personnel.
9) Work measurement and Develop production program and guidelines to support company objectives.
10) Schedule equipment maintenance and inspection on regular basis.
11) Suggest process improvements to enhance production quality and capacity.
12) Organize job trainings to team members to achieve production goals.
13) Quality control

Operations Strategy and Competitiveness

Strategy:

- A plan of action designed to achieve a long-term or overall aim.
- Strategy is a way of doing something. It usually includes the formulation of a goal and a set of action plan for accomplishment of the goal.

- 'Strategy is the direction and scope of an organisation over the long term: ideally, which matches its resources to its changing environment, and in particular its markets, customers or clients so as to meet stakeholder expectations.'
- For example the art of planning and directing overall military operations and movements in a war or battle.

Types of Strategy:

Corporate level Strategy:

- At the highest or corporate level the strategy provides long-range guidance for the whole organisation
- What business should we be in?

Business Level Strategy

- Here the concern is with the products and services that should be offered in the market defined at the corporate level –
- How do we compete in this business?

Functional Level Strategy

- This is where the functions of the business (e.g. operations, marketing, finance) make long-range plans which support the competitive advantage being pursued by the business strategy
- How does the function contribute to the business strategy?

Strategy Management:

- Strategy Management may be the process of formulating, implementing and evaluating business strategy to achieve organizational goals.
- Strategy Management is that set of managerial decisions and action that determines the long term performance of a corporation.
- It involves environmental scanning, strategy formulation, strategy implementation, evaluation and control.
- The study of Strategy Management emphasis monitoring and evaluating environmental opportunities and threat in the light of a corporation's strength and weaknesses.
- Strategy management involves five steps;
  - **Step-1:** Select the corporate mission and major corporate goals **(Strategy management Process)**
  - **Step-2:** Analyse the opportunities and threats that exists in the external environment. Also analyse the strength and weaknesses that exists in the internal environment**.** **(Environment Scanning)**
  - **Step-3:** Formulation strategy that will match the organization's strength and weaknesses with the environment's threats and opportunities.**(Strategy Formulation)**
  - **Step-4:** Implement the strategy
  - **Step-5:** Evaluate and control activities to ensure that the organization's objectives are achieved.

What is Operations Strategy?

Operations strategies provide the road map for achieving the operations objectives and form the long-range game plan for production of the firm's goods and services. Operations strategies include decisions about each major product line on such issues as, what new production facilities are needed and when they are needed, what major production technologies and processes must be developed and what production schemes will be followed to produce the sales forecast, Operations objectives, and the strategies for realizing these objectives, are embodied in the production plan – the plan that will guide the operations function towards fulfilling it part of the business plan.

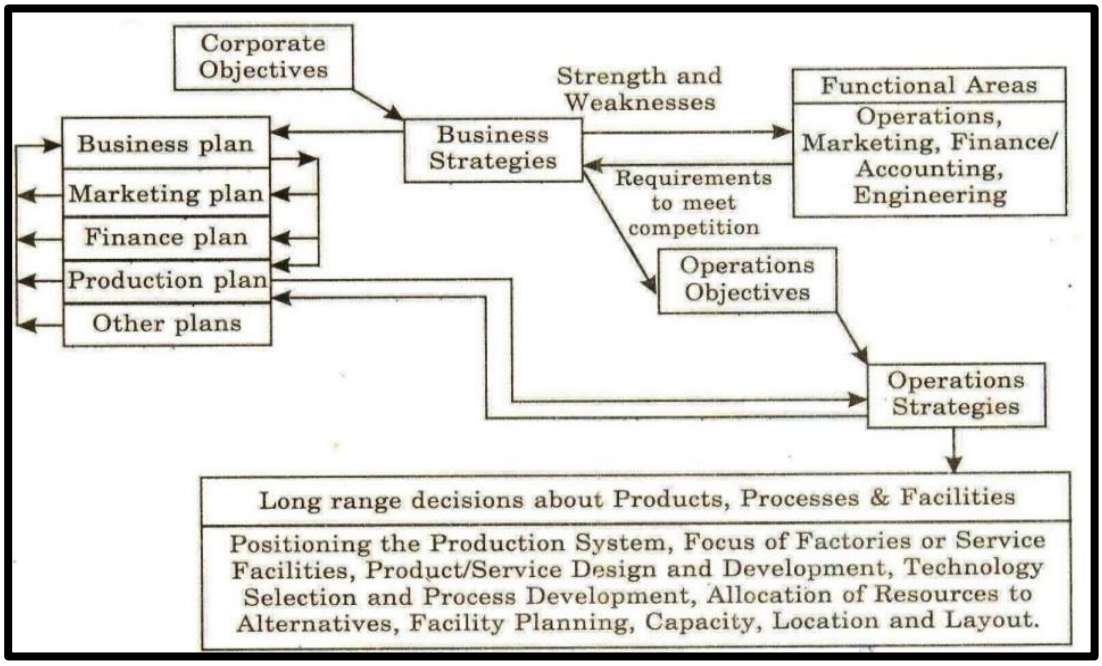


Figure: Developing Operations Strategies

Operations strategy is the total pattern of decisions which shape the long-term capabilities of any type of operation and their contribution to overall strategy, through the reconciliation of market requirements with operations resources. Operations Strategy is concerned with the reconciliation of market requirements and operations resources. It does this by:

- Satisfying market requirements (measured by competitive factors) by setting appropriate performance objectives for operations
- Taking decisions on the deployment of operations resources which effect the performance objectives for operations

Using a market-based approach to operations strategy an organisation makes a decision regarding the markets and the customers within those markets that it intends to target.

The organisation's market position is one in which its performance enables it to attract customers to its products or services in a more successful manner than its competitors.



- A resource-based view of operations strategy works from the inside-out of the firm, rather than the outside-in perspective of the market-based approach.
- Here there is an assessment of the operations decisions regarding:
  - structural decisions - physical arrangement and configuration of resources.
  - infrastructural decisions - activities that take place within the operation's structure.
- It has been found that not all companies pursue strategy in accordance with a pure market-based approach and it has been found that competitiveness is not just a matter of simply improving performance along specific competitive dimensions in response to market needs.



Figure: Global Operation Strategy

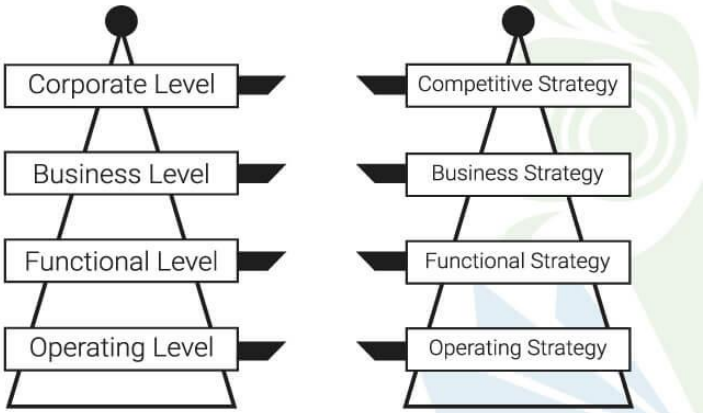


Figure: Operation Strategy of Company

Building production/operations strategy on competitive priorities:

1) The Production/Operations Strategy is derived from the business strategy which has a broader scope than production strategy Production /Operations strategy relates to *products, processes, methods, operating resources, quality, costs, lead times and scheduling.*
2) The Production/Operations strategy should be linked to the business strategy and the two should not be formulated independently.
3) On the other hand, the business strategy should take into account the realities of the strengths and weaknesses of production; capitalizing on its strengths and dealing with its weaknesses.

4) Likewise, production strategy must be consistent with the business strategy and formulated to support the goals of the business organization.
5) Production/Operations strategy may have a major influence on the competitiveness of an organization. If it is well designed and well executed, it improves the chances of success of an organization.
6) In the 1970's and early 80's, production strategy was neglected in favour of marketing and financial strategies.
7) But in the late 1980's and early 90's many companies began to realize the importance of operations strategy and hence they developed strategies that have *quality* or *time* as their major concern.

Operations Strategy Formulation:

1) Strategy formulation is a key element of business strategy and production strategy. To formulate an effective strategy, the distinctive competencies are taken into account.
2) The environment of the business must be scanned to determine what competitors are doing, or planning to do and take that into account. The factors that could have either positive or negative effects on the firm must be critically examined (sometimes referred to as SWOT analysis).
3) In formulating a successful strategy, a firm must take into account both order qualifiers and order winners. Order qualifiers are those characteristics that customers perceive as minimum standards of acceptability to be considered as a potential for purchase.
4) Order winners are those characteristics of a firm's goods or services that cause it to be perceived as better than the competition. Distinctive competencies are those special attributes or abilities that give a firm a competitive edge over others. Examples of distinctive competencies are given in Table.

Table: Examples of Distinctive Competencies

Dimension	Competency
Price	Low cost
Quality	High performance design, high quality, consistent quality
Time	Rapid delivery, on-time delivery
Flexibility	Variety, volume
Service	Superior customer service
Location	Convenience

Even though firms have tended to emphasize traditional strategies based on cost minimization or product differentiation, many firms are now adopting strategies based on quality and time which are rapidly gaining ground.

Quality - based strategies focus on satisfying the customer by integrating quality into all phases of the firm. This includes not only the final products or services offered to the customer but also the related processes such as product or service design, production and after-sales-service. Time-based strategies focus on reducing the time required to complete various activities (for examples, develop new products or services and market them, respond to change in customer demand or deliver a product or a service).

Time-based strategies focus on reducing the time needed to conduct the various activities in a process. By reducing time, costs are also reduced, productivity is increased, quality tends to be better, innovative products are launched to the market and customer service is improved.

In time based competition, the time reduction in some of the following activities have been achieved: Planning time, product/service design time, processing time, change over time, delivery time, response time to attend to customer's complaints etc.

- Bridging the gaps begins by spelling out the marketing strategy into the key factors that affect competitive success. Such factors include at least -
  - pricing
  - product or service quality
  - delivery speed and reliability
  - after sales support
- Careful review of these things can guide priorities for improving operations. The key issues for these operations include -
  - quality
  - speed
  - dependability
  - flexibility
  - cost

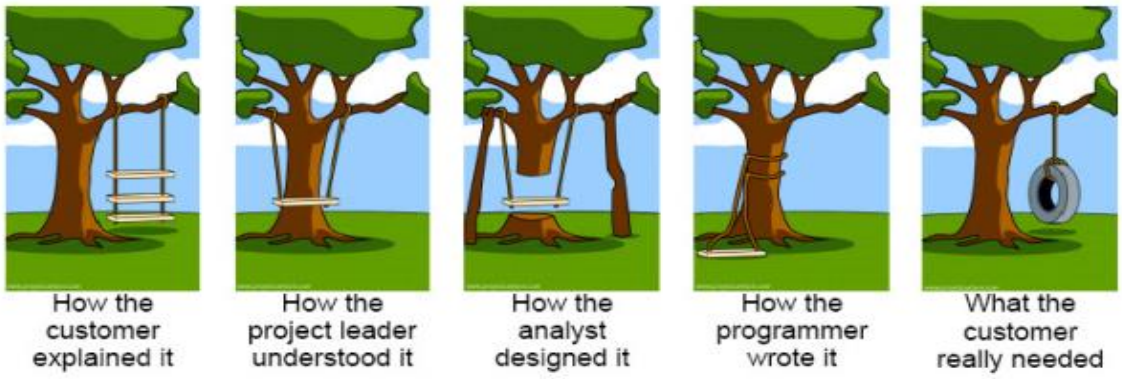
There are many alternative procedures for developing an operations strategy for a particular organisation. These will generally require an analysis of market requirements (marketing) and the operation's resource capabilities (operations). The procedure covered is Known as ***the Terry Hill Framework.*** Terry Hill framework for Operations Strategy Formulation Or Hill method has five stages;

1) Define corporate objectives
2) Determine the marketing strategies to achieve these objectives
3) Check how various products win sales against competitors
4) Decide the most suitable approach deliver these sets of products
5) Provide the requisite infrastructure to enable operations

The Hill separates the factors into two broad types. These are order winning and qualifying.

An order *winner* is a product factor that tips the customer in favor of purchasing.

An order *qualifier* is an attribute of a product or service that is basic to the customer even considering the offer. These are prerequisite to market membership.



Example: Operation Strategy to meet customer demand

Operation Competitiveness:

Competitiveness or competitive advantage denotes a firm's ability to achieve market superiority over its competitors. In the long run, a sustainable competitive advantage provides above-average performance. A strong competitive advantage is derived from an organization's competitive priorities, or rather distinctive competencies. It should have six (6) characteristics:

1) It is driven by customer wants and needs.
2) It makes a significant contribution to the success of the business.
3) It matches the organization's unique resources with the opportunities in the environment.
4) It is durable and lasting and difficult for competitors to copy.
5) It provides a basis for further development.
6) It provides direction and motivation to the entire organization.

Traditional View of Competitiveness:

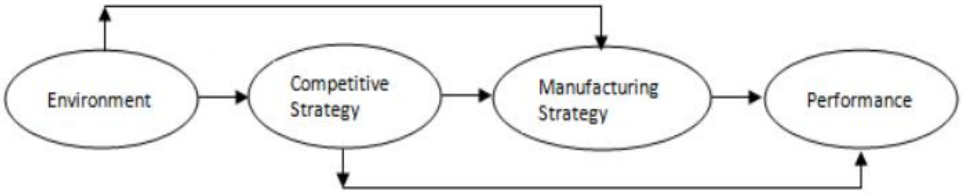
The traditional literature on competitiveness suggests that a firm can possess two basic types of competitive advantages:

1) ***Cost Leadership:*** Many firms gain competitiveness by establishing themselves as low-cost leaders in the market.
2) ***Product Differentiation:*** Product differentiation refers to any special features (e.g. design, cost, quality, ease of use, convenient location, warranty, etc.) that cause a product to be perceived by the buyer as more suitable than a competitor product or service.

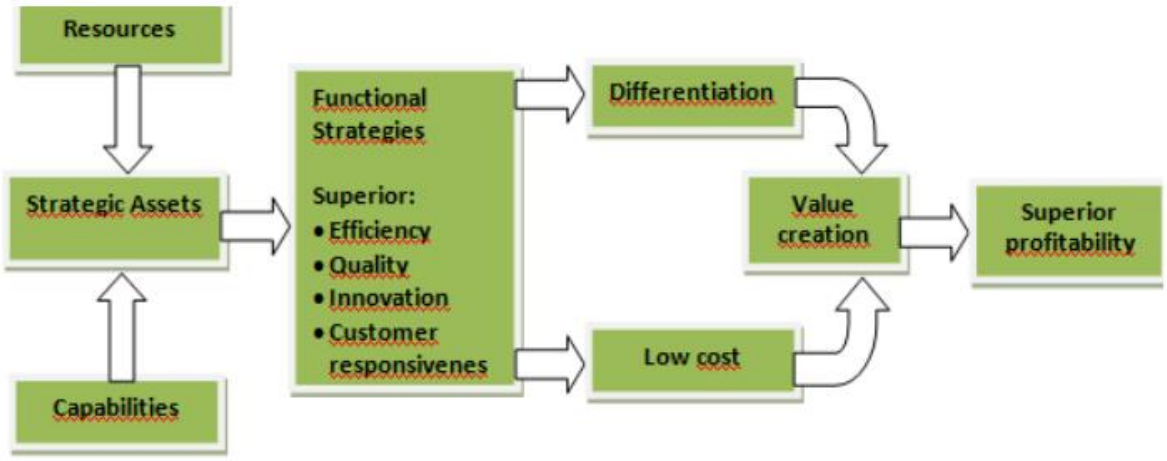
Modern View of Competitiveness:

- More recently, the modern view towards competitive advantage has been focused on adopting more Quality-based and Time-based competitiveness. However at the same time keeping in mind cost-efficiency and product differentiation.
- ***Quality:*** This focuses on satisfying the customer by integrating quality into all phases of the organization. This includes not only the final product or service that is provided to the customer, but also the related processes such as production, design, and after-sales service.
- ***Time:*** It focuses on reducing the time required to accomplish various activities. By doing so, organizations seek to improve services to the customer, and to gain a competitive advantage over rivals who take more time to accomplish the same tasks.

The relationship of environment, competitive strategy, operations/manufacturing strategy, and performance



The relationship among strategic resource, operations strategy (functional strategies), competitive strategy and performance



A Global View of Operation Competitiveness

1) Improve the supply chain
2) Reduce costs (labor, taxes, tariffs, etc.)
3) Improve operations
4) Understand markets

5) Improve products
6) Attract and retain global talent

Process Analysis:

Process

- A series of actions or steps taken in order to achieve a particular end.
- Perform a series of operations on (something) in order to change or preserve it.
- Example mechanical or chemical process etc.

Analysis

- Detailed examination of the elements or structure of something.
- Example: examination, investigation, inspection, survey, scanning, study etc.

Process Analysis:

Process analysis is an approach that helps managers to improve the performance of their business activities. It can be a milestone in continuous improvement. It is the documentation and detailed understanding of how work is performed and how it can be re-designed.

Process analysis can be defined as, "Understanding process elements and the relationships between them, and identification of opportunities for improvement."

Process Analysis Terms may be involved;

i. **Process :** Is any part of an organization that takes inputs and transforms them into outputs.
ii. **Cycle Time :** Is the average successive time between completions of successive units.
iii. **Utilization :** Is the ratio of the time that a resource is actually activated relative to the time that it is available for use.

A process analysis is an examination of a process to understand its elements such as steps and actions; and the relationships between them, including:

- The order of the steps,
- What things can be done in parallel versus sequentially?
- Who or what performs each of the steps, and
- May be where they are performed.

Process analysis thus involves understanding the processes, the relationships between them and the overall operation, and how various tools can be used to analyze the process. Process analysis explains a series of steps with a predictable result. These steps are;

1) Define the individual steps in the process, the inputs into them, and the outputs they produce.
2) Construct a process flow diagram to demonstrate how the steps are related and how the inputs flow through the process.
3) Determine the capacity, efficiency and other properties of the various steps.
4) Identify any bottlenecks where a step has a lower capacity than all other steps in its sequence.
5) Determine what the impact of removing these bottlenecks would be.
6) Carry-out a cost benefit analysis of increasing flow through the bottlenecks.
7) Decide what should be done to maximize the value of the process.

Objectives of Process Analysis:

The objectives of process analysis are as follows:

a. Recognize overlaps between functional areas.
b. Minimize and eliminate bottlenecks.
c. Describe skills and knowledge necessary for process analysis.
d. Perform a process analysis.
e. Determine the correlation between system components.
f. Given results of a process analysis and draft a summary report.

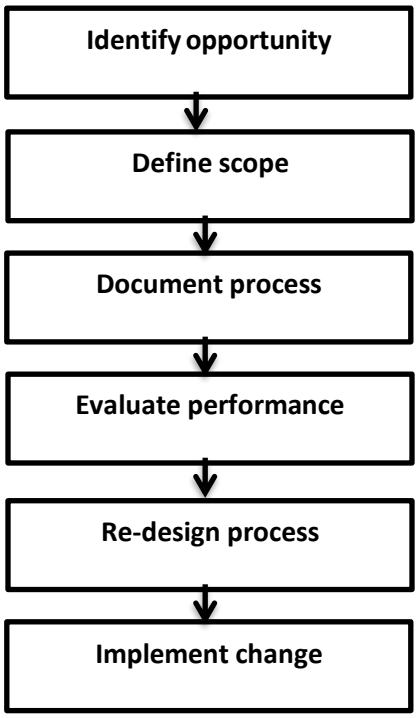
Procedure of Process Analysis:

Following steps are involved in the procedure of process analysis:

Step-1: Identify Opportunities: In order to identify opportunities, managers must pay particular attention to the four core processes:

1. Supplier relationship
2. New service/product development
3. Order fulfillment, and
4. The customer relationship.

Each of these processes and the sub processes nested within them, are involved in delivering value to external customers. Are customers currently satisfied with the services or products they receive, or is there room for improvement? How about internal customers? Customer satisfaction must be monitored periodically, either with a formal measurement system or with informal checks or studies. Managers sometimes develop an inventory of their core and support processes that provide a guide for what processes need scrutiny.



Step 2: Define the Scope:

Established the boundaries of the process to be analyzed. Is it a broad process that stretches across the whole organization, involving many steps and many employees? A process's scope can be too narrow or too broad. The resources that management assigns to improving or re-engineering a process should match the scope of the process. For a small nested process involving only one employee, perhaps it is being asked to re-design the process. For a project that deals with a major core process, managers typically establish one or more teams. A design team consists of knowledgeable, team oriented individuals who work at one or more steps in the process do the process analysis, and make the necessary changes. Other resources may be full-time specialist called internal or external facilitators. Facilitators know process analysis methodology, and they can guide and train the design team.

Step 3: Document Me Process:

Once scope is established, the analyst should document the process, Documentation includes making a list of the process's inputs, suppliers (internal or external), outputs, and customers (internal or external). The next part of documentation understands the different steps performed in the process, using one or more of the diagrams, tables, and charts. When breaking-down the process into steps, the analyst notes the degrees and types of customer contact and process divergence along the various steps in the process. The analyst also notes what steps are visible to the customer and where in process work is handed-off from one department to the next.

Step 4: Evaluate Performance:

It is important to have good performance measures to evaluate a process for clues on how to improve it. Metrics are performance measures for the process and the steps within it. The analyst creates multiple measures of quality, customer satisfaction, time to perform each step or the whole process, cost, errors, safety, environmental measures, on-time delivery, flexibility, and the like.

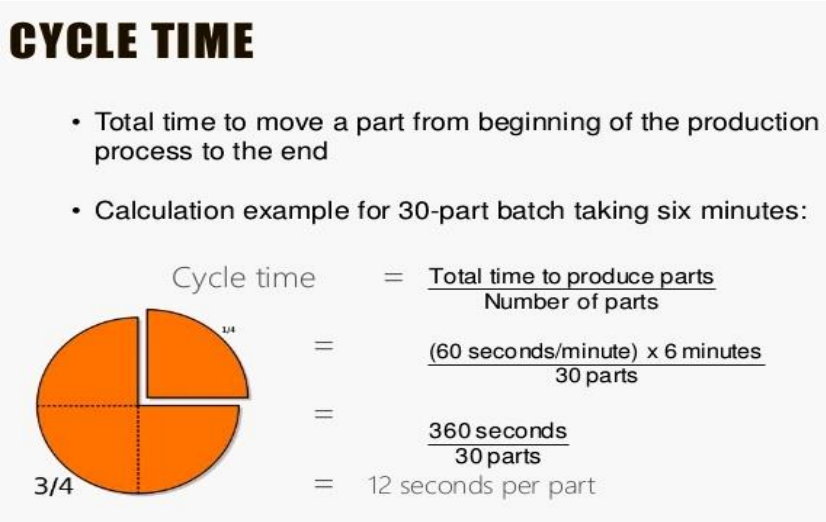
Once the metrics are identified, it is time to collect information on how the process is currently performing on each one. Measurement can be rough-cut estimates or quite extensive. Techniques for analyzing wait times and delays can provide important information.

Step 5: Re-Design the Process:

Using analytical and creative thinking, the design team generates a long list of ideas for improvements. These ideas are then shifted and analyzed. Ideas that are justifiable, where benefits outweigh costs, are reflected in a new process design. The new design should be documented "as proposed". Combining the new process design with the documentation of the current process gives the analysts clear before and after pictures. The new documentation should make clear how the revised process will work and the performance expected for the various metrics used.

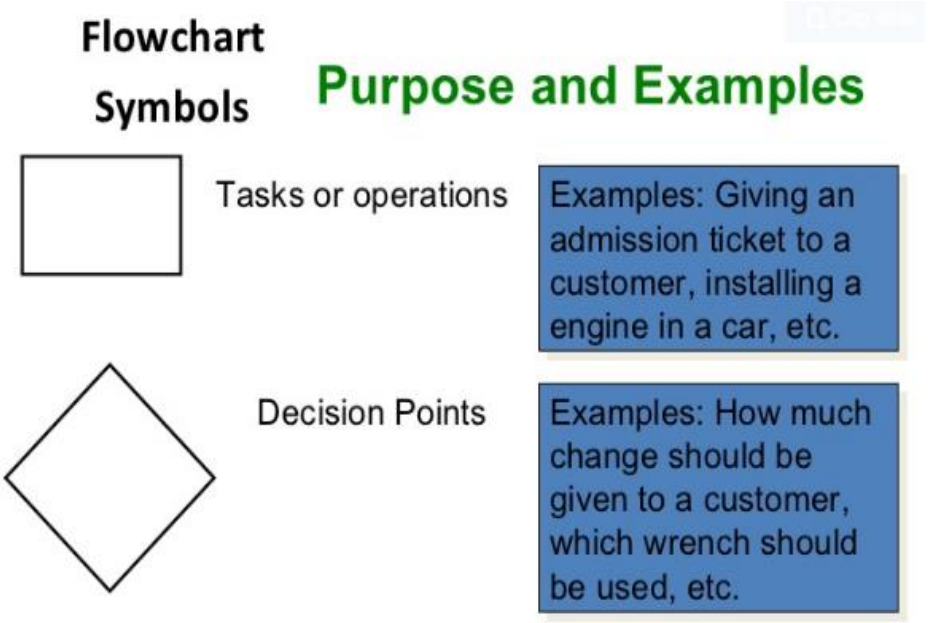
Step 6: Implement Changes:

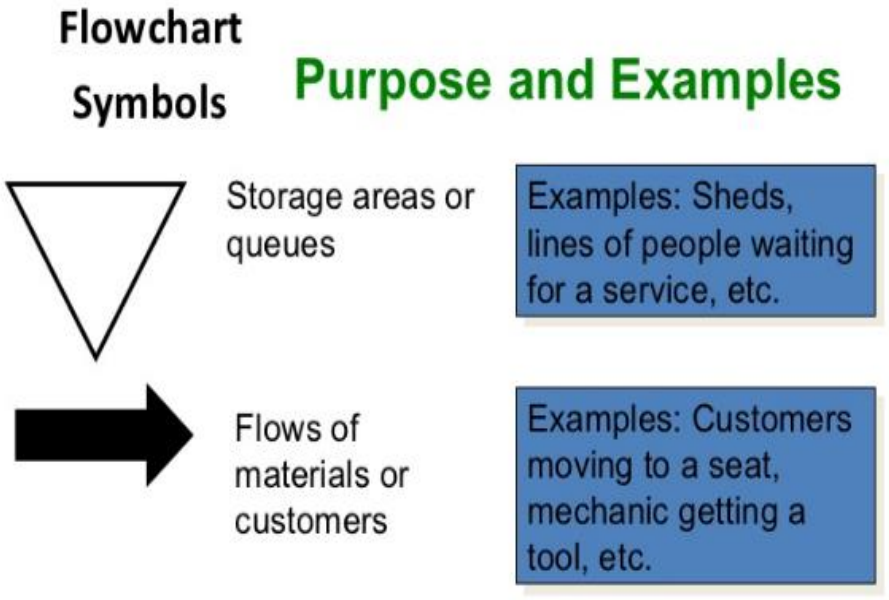
Implementation is more than developing a plan and carrying it out. Many processes have been re-designed effectively, but never get implemented. People resist change - they have always done it that way or they tried that before. Widespread participation on process analysis is essential, not only because of the work involved but also because it builds commitment. Implementation brings to life the steps needed to bring the re-designed process online. Management or the steering committee must make sure that the implementation project goes according to schedule.

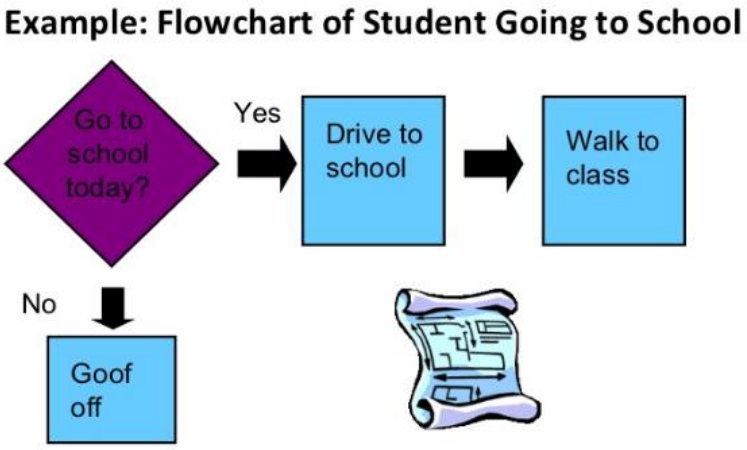


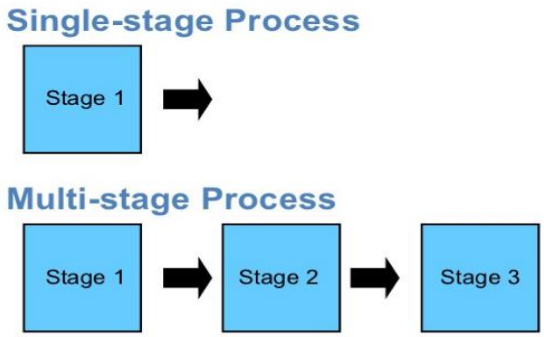
Process Flowcharting:

- Process flowcharting is the use of a diagram to present the major elements of a process.
- The basic elements can include tasks or operations, flows of materials or customers, decision points, and storage areas or queues.
- It is an ideal methodology by which to begin analyzing a process.

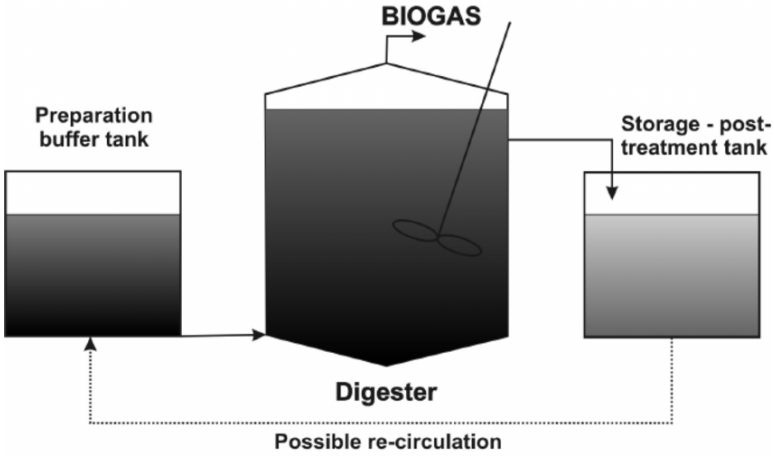






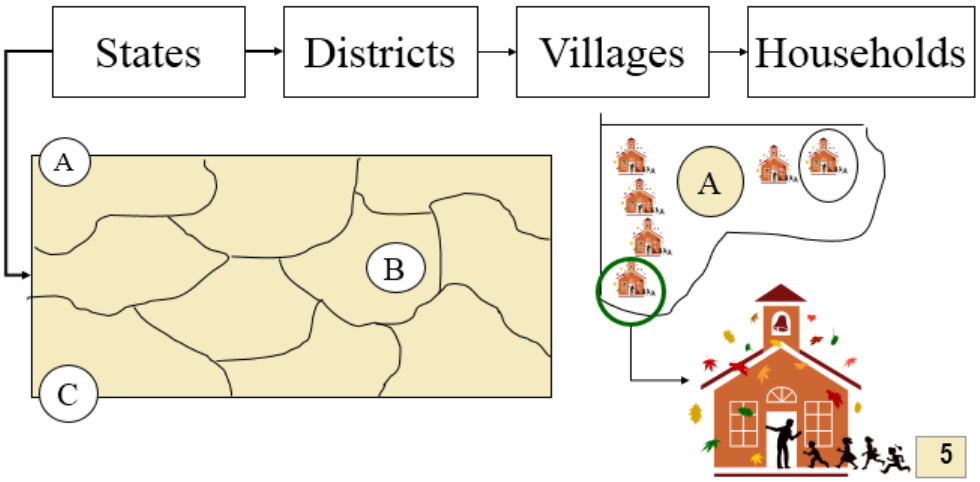


Single Stage Process: Having only one stage; completed in one operation; not continued through two or more similar stages.

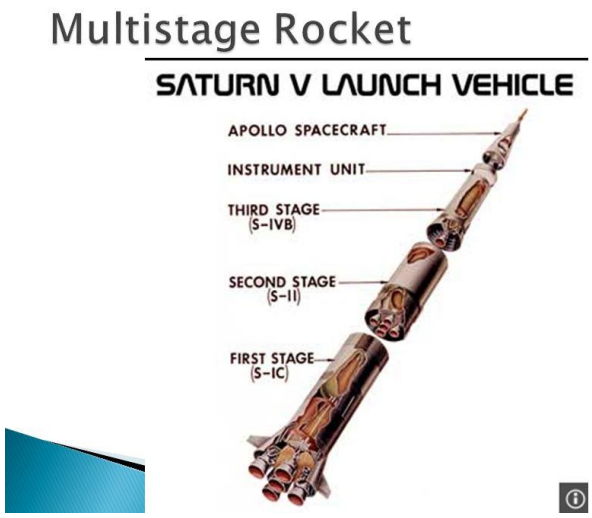


Multi Stage Process:

Example:
(A rocket or missile) having several stages, each of which can be jettisoned after it has burnt out (of any process or device) having more than one stage.



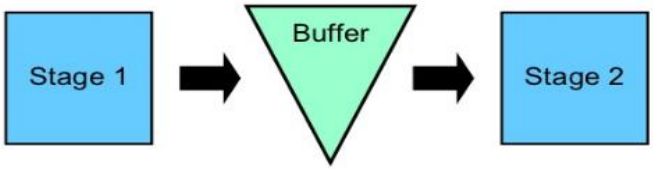
Multi-stage sampling Data Collections



Types of Processes (Continued)

A buffer refers to a storage area between stages where the output of a stage is placed prior to being used in a downstream stage

Multi-stage Process with Buffer



Buffering: Buffering is used in manufacturing to compensate for variations in the production process. Changes in supply and demand would be an example of these variations.

Think of buffering as a means to ensure that production lines continue running smoothly despite unforeseen factors, such as machine breakdowns, coming into play.

Other Process Terminology

- Blocking
  - Occurs when the activities in a stage must stop because there is no place to deposit the item just completed
  - If there is no room for an employee to place a unit of work down, the employee will hold on to it not able to continue working on the next unit
- Starving
  - Occurs when the activities in a stage must stop because there is no work
  - If an employee is waiting at a work station and no work is coming to the employee to process, the employee will remain idle until the next unit of work comes

Other Process Terminology (Continued)

- **Bottleneck**
  - Occurs when the limited capacity of a process causes work to pile up or become unevenly distributed in the flow of a process
  - If an employee works too slow in a multi-stage process, work will begin to pile up in front of that employee. In this is case the employee represents the limited capacity causing the bottleneck.
- **Pacing**
  - Refers to the fixed timing of the movement of items through the process

Process Performance Metrics

- Operation time = Setup time + Run time
- Throughput time = Average time for a unit to move through the system
- Velocity = $\frac{\text{Throughput time}}{\text{Value-added time}}$

Process Performance Metrics (Continued)

- Cycle time = Average time between completion of units
- Throughput rate = $\frac{1}{\text{Cycle time}}$.
- Efficiency = $\frac{\text{Actual output}}{\text{Standard Output}}$

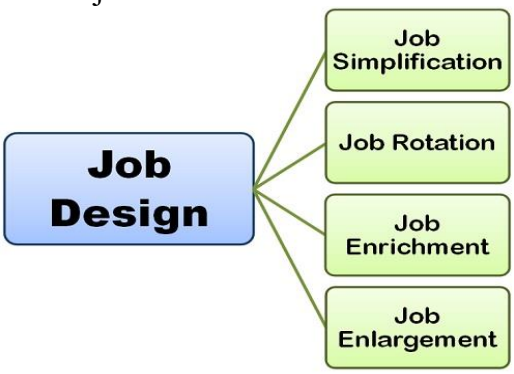
Process Performance Metrics (Continued)

- **Productivity = $\frac{\text{Output}}{\text{Input}}$**

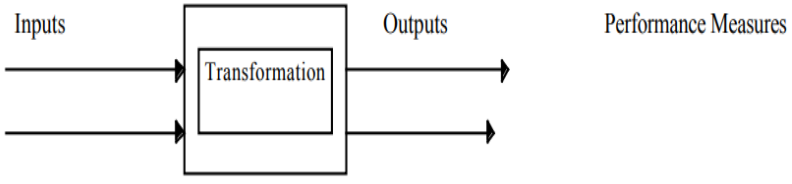
- **Utilization = $\frac{\text{Time Activated}}{\text{Time Available}}$**

Job Design:

Job design (also referred to as work design or task design) is a core function of human resource management.
The process of job design has been defined as, " the specification of the contents, methods, and relationships of jobs in order to satisfy technological and organizational requirements as well as the social and personal requirements of the job holder."



- Its principles are geared towards how the nature of a person's job affects their attitudes and behavior at work, particularly relating to characteristics such as skill variety and autonomy.
- The aim of a job design is to improve job satisfaction, to improve through-put, to improve quality and to reduce employee problems (e.g., grievances, absenteeism).



Job design primarily focuses in on designing the *process of transformation* of inputs into outputs and considers the human and organizational factors that impact that transformation.

Aspects of Job Design:

Work Organization :

- Rearranging or replacing work (e.g. automating, teaming, work groups, division of labor) Giving the worker additional responsibility/tasks (job enlargement) & Job rotation

Job Structuring

- Giving responsibility for different types/levels of work (job enrichment)
- Granting control over work (autonomy)
- Self-Organization (time/process management)

Location/Scheduling

- Telecommuting (part or full off-site work)
- Alternative scheduling (4 day work week, flextime, etc.) Virtual Office/Virtual Organization.

Factors Affecting Job Design:

Job design is affected by the following factors:

Organizational Factors: Organizational factors that affect job design can be work nature or characteristics, work flow, organizational practices and ergonomics.

a) ***Work Nature:*** There are various elements or a job and job design is required to classify various tasks may be planning, executing, monitoring, controlling, etc. and all these are to be taken into consideration while designing a job.

b) ***Ergonomics:*** Ergonomics aims at designing jobs in such a way that the physical abilities and individual traits of employees are taken into consideration so as to ensure efficiency and productivity.

c) ***Workflow:*** Product and service type often determines the sequence of work flow. A balance is required between various product or service processes and a jobdesign ensures this.

d) ***Culture:*** Organizational culture determines the way tasks are carried out at the work places. Practices are methods or standards laid out for carrying out a certain task. These practices often affect the job design especially when the practices are not aligned to the interests of the unions.

Environmental Factors: Environmental factors affect the job design to a considerable extent. These factors include both the internal as well as external factors,. They include factors like employee skills and abilities, their availability, and their socio economic and cultural prospects.

a) ***Employee Availability and Abilities:*** Employee Skills, abilities and time of availability play a crucial role while designing of the jobs. The above mentioned factors of employees who will actually perform the job are taken into consideration. Designing a job that is more demanding and above their skill se twill lead to decreased productivity and employee satisfaction.

b) ***Socio-economic and Cultural Expectations:*** Jobs are now-a-days becoming employee centered rather than process centered. They are therefore designed keeping the employees into consideration. In addition the literacy level among the employees is also on the rise. They now demand jobs that are their liking and competency and which they can perform the best.

Behavioral Factors: Behavioral factors or human factors those that pertain to the human need and that need to be satisfied for ensuring productivity at workplace. They include the elements like autonomy, diversity, feedback etc. a brief explanation of some is given below:

a) ***Autonomy:*** Employees should work in an open environment rather than one that contains fear. It promotes creativity, independence and leads to increased efficiency.

b) ***Feedback:*** Feedback should be an integral part of work. Each employee should receive proper feedback about his work performance.

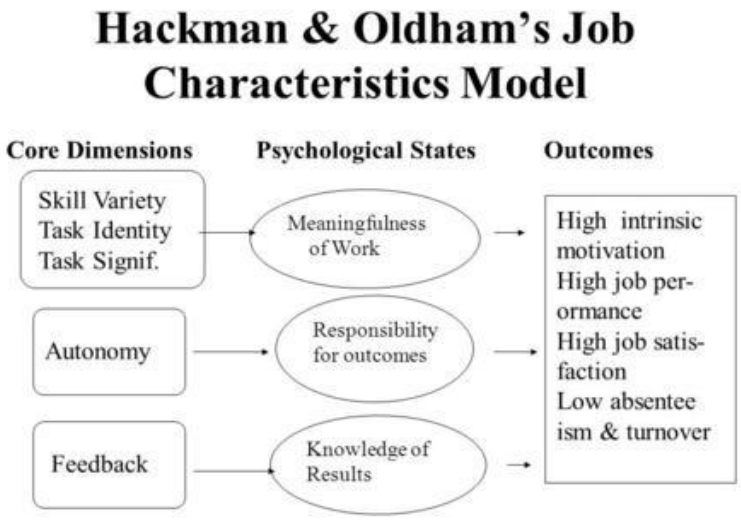
c) ***Diversity:*** Repetitive jobs often make work monotonous which leads to boredom. A job should carry sufficient diversity and variety so that it remains as interesting with every passing day. Job variety / diversity should be given due importance while designing a job.

d) ***Use of Skills and Abilities:*** Jobs should be employee rather than process centered. Though due emphasis needs to be given to the latter but jobs should be designed in a manner such that an employee is able to make full use of his abilities and perform the job effectively.

Characteristic Job Design (Job characteristic theory):

The job characteristic theory proposed by Hackman & Oldham (1976) stated that work should be designed to have five core job characteristics, which engender three critical psychological states in;

- Individuals experiencing meaning,
- feeling responsible for outcomes,
- and understanding the results of their efforts.



Core Job Dimensions:

1) ***Skill variety* :**This refers to the range of skills and activities necessary to complete the job.

2) ***Task identity* :**This dimension measures the degree to which the job requires completion of a whole and identifiable piece of work.

3) ***Task significance* :** This looks at the impact and influence of a job. Jobs are more satisfying if people believe that they make a difference, and are adding real value to colleagues, the organization.

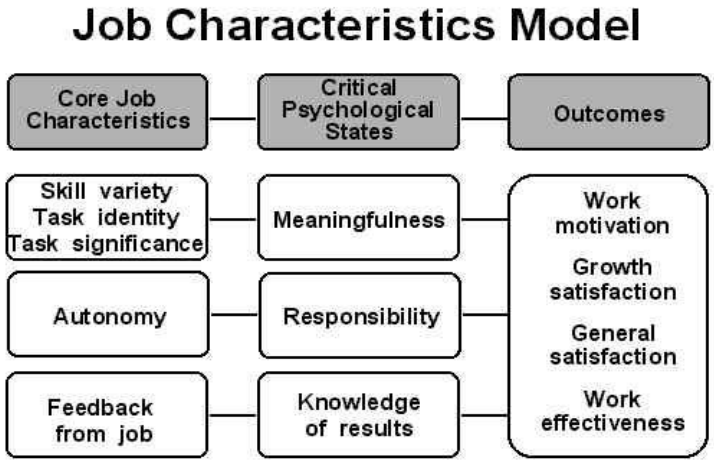
4) ***Autonomy*:** This describes the amount of individual choice and discretion involved in a job. More autonomy leads to more satisfaction. For instance, a job is likely to be more satisfying if people are involved in making decisions, instead of simply being told what to do.

5) ***Feedback* :** This dimension measures the amount of information an employee receives about his or her performance, and the extent to which he or she can see the impact of the work.

The more people are told about their performance, the more interested they will be in doing a good job. So, sharing production figures, customer satisfaction scores etc. can increase the feedback levels. The five core job dimensions listed above result in three different psychological states.

- ***Experienced meaningfulness of the work*:** The extent to which people believe that their job is meaningful, and that their work is valued and appreciated (comes from core dimensions 1-3).

- ***Experienced responsibility for the outcomes of work*:** The extent to which people feel accountable for the results of their work, and for the outcomes they have produced (comes from core dimension 4).
- ***Knowledge of the actual results of the work activity*:** The extent to which people know how well they are doing (comes from core dimension 5).



Techniques of job design:

Job Rotation: *Job rotation* is a job design method which is able to enhance motivation, develop workers' outlook, increase productivity, improve the organization's performance on various levels by its multi-skilled workers, and provides new opportunities to improve the attitude, thought, capabilities and skills of workers.

Scientific Management:

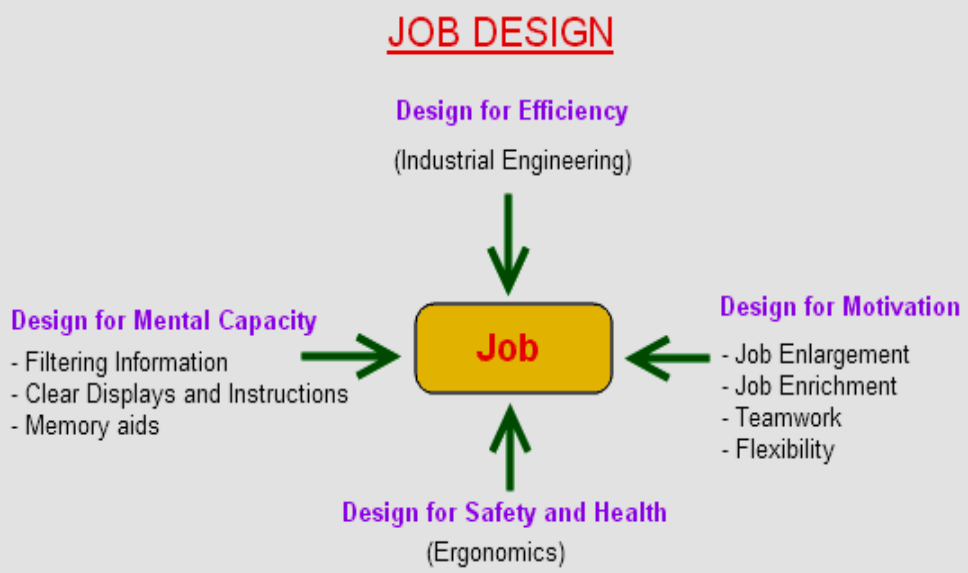
- Under *scientific management* people would be directed by reason and the problems of industrial unrest would be appropriately (i.e., scientifically) addressed.
- This philosophy is oriented toward the maximum gains possible to employees.
- Managers would guarantee that their subordinates would have access to the maximum of economic gains by means of rationalized processes. Organizations were portrayed as rationalized sites, designed and managed according to a rule of rationality imported from the world of technique.

Human Relations School: The *Human Relations School* takes the view that businesses are social systems in which psychological and emotional factors have a significant influence on productivity.

Socio-technical systems: *Socio-technical systems* aims on jointly optimizing the operation of the social and technical system; the good or service would then be efficiently produced and psychological needs of the workers fulfilled.

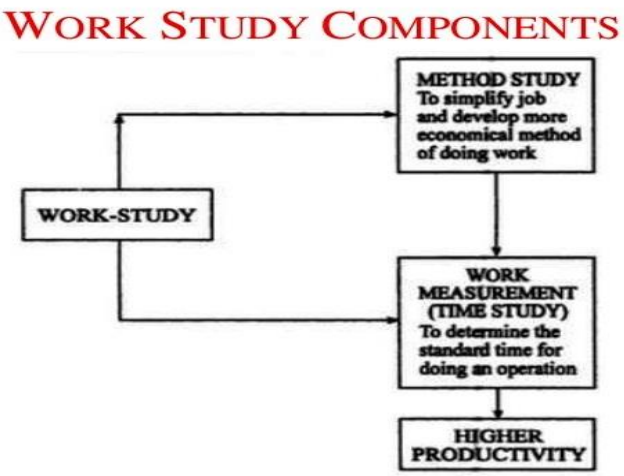
Motivational work design: The psychological literature on employee motivation contains considerable evidence that job design can influence satisfaction, motivation and job performance.

Work reform: Work reform states about the workplace relation and the changes made which are more suitable to management and employee to encourage increased workforce participation.



Work Study:

1) It is defined as that body of knowledge concerned with the analysis of work methods and the equipment used in performing a job , the design of an optimum work methods and the standardization of proposed work method.
2) Work study is also understood as a systematics, objective and critical examination of the factors, affecting productivity for the purpose of improvement.
3) Work study is comprises of two areas of study:
   - **Method study (motion study)**
   - **Time study (work measurement)**



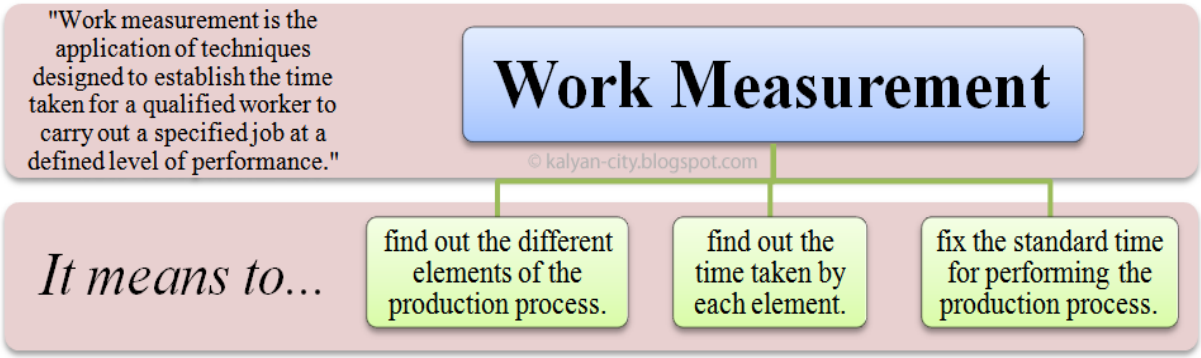
Work Measurement:

Method Study and work measurement are two techniques of work study. Whereas method study or Methods Analysis is a tool for standardizing the methods of doing a job, work measurement establishes the work content of a job.

Both, method study and work measurement are important elements in achieving higher labour productivity. To overall productivity of an organization is the result of the productivity achieved by all components of the organization such as capital assets, labour, material, and plant and equipment.

Definition of Work Measurement:

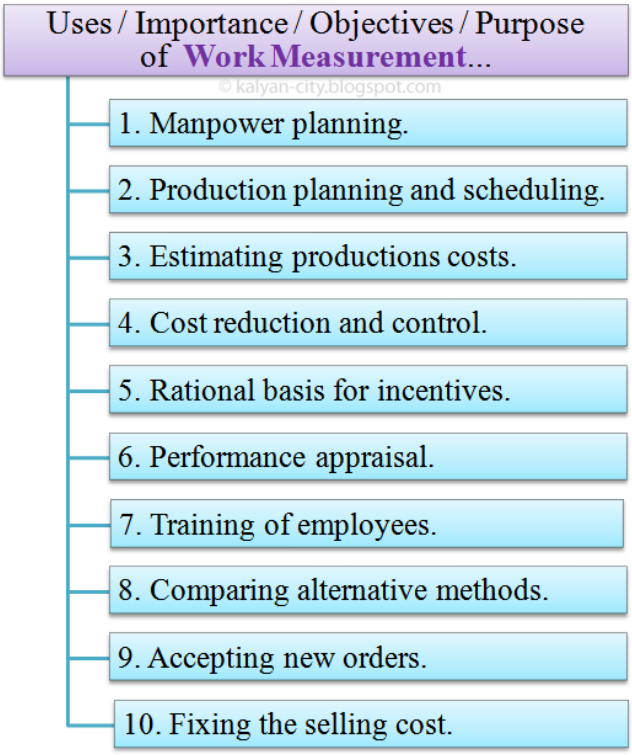
1) Work measurement is defined as the application of techniques designed to establish the work content of a specified task by determining the time required for carrying out the task at a defined standard or performance by a qualified worker.
2) Work measurement is the process of establishing the time that a given task would take when performed by a qualified worker working at a defined level of performance.
3) Work measurement is concerned with the determination of the amount of time required to perform a unit of work.
4) Work measurement is very important for promoting productivity of an organization.
5) It enables management to compare alternate methods and also to do initial staffing. Work measurement provides basis for proper planning.



***Qualified Worker:** "A qualified worker is one who is accepted as having the necessary physical attributes, possessing the required intelligence and education and having acquired the necessary skill and knowledge to carry out the work in hand to satisfactory standards of safety, quantity and quality".* Work measurement may be defined as the techniques applied to determine the amount of time necessary for a qualified worker to perform a particular task.

Objectives of work measurement can be to achieve:

a. Improved planning and control of activities or operations
b. More efficient manning of the plant
c. Reliable indices for labour performance
d. Reliable basis for labour cost control
e. Basis for sound incentive schemes.



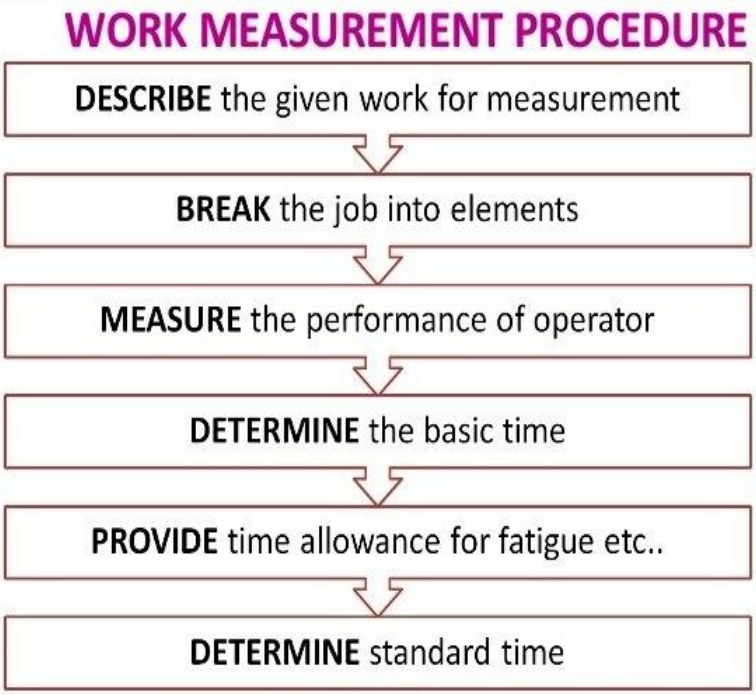
Benefits of Work Measurement:

1) To develop a basis for comparing alternate methods developed in method study by establishing the work content in each method of doing the job.
2) To prepare realistic work schedules by accurate assessment of human work.
3) To set standards of performances for labour utilization by establishing the labour standards for an element of worm, operation or product under ordinary working condition.
4) To compare actual time taken by the worker with the allowed time (standard time) for proper control of labour.
5) To provide information related to estimation of tenders, fixation of selling price and assessment of delivery schedule.

Steps in Work Measurement:

The various steps are;

1) Break the job into elements.
2) Record the observed time for each element by means of either time study, synthesis or analytical estimating.
3) Establish elemental time values by extending observed time into normal time for each element by applying a rating factor.
4) Assess relaxation allowance for personal needs and physical and mental fatigue involved in carrying out each element.
5) Add the relaxation allowance time to the normal time for each element to arrive at the work content.
6) Determine the frequency of occurrences of each element in the job, multiply the work content of each element by its frequency(*i.e.*, number of time the element occurs in the job) and add up the times to arrive at the work content for the job.



Decision Making in Production

Production has three types of decision making process

1. Strategic Decisions
2. Operating Decisions
3. Control Decisions

Strategic Decision

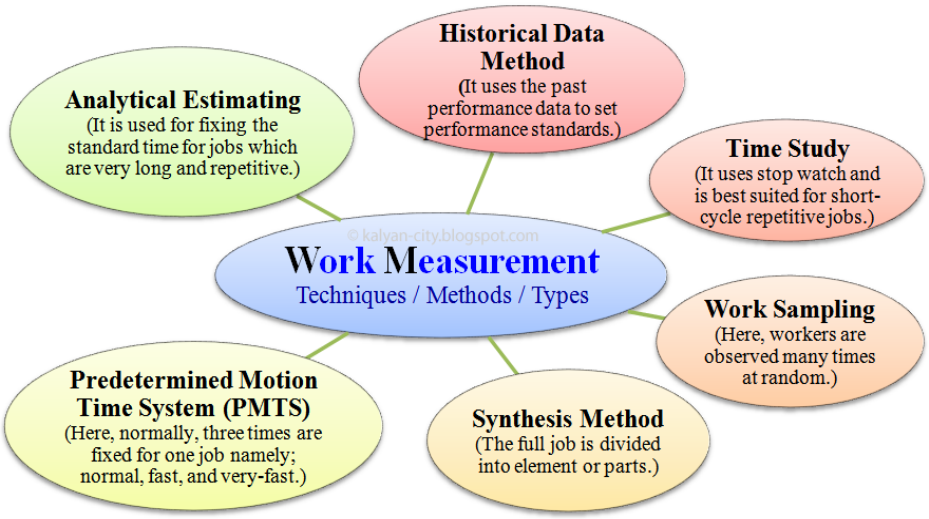
It relates to products, processes and manufacturing facilities. These decisions are major ones having strategic importance and long term significance for the organization.

Types of Decisions	Areas of Involvement	Nature of Activities
I. Strategic Decisions (Planning Products Process and Facilities)	1. Production Process 2. Production Technology 3. Facility layout 4. Allocating Resources to Strategic Alternatives 5. Long Range Capacity Planning and Facility Location	Developing long range production plans including process design. Selecting and managing production technology. Planning for the optimal distribution of scarce resources among product lines or business units Answering the 'how much' and 'where' questions about long range production capacity
II. Operating Decisions (Planning Products to meet demand)	1. Production Planning Systems 2. Independent Demand Inventory Systems 3. Resource Requirements Planning Systems 4. Shop Floor Planning and Control at each work center. 5. Materials management	Aggregate planning and master production scheduling Planning and controlling finished goods inventories Planning materials and capacity requirements. Short range decisions about what to produce and when to produce Manageing all facets of materials systems
III. Control Decisions (Planning and Operations)	1. Productivity and Employees 2. Total Quality Control 3. Project Planning and	Planning for the effective and efficient use of human resources in operations. Planning and controlling the

	Control Techniques 4. Maintenance Management and Reliability	quality of products and services Planning and controlling projects Planning for Maintaining the and facilities of products

Techniques of Work Measurement:

1) **Historical data methods**
2) **Time Study**
3) **Work Sampling**
4) **Synthesis methods**
5) **Pre-determined Motion Time System**
6) **Analytical Estimating**



Historical Data Method : It comprises the techniques and guidelines by which historians use primary sources and other evidence, including the evidence of archaeology, to research and then to write histories in the form of accounts of the past. The question of the nature, and even the possibility, of a sound historical method is raised in the philosophy of history as a question of epistemology.

Time Study: Time study concern with the determination of the amount of time required to perform a unit of work. According to ILO (International labour organization), it may be defined as time study is a work measurement technique for recording the times and rates of working for the elements of a specific job carried out under specified condition and defined level of performance.

Work Sampling: It was developed by L. Tippet in 1930. Estimate the percentage of time that worker spend on various activities. Work sampling involves random observation to record the activity that the worker performing. Also used to determine ratio delay (unavoidable delay).

Synthesis method:

- Synthesis is s technique of work measurement for building up the time required to do a job at a defined level of performance by synthesizing or totaling elemental times values obtained from previous time studies on the other jobs.
- To estimate standard time for new jobs.
- To estimate production time for determining the prices of products to be sold.

Pre-determined Motion Time System: (PMTS)

- PMTS is defined as a work measurement technique by which normal or basic times are established for the basic human motion and these times values are used to build up the time for a job at a defined level of performance.
- PMTS is an improvement over motion study.
- Example: basic or elementary human body motion are move, reach, positions etc.

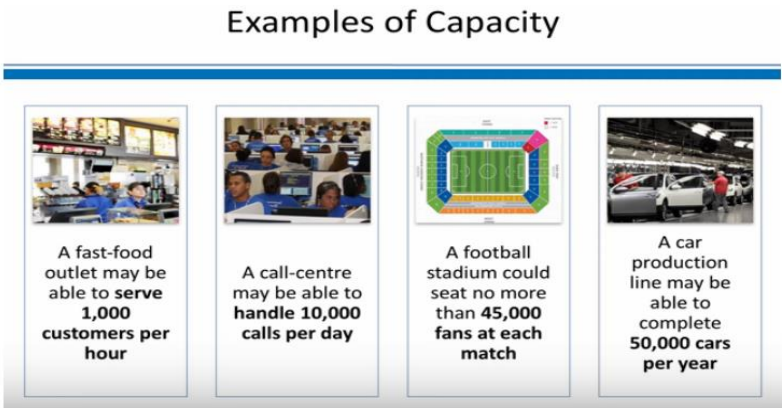
Analytical Estimating:

- This technique of work measurement is used to determine the time values for jobs having long and non-repetitive operations.
- The time values are determine by using synthetic data or on the basis of the past experience of the work study manager, when no synthetic or standard data is available.
- Find out the job details and job conditions
- Its break the job into its elements.

Capacity Planning- concept:

What is Capacity?

It can be defined as the amount of resource inputs available to the output requirement over a particular period of time. In general, terms capacity is referred as maximum production capacity, which can be attained within a normal working schedule.



What is Capacity Planning?

1) Capacity planning is the process of determining the production capacity needed by an organization to meet changing demands for its products.
2) 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.
3) Capacity planning is essential to be determining optimum utilization of resource and plays an important role decision-making process, for example, extension of existing operations, modification to product lines, starting new products, etc.
4) It is a long term strategic decision which establishes a firm's overall level of resources. The major capacity decisions involved are:-
   - How much capacity to be installed?
   - When to increase capacity?
   - How much to increase?
   - Long range capacity planning decision.

Capacity decision usually involves following activities:

- Estimating the capacity of the current (existing) facility.
- Forecasting the long range future capacity need for all products and services offered by the firm.
- Identifying and analyzing sources of capacity to meet the future capacity needs.
- Developing capacity alternatives.
- Selecting from the alternative sources of capacity.

Types of Capacity

There are four kinds of capacity:

1. Production capacity: It is the maximum rate of production (output) of an organization.
2. Maximum capacity (Peak Capacity): It is the maximum output that facility can achieve under ideal condition. Where capacities measured relative to equipment alone is known as Rated Capacity.

$$capacity\ utilisation\ rate = \frac{\text{capacity used (actual output)}}{\text{best operating level (design capacity)}}$$

3. Design capacity: It refers to the maximum capacity of output that can possibly be attended. It is the maximum rate of output achieved under ideal condition.
4. Effective capacity: It is the maximum possible output given at a product mix, scheduling difficulties, machine maintenance, quality factor, absenteeism etc.

Types of Capacity Planning:

1) **Long range capacity planning**
2) **Intermediate range capacity planning**
3) **Short range capacity planning**

Long range capacity planning:

1) Time horizon of more than one or two years.
2) Its required approval of top level management.
3) It is carried for productive of resources example buildings, machinery, materials handling equipment etc.

Intermediate range capacity planning:

1) Time horizon for the next 6 to 18 months.
2) Its should be varied by hiring labour, making new tools, purchasing small equipment etc.

Short range capacity planning

1) Time horizon of less than one month.
2) It is concern with day to day planning such as daily scheduling and machine loading or weekly scheduling process.
3) Example , it concern with overtime, transfer of personal and changing the production routings.

Strategic Capacity Planning:

- A technique used to identify and measure overall capacity of production is referred to as strategic capacity planning.
- Strategic capacity planning is utilized for capital intensive resource like plant, machinery, labor, etc.
- Strategic capacity planning is essential as it helps the organization in meeting the future requirements of the organization.
- Planning ensures that operating cost are maintained at a minimum possible level without affecting the quality.
- It ensures the organization remain competitive and can achieve the long-term growth plan.

The broad classes of capacity planning are;

1) **Lead Strategy,**
2) **Lag Strategy,**
3) **Match Strategy,**
4) **Adjustment Strategy.**

Lead strategy is adding capacity in anticipation of an increase in demand. Lead strategy is an aggressive strategy with the goal of luring 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. It decreases the risk of waste, but it may result in the loss of possible customers either by stockout 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 or large amounts due to consumer's demand, or, due to major changes to product or system architecture.

Developing Capacity Alternative:

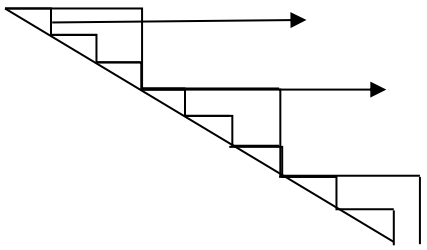
To enhance capacity management, the following to capacity alternative could be developed:

1) ***Designing flexibility into the system:*** Designing flexible production system can offer potential benefit in long ranger capacity planning because of the risk inherent in long term forecast.

2) ***Differentiate between new and mature product and services:*** Capacity requirement on mature products can be predicted more precisely and mature product may have limited life span. The possible limited life span of mature product or service may necessitate finding an alternative. On the other hand new product tends to carry higher risk because of the quantity demand and duration of the demand can't be predicted accurately.

3) ***Taking a "big picture" approach to capacity change:*** While developing capacity alternative a firm must consider how different parts of the system inter-relate.

4) ***Preparing to deal with "chunks" of capacity:*** Usually capacity increases are often acquired in the firm of fairly large chunks of the capacity rather than small increment in the capacity.



5) Identifying the optimal operating level: The optimal operating level is the ideal level of operation at which the cost per unit is the lowest for the production unit. Larger or smaller volume output would result in higher unit cost.

Selection of the capacity alternative:

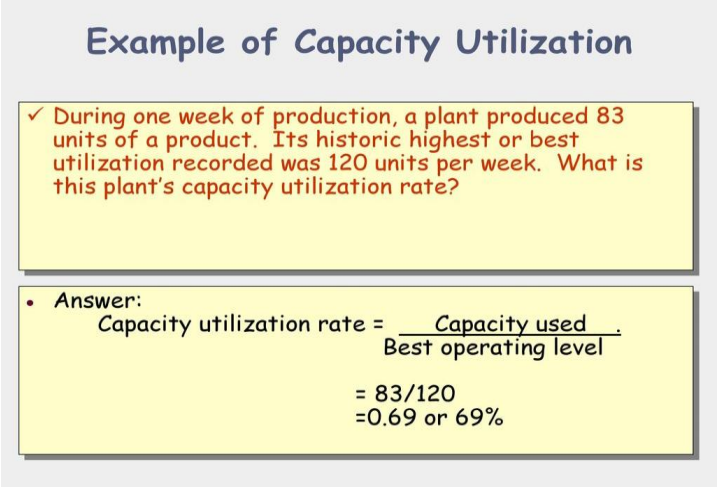
The question to be answered to choose best alternative from among the several alternative sources of capacity are:-

- Will an alternative be economically feasible?
- What would be the operating and maintenance cost?
- How soon it can be acquired?
- What would its useful life?
- Would it be compatible with present personnel and present operating system?
- What would be the public opinion or reaction to new facility (community attitude)?

Methods of choosing the alternatives:

1) Break even analysis and cost-volume analysis
2) Financial analysis (present value and cash flow analysis)
3) Decision tree analysis
4) Computer simulation and weighting time analysis

Example on Capacity Utilization:



Capacity Planning Concept

Example - Capacity Utilization

- Design capacity = 50 trucks/day
- Actual output = 36 trucks/day
- ***Utilization = ?***



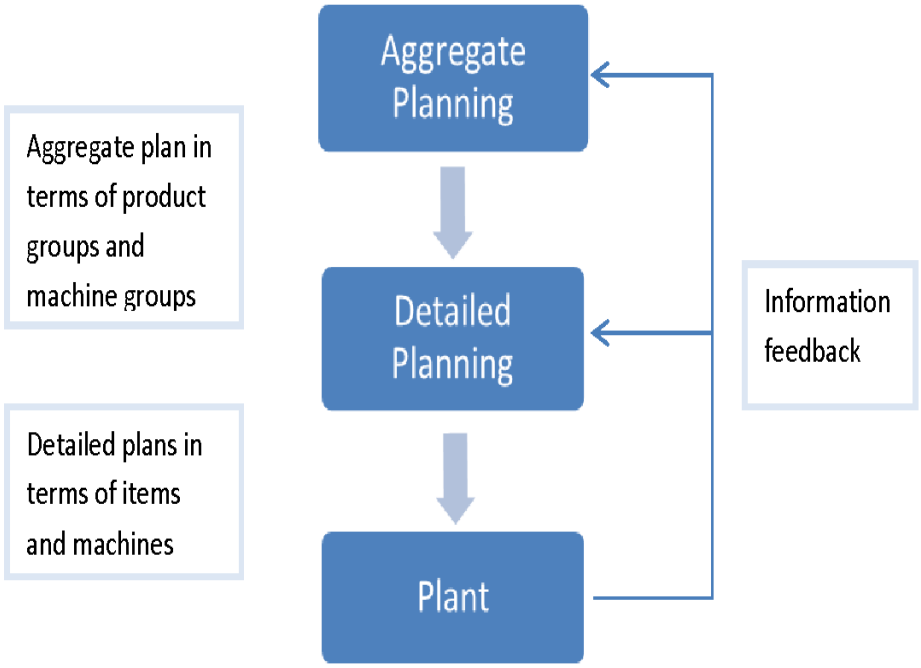
Solution:

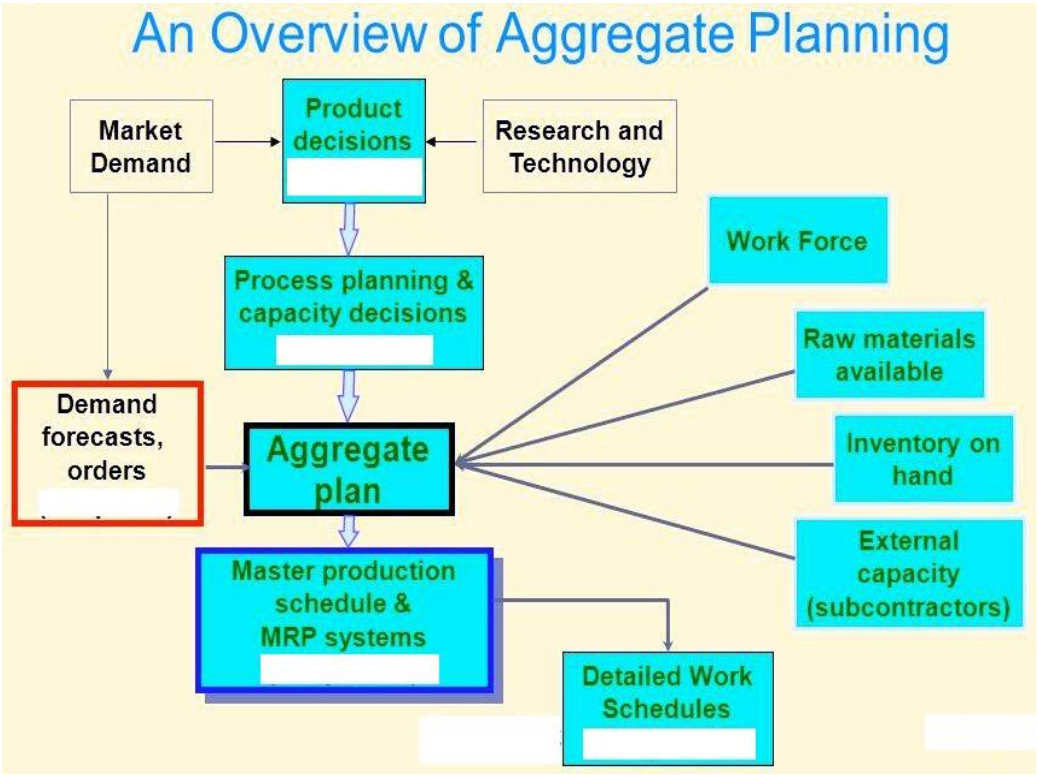
$$\text{Utilization} = \frac{\text{Capacity used}}{\text{Best operating level}} = \frac{36 \text{ trucks/day}}{50 \text{ trucks/day}} = 0.72$$

10

Aggregate Planning:

1) Aggregate planning is an operational activity critical to the organization as it looks to balance long-term strategic planning with short term production success.
2) Planning of workforce size, production rate and inventory levels etc. are some of examples of aggregate planning.
3) Aggregate Planning is used to balance/create capacity to meet fluctuating demand at minimum cost. The decisions are related to the workforce employed and the production time used in every period of planning.
4) 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 organization is kept to the minimum over that period.


Aggregate Planning
Aggregate plan in terms of product groups and machine groups
Detailed Planning
Information feedback
Detailed plans in terms of items and machines
Plant


An Overview of Aggregate Planning
Market Demand
Product decisions
Research and Technology
Work Force
Process planning & capacity decisions
Raw materials available
Demand forecasts, orders
Aggregate plan
Inventory on hand
External capacity (subcontractors)
Master production schedule & MRP systems
Detailed Work Schedules

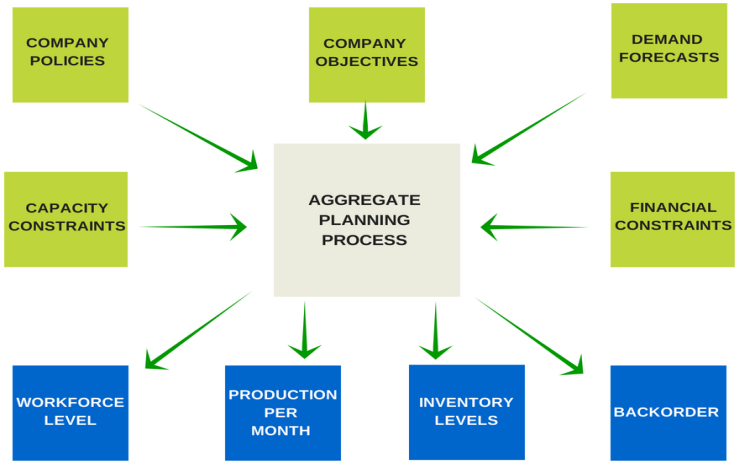
Objectives of Aggregate Planning:

1) Minimize cost
2) Maximize profit
3) Maximize customer service
4) It is to balance work force stability, cost and profit analysis etc.
5) To establish co. wide strategic plan for allocating resources.
6) To develop an economic strategy to meet customer demand.
7) Minimize inventory investment
8) Minimize change in production rate
9) Minimize utilization of plant and equipments.

Input & Input of Aggregate Planning:

Input	Input
Facilities and or Resources	Total cost of plan
Demand Forecast	
Policy on Workforce (Changes)	
Back Order	
Inventory levels and costs: i. Inventory carrying cost ii. Back Order cost iii. Work force hiring/lay-off cost iv. Inventory changing cost	Project levels of; i. Inventory ii. Output iii. Employment iv. Subcontracting v. Back Ordering

Aggregate Planning Process:



Nature of Aggregate Planning:

1) ***Regular time production capacity:*** Regular time production capacity may not be sufficient to cope with the demands of various products. So it is necessary to decide what rate of production is to operate.
2) ***Subcontracting capacity:*** Apart from regular production capacity ,there is a scope to bring the extra unit from outside to cope up with the requirement.
3) ***Overtime capacity:*** Overtime production sometimes full fill the requirement as by the need of the customer.
4) ***Hiring and firing capacity:*** As by the situational fluctuation there is need to hire people and machinery at peak demand and fire of the above when there is a less demand.

Aggregate Planning Strategies:

Two Type of strategies are adopted during aggregate plan for smoothing fluctuation in demand, which are: **Pure strategy & Mixed strategy**

Pure Strategy: When a single strategy of the following s is used to meet the demand ,then it is called as a pure strategy.

- Building and utilizing inventory through constant work force
- Varying the size of the work force
- Overtime utilization
- Subcontracting
- Making changes in demand pattern

Mixed Strategy: By taking more than two strategies of the above at a time is called mixed strategy.

1) ***Building And Utilizing inventory Through Constant Workforce Size :*** Since the demand is not a constant quantity, there may be mismatch between the production quantity and the demand of each period. So the company can use constant work force during the planning horizon, which will result into a constant output during each period in the planning horizon. The excess production in a period can be carried as inventory for use in future periods.

2) ***Varying the size of the workforce:*** This pure strategy can be implemented through hiring and firing of employees. During periods of increased demand, the co. can hire employees and during period of decreased demand ,the co. can fire employees s.t there is an exact match between the production quantity and the demand of each period in the planning horizon.

3) ***Subcontracting:*** In this strategy order can be placed with a subcontractor or a set of subcontractors depending on the demands of various products and It is generally used when a there is a peak demand period to increase the capacity.

4) ***Making changes in demand pattern:*** To even out the fluctuation in demand of products, the co. can offer some discount scheme during off-seasons or during period with fewer loads on some service system, which is nothing but influencing demand pattern. Ex: Giving discount on the items like refrigerator, air cooler, air conditioner etc. during winter season.

5) ***Overtime utilization:*** To meet the demand sometimes, the co. may ask to the men for overtime utilization and over time utilization of machinery.

Factors Affecting Aggregate Planning:

The various inputs to aggregate planning that affect the performance of production and operationa managers are engineering, materials, operations, marketing& distribution, accounting and finanace and human resource. Other factors are;

1) A complete information is required about available production facility and raw materials.
2) A solid demand forecast covering the medium-range period
3) Financial planning surrounding the production cost which includes raw material, labor, inventory planning, etc.
4) Organization policy around labor management, quality management, etc.

Relevant Cost:

The choice concerning aggregate production, workforce and inventory levels influence several relevant costs. These costs need to be identified and measured so that alternative aggregate plans can be evaluated on a total cost criterion. Some of the cost item may be relevant are:

a) Pay roll costs,
b) Costs of overtime, second shift and subcontracting,
c) Cost of hiring and lying off workers,
d) Costs of excess inventory and backlogs,
e) Cost of production rate changes

Relevant Cost and Strategies

Aggregate production planning is concerned with the determination of production, inventory, and work force levels to meet fluctuating demand requirements over a planning horizon that ranges from six months to one year.

Typically the planning horizon incorporate the next seasonal peak in demand. The planning horizon is often divided into periods.

For example, a one year planning horizon may be composed of six one-month periods plus two three-month periods. Normally, the physical resources of the firm are assumed to be fixed during the planning horizon of interest and the planning effort is oriented toward the best utilization of those resources, given the external demand requirements.

Once the aggregate production plan is generated, constraints are imposed on the detailed production scheduling process which decides the specific quantities to be produced of each individual item.

The plan must take into account the various ways a firm can cope with demand fluctuations as well as the cost associated with them. Typically a firm can cope with demand fluctuations by:

a. Changing the size of the work force by hiring and firing, thus allowing changes in the production rate. Excessive use of hiring and firing may limited by union regulations and may create severe labor problems.
b. Varying the production rate by introducing overtime and/or idle time or outside subcontracting.
c. Accumulating seasonal inventories. The tradeoff between the cost incurred in changing production rates and holding seasonal inventories is the basic question to be resolved in most practical situations.
d. Planning backorders.

Costs relevant to aggregate production planning:

a. Basic production costs: material costs, direct labor costs, and overhead costs. It is customary to divide these costs into variable and fixed costs.
b. Costs associated with changes in the production rate: costs involved in hiring, training, and laying off personnel, as well as overtime compensations.
c. Inventory related costs

Strategies involved in aggregate production plans are: The just-in-time production plan and the production-smoothing plan.

The **Just-in-time production plan**, also known as the chase plan, consists in changing the production rate to exactly satisfy demand. The idea is consistent with the JIT production philosophy and results in low holding costs but may result in high cost of adjusting the production rate, i.e., high firing and hiring costs or high idle times. As a consequence, the just-in-time plan is best suited to situations where the cost of changing the production rate is relatively inexpensive.

The production-smoothing plan, also known as the stable plan, consists in keeping the production rate constant over time. This strategy minimizes the production cost when production costs are convex. A stable, make to stock, production strategy needs to build inventories to cope with peaks in demand and may result in high holding costs. As a result, the production smoothing plan is best suited to situations where inventory carrying costs are low.

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(Facility Location and Layout, Inventory Management)

Module-2

Facility Location and Layout

OPERATIONS MANAGEMENT (BY. Manoj Kumar Rout)

Plant Location & Layout

Plant Location :-

⇒ plant location refers to the choice of the region where men, materials, money, machinery and equipment are brought together for setting up a business or factory.

⇒ plant location may be understood as the function of determining where the plant should be located for maximum operating economy and effectiveness.

⇒ plant location or the facilities location problem is an important strategic level decision making for an organization.

⇒ The selection of location is a key-decision as large investment is made in building plant and machinery.

⇒ plant location should be based on the company's expansion plan and policy, diversification plan for the products, changing market conditions, the changing sources of raw materials and many other factors that influence the choice of the location decision.

Need For Plant Location :-

⇒ When the business is newly started.

⇒ The existing business has outgrown its original facilities and expansion not possible.

⇒ The volume of business or the extent market necessitates the establishment of branches.

⇒ A lease expires and the landlord does not renew the lease.

⇒ Social and economic reasons i.e. inadequate labour supply and shifting of the market.

⇒ when a company thinks to reducing manufacturing cost by shifting from one location to another location.

Objective & Nature of Plant Location :-

⇒ The basic objective of plant location decision is to determine the minimum cost level in keeping view of all input costs.

⇒ The chosen location decision should permit minimization of both long term and short term costs, so the location study requires continuous monitoring.

→ Thus, the problem of decision to move or to stay at a particular location is always before the management specially when some expansion programme is contemplated. The shift of the location of plant to some other place is known as Relocation.

⇒ The intended objective for choice of location is profit maximization for economic activities, where prices of products are uniform in all locations, then the criterion becomes maximum revenue.

→ The relocation of plant may be necessary due to following reasons;

(i) Shift in the structure of the market
(ii) changes in the nature and cost of transportation
(iii) Rise in labor costs and other overheads.
(iv) change in the pricing policy of the enterprise.
(v) Undesirable labor situation
(vi) Other factor such as education, housing facilities etc.

⇒ The problem of relocation can be visualized in a number of ways by the management of the enterprise. Some of the alternatives can be;

(i) Not to expand the plant and to allow the growth in business to be enjoyed by other competitors in the field.
(ii) Instead of expanding the physical facilities the sub contracting policy may be expanded to achieve overall expansion.
(iii) Expand the plant at the present location.
(iv) The existing plant may be retained but other facilities may be developed at adviser places.
(v) Abandon the existing plant and relocate all facilities elsewhere.

Location Theory:-

→ Alfred Weber (1868-1958), with the publication of theory of the location of Industry in 1909, developed general theory of industrial location.

⇒ Weber's basic principle is that a firm would choose location where costs are the least.

⇒ There existed a need for a general theory of locational factors which can be defined as advantages to be obtained when an economic activity takes place at one point rather than elsewhere.

→ The point for locating an industry that minimizes cost of transport-ation and labour requires, analysis of three factors;

(i) The point of optimal transportation based on the cost of distance to the "material index", the ratio of weight to intermediate products to finished product.

(ii) The labour distortion, in which more favourable sources of lower cost of labour may justify greater transport distances.

(iii) Agglomeration and Degglomerating

Agglomeration :- Agglomerative refers to the advantages or cheapening of cost of production due to concentration of an industry. In others words minimizing cost of production due to centralization of many industries in a particular area through internal and external economics of various kind such as;

(i) sharing of equipments.
(ii) Specialization
(iii) Large scale of business and selling.

Degglomerating:- It occurs when companies and services leave because of over concentration of industries or of the wrong types of industries or shortage of labour, capital, affordable land etc. Weber also examined factors leading to the diversification of an industry in the horizontal relations between processes within the plant.

Freedom of Location:-

An entrepreneur seeking location for his enterprise has greater freedom than in the past. The passage of time has made site selection easy for businessmen, thanks to specific development which are given below;

(i) Speed of Services and delivery of products.
(ii) Improvement in transportation and communication facilities.
(iii) Mobilization of workers and management.
(iv) Reduction in wage differentials between regions.
(v) Improvement in construction methods and design for plant building
(vi) Vigorous (Strong / Healthy) policy pursued by Govt. to remove regional imbalances in industrial development which make all regions equal in attraction.
(vii) Improvement in processing and machine designs that reduce the relative number of employees.
(viii) Availability of air-conditioning equipment to counteract adverse climatic condition for employees and processes.
(ix) Expansion of market for almost all goods and services so that more enterprises are needed to meet the demands.

③

Errors in Selection :-

Though location selection is relatively easy, businessmen commit errors and wrong locations are selected. Some of the most common errors are;

(i) Lack of thorough investigation and consideration of factors involved.

(ii) Personal likes and prejudices of key executives or owner overriding impartially established facts.

(iii) Reluctance (unwillingness) of key executives to move from traditional established home ground to new and better locations.

(iv) Moving to congested areas already or about to be over industrialized.

(v) Preference for acquiring an existing structure that is improperly located or not designed for the most efficient production.

(vi) choice of community with low cultural and educational standards, so that key administrative and technical personnel accept employement elsewhere.

Importance of plant Location

Selection of plant location or site is important due to the following reasons;

- ⇒ It enables the enterprise to operate smoothly, efficiently and with the minimum costs.
- ⇒ It control wastages in efforts and talents of the enterpreneurs.
- ⇒ It reduces uncertainty in results.
- ⇒ It encourages effective mobilization of raw-materials, labour and potential customers.
- ⇒ It develops the area by attracting other potential entrepreneurs and endowments like physical, economic and social variables.

Steps in Location Selection

Generally, entrepreneur is free to select and location or site for the plant development. However, regulatory provisions of the government also affect the choice of plant location or site. The following steps are important in selecting a particular location or site for the plant;

(1) Within the Country or Outside
(2) Selection of the Region
(3) Selection of the Locality or Community
(4) Selection of the Exact site.

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(1) Within the Country or Outside

→ The first step in plant location is to decide whether the facility should be located domestically or internationally.

→ If the management decides on foreign location, the next step would be decide upon a particular country for location.

→ This is necessary because, countries across the world are vying (present participle) with each other to attract foreign investments.

→ The choice of a particular country depends on such factors as political stability, export and import quotas, currency and exchange rates, cultural and economic peculiarities and natural or physical conditions.

(2) Selection of Region

The selection of a particular region out of the many natural regions of a country is the second step in plant location. The following factors are given below;

(a) Availability of Land

→ Land should be large enough to meet out present requirement with provision for further expansion.

→ Land should be for industrial use and proper layout of plant and equipment must be possible as per the technical feasibility study, such as drainage level, soil test etc.

(b) Availability of Raw Materials

→ Availability of required quantity and quality of raw materials at reasonable cost.

→ The cost of materials constitutes a major chunk of total cost of production and thus, the impact of raw materials on location depends upon their nature and the source of their deposits.

(c) Nearness to the Market

→ Availability of consumer market also affects the viability of the enterprise. An entrepreneur can improve his customer relations if they are available in nearby areas and easily render rapid services to them.

→ Goods are produced for sale, it is very importance that the factory should be located near their market, due to reduction in transporting cost, prompt service to the customer and provide after-sale services, execute replacement orders without delay etc.

(d) Availability of Water, Power & Fuel

→ Uninterrupted operations of an enterprise is the result of sufficient supply of water, power and fuel etc.

⑤

→ Efforts are required to assess local sources of water, besides required water supply to be assessed in term of water conditions or sub-soil water etc.

→ Availability of power in the region is to be evaluated in terms of actual requirements. Some industries consume lot power (aluminium) or water (paper industry) and these variables are a very important factors for them.

(e) Transport Facilities

→ Transport facilities are essential for bringing raw material and men to the factory and for carrying the finished product from the factory to the market.

→ A place which is well connected rail, road and water transport is ideal for a plant location.

→ Now a days industry follows transportation, which means place with well developed, transport attract industries.

(f) Suitability of Climate

→ The climate has its own importance in the location of a plant because of two reasons. First climate affects labour efficiency.

→ Secondly, there are certain industries which, because of the nature of their production, required particular condition.

→ For example, humid climate for cotton textiles and jute.

(g) Government policy

→ The influence of Govt. policies and programmes on plant location is apparent to balanced regional development, many backward regions in India have been selected for the location of new industries, which generate the region economy along with national economy.

→ The Govt. of India has been influencing plant location in a number of ways, which are;

(i) Licensing Policy
(ii) Freight Rate Policy
(iii) Establishing a unit in the public sector in a remove area and developing it to attract the other industries.

(h) Competition Between States

Different states in India, vie with each other to attract new industries. Various states offer investment subsidies and sales tax exemptions to new organization / unit.

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③ Selection of Locality or Community

(a) Availability of Labour

⇒ Labour is an important factor in the production of good.

⇒ An adequacy of labour supply at reasonable wages is very essential for the smooth and successful working of an organization.

⇒ The labour required may be skilled, semi-skilled, high skill and unskilled. It is skilled labour which influences plant location because unskilled labour is supposed to be available everywhere.

(b) Availability of Civic Amenities

⇒ Availability of civic amenities for workers also plays role in facility location.

⇒ Besides good working conditions inside the factory, the employees required certain facility such as clubs, theatres and parks, must be provided for the employees.

(c) Existence of Complementary & competing Industries

It is favourable to the location of industries because an industrial unit, in association with other units, can get following benefits:

(i) An industrial unit, a collaboration with other similar units, can secure materials on better terms that it can do it by itself.

(ii) The concentration of similar industries at one place improve the labour market both for employer and employee.

(iii) In specialised centres, banks become familiar with the requirement of industry.

(iv) A group of plant will attract a variety of repair plants such as foundries, machine shops, tool makers etc.

(v) The reputation build up by the existing units will be shared by the new units established in the same locality.

(d) Availability of Finance & Research Facility

⇒ Adequate capital is essential for the successful working of any organization. A place where facility for raising capital are available attract new industries.

⇒ Moreover a manufacturing unit has to be dynamic i.e. it should always be on the look out for new technology

⇒ For this purpose, research facilities are essential and a place where such facilities are available naturally attract new industries.

(e) Availability of water and Fire-fighting Facilities

→ Factories must be located in place where water is available and it may be obtained from the local authority from canal, river, lake or borewell.

→ Industrial units are exposed to fire hazards. Though the availability of fire-fighting facilities is not a decisive factor in plant location, the fact remains that the existence of such facilities will enhance the suitability of a location.

(f) Local Taxes & Restriction

Local authorities collect charges for the supply of water, electricity and other facilities, along with other various taxes from industrial units. The impose of restriction on the location of new units in the public interest.

(g) Momentum of an Early Start

The momentum of an early start exercise a considerable influence on plant location. For example;

(i) Transport facilities are developed because the railways and other agencies find it economical to serve such places.

(ii) Facilities for repairs and maintenance begin to be provided by specialized firm.

(iii) Banking facilities become available

(iv) Labour possessing various skill is attracted to those places.

(h) Personal Factors

There are entrepreneurs, specially small industrialists, who locate their plants purely on personal grounds disregarding economic consideration. Such location sometimes totally disapprove the may current theories of plant location.

(4) Selection of the Site

(a) Soil, Size & Topography

→ For agro-based industries, a fertile soil is necessary for ensuring a strategic plant location.

→ The size of the land should be such as to accomodate not only the existing manufacturing facilities, but offers future expansion programme as well.

→ The topography of the place deserves consideration to some extent. A hilly, rocky and rough terrain is unsuitable for plant location because a great deal of expenditure has to be incurred to level it.

(b) Disposal of Waste

→ The site selected for the location of the plant should have provision for the disposal of waste.

→ There must be enough vacant land for the dumping of solid waste. For liquid waste, satisfactory sewer connections or a river or sea should be available.

Factors Influencing plant Location

- Law and order situations.
- Availability of Infrastructure
- Good Industrial relation
- Availability of skilled workforce.
- Social infrastructure
- Investor-friendly attitude
- Nearness to market
- Nearness to source of raw material
- Supporting industries and services.
- Must meet safety requirements.
- Other factors which also affect plant location are availability and cost of land, suitability of land - soil & topography, climate conditions, location of similar units etc.

General Factors Affecting Location Decision

- Availability of basic infrastructure
- Basic amenities
- Proximity to raw material and markets
- Residential complexes, schools, hospitals, club etc.
- Availability of cheap labour
- Government policies
- Environment and community
- cheap land.

Village Site (Rural Site)

→ The facility available at a village site are not as many as are found in a city, but they are more attractive, Example:

(i) cheaper rate of land
(ii) Negligible of rates and taxes.
(iii) Open spaces and spacious layout

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(9)

(iv) Advantages of single-storey building are available
(v) Low wages of unskilled workers and fewer labour troubles
(vi) Absence of restrictions on smoke and disposal of waste.

Suburban Site

(i) It offers a compromise between the city and the village.
(ii) Less costly as compare to city.
(iii) Availability of rail and road transport facilities.
(iv) Low wages of Labours.
(v) Avoidance of danger from fire and other hazards.
(vi) Fewer labour troubles.

Urban Site

(i) Transport facility
(ii) Labour is available in plenty.
(iii) Availability of municipal services for water, sewage disposal, public health and education facility.
(iv) Training of employees due to presence of technical & commercial Institution.
(v) Availability of banking, repair and relative services.
(vi) Availability of a large local market
(vii) High advertising value is available.

Comparision of Rural & Urban Site Selection for Plant

Urban	Rural
⇒ Labour availability - diversified type of labour is available	⇒ Difficult to get requisite skilled labour.
⇒ Local demand for the product is fairly high due to large population	⇒ Market place is far away from the enterprise so cost of distribution of finished product is more.
⇒ Good transportation facilities are available.	⇒ Requisite transportation facilities are not available.
⇒ In proximity of allied industry.	⇒ Away from allied units.
⇒ Education, recreational health and other social facilities are available.	⇒ Absence of educational, recreational social and health facilities.
⇒ Sufficient land is not available even at higher rates.	⇒ Sufficient land is available at cheaper rates.
⇒ Tax rates are high.	⇒ Taxes are quite low.

(10)

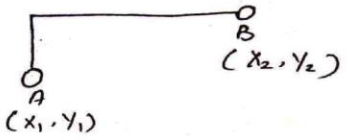
⇒ There are many restrictions on factory building construction.	⇒ No restriction on building construction
⇒ Certain facilities and public utility services such as water supply drainage and fire fighting etc. are available.	⇒ These facilities and public utility services are not available.
⇒ Prompt postal and communication services are available.	⇒ Prompt postal and public telephone services are not available.

Single Facility location problems (Facility Location Techniques)

① **Rectilinear distance**

Along
Location Paths that are orthogonal or perpendicular to each other.

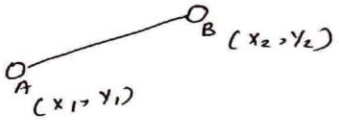
$$RD = |x_1 - x_2| + |y_1 - y_2|$$



② **Euclidean Distance**

Straight line between two point.

$$ED = \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}$$



③ **Flow path distance**

Exact traveling distance between two points.



Single Facility Minisum location problem

objective Function : $\min f(x) = \sum_{i=1}^{m} w_i d(x, P_i)$

Distance in rectilinear model

$$d(x, P_i) = |x - a_i| + |y - b_i|$$

where

$x = (x, y)$ Location of new facility.

$P = (a_i, b_i)$ Location of existing facilities.

w_i = weight associated with travel between the new facility and existing facility 'i'.

$d(x, P_i)$ = distance between the new facility and existing facility 'i'.

Steps

⇒ Find the x, y values for the new facility that satisfy the given objective function.

$$\min f(x) = \sum_{i=1}^{m} w_i |x - a_i| + \sum_{i=1}^{m} w_i |y - b_i|$$

⇒ Apply these rules to find the optimum value of X & Y.

* X - coordinate of the new facility will be same as the x-coordinate of some existing facility.

(1)

* Median condition : Selected X- coordinate can not be more than half the total weight which is to the right of x or which is to the left of x.

⇒ Same rules apply in selection of the optimum value of y.

Procedure

1. → Find x- coordinate
   → Order the facilities based on the ascending order of their x- coordinates
   → calculate parallel sum of weights.
   → Find the facility for which the parallel sum request equals or exceeds one- half the total weight.
   → The x- coordinate of the new facility will be the same as the x-coordinate of this facility.
2. Find y- coordinate
   Repeat the same for y-coordinate.

Example

A new location for a manufacturing facility is being considered. The facility has frequent relationship with its (three) major suppliers and since the supplied material is bulky and transportation cost are high the closeness to the five suppliers has been determined as the major factor for the facility location. The current coordinates of the suppliers are $S1 = (1,1)$, $S_2 = (5,2)$, $S_3 = (2,8)$, $S_4 = (4,4)$ and $S_5 = (8,6)$. The cost per unit distance travelled is the same for each supplier, but the no. of trips per day between the facility and each of its suppliers are 5, 6, 2, 4 and 8.

(i) Find a new location for the facility which minimizes the transportation cost.

(ii) calculate the total weighted distance for the new location.

Supplier	Coordinates		Rel^n with the facility (trip per day)
	a_i	b_i	w_i
1	1	1	5
2	5	2	6
3	2	8	2
4	4	4	4
5	8	6	8

(2)

1. For x- coordinates

Supplier	Coordinates a_i	Relation with the facility (trip/day) w_i	Σw_i
1	1	5	5
3	2	2	7
4	4	4	11
2	(5)	6	17
5	8	8	25

$\frac{25}{2} = 12.5$

2. For y- coordinates

Supplier	b_i	w_i	Σw_i
1	1	5	5
2	2	6	11
4	(4)	4	15
5	6	8	23
3	8	2	25

$\frac{25}{2} = 12.5$

The best location for the new facility corresponds to the coordinates $x = 5$ & $y = 4$.

The total weighted distance between the new facility and its suppliers can be found as:

$$f(x) = \sum_{i=1}^{m} w_i |x - a_i| + \sum_{i=1}^{m} w_i |y - b_i|$$

$$f(5,4) = 5(|5-1| + |4-1|) + 6(|5-5| + |4-2|) + 2(|5-2| + |4-8|) + 4(|5-4| + |4-4|) + 8(|5-8| + |4-6|)$$

$$= 105.$$

* Minisum Location problem

Minimizing the sum of weighted distance between the new facility and the other existing facilities.

* Minimax Location Problem

Minimizing the maximum distance between the new facility and any existing facility.

(3)

Example

Consider the location of a new plant which will supply raw materials to a set of existing plants in a group of companies, let there are 5-existing plants which have a materials movement relationship with the new plant. Let the existing plants have locations at (400, 200), (800, 500), (1100, 800) (200, 900) and (1300, 300). Furthermore suppose that the number of tons of materials transported per year from the new plant to various existing plants are 450, 1200, 300, 800 and 1500 respectively, the objective is to determine optimum location for the new plant such that the distance moved (cost) is minimized.

Existing plant	X-coordinate	Y-coordinate	weight
1	400	200	450
2	800	500	1200
3	1100	800	300
4	200	900	800
5	1300	300	1500
			4250 Tons.

For x-coordinates

Existing plant	x	w	Cumulative weight
4	200	800	800
1	400	450	1250
2	800	1200	2450
3	1100	300	2750
5	1300	1500	4250

$\frac{4250}{2} = 2125$

For y-coordinates

Existing plant	y	w	Cumulative weight
1	200	450	450
5	300	1500	1950
2	500	1200	3150
3	800	300	3450
4	900	800	4250

$\frac{4250}{2} = 2125$

The optimal location = x = 800
y = 500.

Minimax Location Problem

objective:- To locate the new emergency facility (X, Y) such that the maximum distance from the new emergency facility to any of the existing facilities is minimized.

$F_i(x, y)$ = distance between the new facilities and the existing facilities.

i.e. $\boxed{F_i(x, y) = |x - a_i| + |y - b_i|}$

(x, y) = Location of new facility.

(a_i, b_i) = Location of existing Facilities.

Then $\boxed{F_{max}(x, y) = \max_{1 \le i \le m} \{|x - a_i| + |y - b_i|\}}$

$F_{max}(x, y)$ = maximum of the distance between the new facility and various existing facility.

m = different ships in an industry. (existing facility)

Step-1

Find

$C_1 = \min_{1 \le i \le m} (a_i + b_i)$

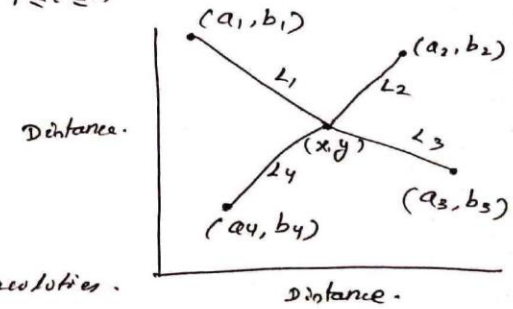
$C_2 = \max_{1 \le i \le m} (a_i + b_i)$

$C_3 = \min_{1 \le i \le m} (-a_i + b_i)$

$C_4 = \max_{1 \le i \le m} (-a_i + b_i)$

$C_5 = \max_{1 \le i \le m} (C_2 - C_1, C_4 - C_3)$

Max. distance b/w new facilities



Step-2 Find P_1 & P_2 (Location of existing facilities.

$P_1 = \left[\frac{1}{2}(C_1 - C_3), \frac{1}{2}(C_1 + C_3 + C_5)\right]$

$P_2 = \left[\frac{1}{2}(C_2 - C_4), \frac{1}{2}(C_2 + C_4 - C_5)\right]$

Step-3

Any point (x^*, y^*) on the line segment joining points P_1 & P_2 is a minimax location that minimize $F_{max}(x, y)$.

(15)

Example

In a steel manufacturing company have seven different department/shops whose coordinates are given in the following table. The company is interested in locating a new costly fire-fighting equipments in the foundry. Calculate the minimax location of the new equipments.

Sl. No	Existing Facility	co-ordinate of centroid
1	Sand plant	10, 20
2	Molding shop	30, 40
3	pattern shop	10, 120
4	Melting shop	10, 60
5	Felling shop	30, 100
6	Fabrication shop	30, 140
7	Annealing shop	20, 190.

$a_1, b_1 = 10, 20$

$a_2, b_2 = 30, 40$

$a_3, b_3 = 10, 120$

$a_4, b_4 = 10, 60$

$a_5, b_5 = 30, 100$

$a_6, b_6 = 30, 140$

$a_7, b_7 = 20, 190$

Step-1

$$c_1 = \min_{1 \le i \le m} (a_i + b_i) = \min[(10+20), (30+40), (10+120), (10+60), (30+100), (30+140), (20+190)]$$

$$= \min[30, 70, 130, 70, 130, 170, 210] = 30.$$

$\boxed{c_1 = 30}$

$$c_2 = \max_{1 \le i \le m} (a_i + b_i) = \max[30, 70, 130, 70, 130, 170, 210] = 210$$

$\boxed{c_2 = 210}$

$$c_3 = \min_{1 \le i \le m} (-a_i + b_i) = \min[(-10+20)(-30+40), (-10+120), (-10+60), (-30+100), (-30+140), [-20+190)]$$

$$= \min[10, 10, 110, 50, 70, 110, 170] = 10$$

$\boxed{c_3 = 10}$

$$c_4 = \max_{1 \le i \le m} (-a_i + b_i) = \max[10, 10, 110, 50, 70, 110, 170]$$

$\boxed{c_4 = 170}$

(6)

$$C_5 = \underbrace{\max}_{1 \le i \le m} (c_2 - c_1 ; c_4 - c_3)$$

$$= \max [(210-30), (170-10)] = \max [180, 160] = 180.$$

$$P_1 = \left[\frac{1}{2}(c_2 - c_3), \frac{1}{2}(c_1 + c_3 + c_5) \right]$$

$$= \left[\frac{1}{2}(30-10), \frac{1}{2}(30+10+180) \right] = (10, 110)$$

$$P_2 = \left[\frac{1}{2}(c_2 - c_4), \frac{1}{2}(c_2 + c_4 - c_5) \right]$$

$$= \frac{1}{2}(210-170), \frac{1}{2}(210+170-180)] = (20, 100)$$

Any point x^*, y^* on the line segment joining points $(10, 110)$, $(20, 100)$ is minimum location for the three weighting equipments.

Multifacility Location problem (Weber Problems)

$$\text{Min.}\ (x_j, y_j)\ j = 1,2,\ldots q \quad \sum_{j=1}^{q}\sum_{i=1}^{m} w_{ij}\, d_{ij} + \sum_{j=1}^{q-1}\sum_{s=j+1}^{q} v_{js}\, d_{js}$$

If we want to locate 'q'-facilities to serve 'm' demanding entities, the problems can be written as;

w_{ij} & v_{js} = weighting factors between a facility and a demanding entity (new location) and between two facilities respectively.

d_{ij} & d_{js} = Distance between a facility and a demanding entity. and between two facilities respectively.

$$\text{Min.}\ (x_j, y_j)\ j = 1,2,\ldots q \quad \sum_{j=1}^{a}\sum_{i=1}^{m} w_{ij}\left(|x_j - a_i| + |y_j - b_i|\right) + \sum_{j=1}^{q-1}\sum_{s=j+1}^{a} v_{js}\left(|x_j - x_s| + |y_j - y_s|\right)$$

The multifacility weber problem take the following form for the Euclidean distances;

$$\text{Min.}\ (x_j, y_j)\ j = 1,2,3\ldots q \quad \sum_{j=1}^{q}\sum_{i=1}^{m} w_{ij}\sqrt{(x_j - a_i)^2 + (y_j - b_i)^2} + \sum_{j=1}^{q-1}\sum_{s=j+1}^{a} v_{js}\sqrt{(x_j - x_s)^2 + (y_j - y_s)^2}$$

d_{ij} = Euclidean distance.

Objective Function

$$\text{Min} \sum_{1 \le j < k \le n} v_{jk}\cdot d(x_j \cdot x_k) + \sum_{j=1}^{n}\sum_{i=1}^{m} w_{ji}\cdot d(x_j \cdot p_i)$$

'm' = new facility is to be located w.r.t the 'n' existing facilities and also with respect to the other new facility.

The location x_j may depend on the location of some point X_k because of the terms involving v_{jk}.

(8)

when term V_{ji} are zero, then

$$\text{Min} \sum_{j=1}^{n} \sum_{i=1}^{m} W_{ji} \cdot d(X_j \cdot P_i) \quad \text{——} (2)$$

The above eqn defines a one-facility total cost expression. So that eqn-2 is the sum of n-different one-facility cost expression and may be written as;

$$\text{Min} \sum_{j=1}^{n} \left(\text{Min} \sum_{i=1}^{m} W_{ji} \cdot d(X_j \cdot P_i) \right) - (3)$$

Location Models

(1) Factor Rating Method
(2) Point Rating Method
(3) Break-even Analysis
(4) Qualitative Factor Analysis.
(5) Quantitative Factor Analysis.
(6) Weighted factor rating method
(7) Load-distance method

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(1) Factor Rating Method

The method has the following advantages;
(i) Simplicity which facilitates communication about why one location is better than another.
(ii) Enables bringing diverse locational consideration into the evaluation process.
(iii) Foster consistency of judgement about location alternatives.

The process of selecting a new facility location involves a series of following steps;
(a) Identify the important location factors.
(b) Rate each factor according to its relative importance i.e. higher the rating indicative of prominent factor.
(c) Assign each location according to the merits of the location for each factor.
(d) calculate the rating for each location by multiplying factor assigned to each location with basic factor considered.
(e) Find the sum of product calculated for each factor and select best location having highest total score.

Example:- In a medical facility, Health-care, is to be located in Bhubaneswar. The location factors, factor rating and scores for two potential sites are shown in the following table. which is the best location based on factor rating method?

SL.NO.	Location Factor	Factor Rating	Rating.	
			Location-1	Location-2
1.	Facility Utilization	8	3	5
2.	Total patient per month	5	4	3
3.	Average time per emergency trip	6	4	5
4.	Land and construction costs	3	1	2
5.	Employee Preferences	5	5	3

Solution:-

SL. NO.	Location Factor	Factor Rating	Location-1		Location-2	
			Rating (2)	Total = (1)·(2)	Rating (3)	Total = (1)·(3)
1.	Facility Utilization	8	3	24	5	40
2.	Total patient per month	5	4	20	3	15
3.	Average time per emergency trip	6	4	24	5	30
4.	Land and construction costs	3	1	3	2	6
5.	Employee Preferences	5	5	25	3	15
			Total =	96	Total =	106

The total score for location '2' is higher than that of location 1. Hence location '2' is the best choice.

(12)

(2) Point Rating Method

→ The relative weight a company assigns to each objective or to each location factor may be represented by the number of points a perfect site would receive in each category.

⇒ Each potential site is then evaluated with respect to every factor a company is looking for and points are assigned for each other factors the site with the highest total number of points is considered superior to other sites.

⇒ The significant in point-rating method is the relative importance of tangible cost factors compared to intangible factors.

→ If two alternative locations are found to be equally attractive by comparing the costs then these two alternative potential locations may further be evaluated, based on the intangible factors using the point rating method.

Example :- After evaluating two potential sites 'X' & 'Y' by comparing costs and finding them approximately equal from cost point of view, a manufacturer decided to evaluate the intangible factors for these two locations by point rating method. (Data are given below in the Table)

Factor Rated	Maximum Possible points	Point Assigned to Locations	
		Location-A	Location-B
Future Availability of fuel	300	200	250
Transportation flexibility and growth	200	150	150
Adequacy of water supply	100	100	100
Labour Availability	250	220	200
pollution Regulation	30	20	20
Site topography	50	40	30
Living Conditions.	150	100	125
Total	1080	830	875

* From the table it is seen that location 'B' has slight advantage over location 'A'.

(13)

(3) Break-even Analysis

⇒ A break-even analysis is a financial tool which helps you to determine at what stage your company or a new service or a product will be profitable.

⇒ In other words, it's a financial calculation for determining the number of product or services a company should sell to cover it costs particularly fixed costs.

⇒ Break-even is a situation where you are neither making money nor loosing money, but all your costs have been covered.

⇒ An economic comparision of locations can be made by identifying the fixed costs and variable costs and plotting costs, the break-even analysis on a graph for each location.

⇒ The steps involved in this method are;

(i) Determine all relevant costs that very with each location

(ii) Categorize the costs for each location into annual fixed costs (FC) & variable cost per unit (VC) and calculate the total cost (TC) for the desired volume of production per annum for each location.

(iii) plot the total costs associated with each location on a single chart or graph of annual cost versus annual production volume.

(iv) Select the location with the lowest total annual cost (TC) at the expected production volume per annum (Q)

Formulas

$$\text{Contribution/Unit} = \text{Selling Price/Unit} - \text{Variable cost/Unit}$$

$$\text{Break-even Point in Quantity} = \frac{\text{Fixed cost}}{\text{Contribution Per Unit.}}$$

Example

From the following particulars, calculate (i) Break-even point in terms of sales value and in units. (ii) Number of units that must be sold to earn a profit of Rs. 90,000.

Fixed Factory overheads cost = 60,000/-
Fixed Selling overheads cost = 12,000/-
variable manufacturing cost per unit = 12
Variable selling cost per unit = 3
Selling price per unit = 24

Sol^n (i) $$\text{Break-even point} = \frac{\text{Fixed cost}}{\text{Selling Price per Unit} - \text{Variable cost per Unit}}$$

Variable cost per Unit = 12 + 3 = 15

(14)

So Total Fixed cost = 60,000 + 12,000 = 72,000/-

Break-even Point = $\frac{72,000}{24-15}$ = 8,000 Units.

S. Break-even point (in Sales values) = 8,000 × 24 = 1,92,000/-

(ii) Number of units that must be sold to earn profit of 90,000/-

$$= \frac{\text{Fixed cost + Profit}}{\text{Selling Price per Unit} - \text{Variable cost per Unit}}$$

$$= \frac{72000 + 90,000}{24 - 15} = 18,000 \text{ Units.}$$

Example

From the following information, calculate Break-even analysis, ascertain by how much the value of sales must be increased by the company to break even.

Sales = 3,00,000
Fixed cost = 1,50,000
Variable cost = 2,00,000

Soln

$$\text{Break-even point} = \frac{\text{Fixed cost} \times \text{Sales}}{\text{Sales} - \text{Variable cost}}$$

$$= \frac{1,50,000 \times 3,00,000}{3,00,000 - 2,00,000} = 4,50,000.$$

Hence, Sales to be increased by the company to break-even are

= 4,50,000 − 3,00,000 = 1,50,000/-.

Example

From the following information calculate

(i) Break-even point
(ii) P/V Ratio

Sales required to earn a profit of Rs. 4,50,000/-
Fixed Expenses = Rs. 90,000/-
Variable cost per Unit; Direct material = 5 Rs.
Direct labour = 2 Rs.
Direct overheads = 100% of direct labour
Selling Price per Unit = 12 Rs.

Soln

Selling Price per Unit = 12.
Less; Variable cost per Unit;
Direct material = 5
Direct labour = 2
Direct overheads = 2
9
Contribution per Units = 12 − 9 = 3.

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(i) P/V Ratio $= \frac{\text{Contribution}}{\text{Sales}} \times 100$

$= \frac{3}{12} \times 100 = 25\%$

(ii) Break-even Sales $= \frac{\text{Fixed Expenses}}{\text{P/V Ratio}} = \frac{90,000}{\frac{25}{100}} = 3,60,000/-$

(iii) Sales required to earn a profit of 4,50,000/-

$= \frac{\text{Fixed Expenses + Desired Profit}}{\text{P/V Ratio}}$

$= \frac{90,000 + 4,50,000}{25\%} = \text{Rs. } 21,60,000/-$ (Ans).

Example

From the following particulars, find out the break-even point:

Variable cost per unit = 15 Rs.

Fixed Expenses = 54,000 Rs.

Selling Price per Unit = 20 Rs.

what should be the selling price per unit, if the break-even point should be brought down to 6,000 Units?

Soln

Contribution per unit = Selling Price − Variable cost per Unit

$= 20 - 15 = \text{Rs. } 5/-$

(i) Break-even Point $= \frac{\text{Fixed Expenses}}{\text{Contribution per Unit}} = \frac{54,000}{5} = 10,800$ Units.

(ii) what should be the selling price per Unit, if the break-even point should be brought down to 6000 units.

So Break-even Point $= \frac{\text{Fixed Expenses}}{\text{Contribution per Unit}}$.

$\Rightarrow 6000 = \frac{54,000}{\text{Contribution per unit}}$

So Contribution per Unit $= \frac{54000}{6000} = \text{Rs. } 9$.

So Contribution = Selling Price − Variable Cost

$\Rightarrow 9 = \text{Selling Price} - 15$

$\Rightarrow$ Selling Price $= 15 + 9 = 24$ Rs. (Ans).

(4) Qualitative Factor Analysis

This approach is referred to as qualitative factor analysis. The steps involved are;

(i) Develop a list of relevant factors.

(ii) Assign a weight to each factor to indicate its relative importance.

(iii) Assign a common scale to each factor and designate any minimum point to be scored by any location.

(iv) Score each potential location according to the designated scale and multiply the scores by the weight to arrive at the weighted scores.

(v) Total the points for each location and choose the location with the maximum point.

Example:- ABC company is evaluating four locations for a new plant and has weighted the relevant scores as given below. Scores have been assigned with higher values indicative of preferred conditions. Using these scores, develop a qualitative factor comparision for the four locations.

Relevant Factors	Assigned Weight	Scores for Location			
		A	B	C	D
Production cost	0.35	50	40	60	30
Raw material supply	0.25	70	80	80	60
Labour Availability	0.20	60	70	60	50
cost of Living	0.05	80	70	40	80
Environment	0.05	50	60	70	90
Markets	0.10	70	90	80	50
Total =	1.00				

Solution:-

Factors.	Weighted Score for Locations			
	A	B	C	D
Production cost	17.5	14.0	21	10.5
Raw material supply	17.5	20	20	15
Labour Availability	12.0	14	12	10
cost of Living	04.0	3.5	2	4
Environment	02.5	3.0	3.5	4.5
Markets	07.5	9.0	8	5
Total =	60.5	63.5	66.5	49.0

∴ So 'C' has the heighest weighted score.

(17)

⑤ Quantitative Factor Analysis

Various quantitative models are used to determine the best locations of facilities. The widely used models for location decision are;

(i) Simple median model
(ii) Simulation model
(iii) Linear programming model.

(i) Simple median model

⇒ Simple median model is also called centre of gravity method. It is a quantitative method for choosing an optimal facility location that minimize cost of transportation based on the median load.

⇒ Centre of gravity is based on primarily on cost consideration. This method can be used to assist managers in balancing cost and service objectives.

⇒ The centre of gravity method takes into account the locations of plants and markets, the volume of good moved and transportation costs in arriving at the best location for a single intermediate.

⇒ The centre of gravity is determined by

$$C_x = \frac{\sum D_{ix} \cdot W_i}{\sum W_i} \qquad C_y = \frac{\sum D_{iy} \cdot W_i}{\sum W_i}$$

where, C_x = x-coordinate of the centre of gravity
C_y = y-coordinate of the centre of gravity
D_{ix} = x-coordinate of location i
D_{iy} = y-coordinate of location i

Example

The new Health-care facility is targeted to serve seven census tracts in Bhubaneswar. The table given below shows the coordinates for the centre of each census tract, along with the projected populations, measured in thousands. Customers will travel from the seven census tract centres to the new facility when they need health-care. Two locations being considered for the new facility are at (5.5, 4.5) and (7.2), which are the centres of census tract 'C' & 'F'. Details of seven census tract centres, coordinate distances along with the population for each centre are given below. Find the target area's centre of gravity for the health-care medical facility.

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Sl. No.	Census Tract	(x, y)	population (l)
1	A	(2.5, 4.5)	2
2	B	(2.5, 2.5)	5
3	C	(5.5, 4.5)	10
4	D	(5, 2)	7
5	E	(8, 5)	10
6	F	(7, 2)	20
7	G	(9, 2.5)	14

Soln:-

To calculate the centre of gravity, start with the following information where population is given in thousands.

Sl. No.	Census Tract	(x, y)	population (l)	Lx	Ly
1	A	(2.5, 4.5)	2	5	9
2	B	(2.5, 2.5)	5	12.5	12.5
3	C	(5.5, 4.5)	10	55	45
4	D	(5, 2)	7	35	14
5	E	(8, 5)	10	80	50
6	F	(7, 2)	20	140	40
7	G	(9, 2.5)	14	126	35
		Total =	68	453.50	205.50

Next we find C_x & C_y.

$$C_x = 453.5/68 = 6.67$$

$$C_y = 205.5/68 = 3.02$$

The centre of gravity is (6.67, 3.02). Using the centre of gravity as starting point, managers can now search in its vicinity for the optimal location.

(ii) Simulation Method

⇒ Simulation model have their own assumptions, specification and conditions for application.

⇒ However, in real world (working situation) these specifications, limitation or assumptions may not be applicable or may not be met, reducing the usefulness of these model.

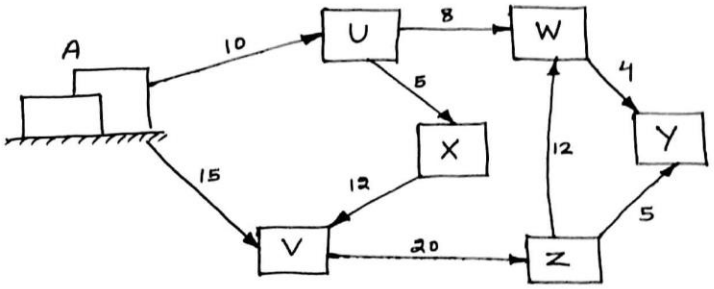
⇒ Hence to cope with this real complex problem, simulation method is developed. This method is based on the approximation technique.

(iii) Linear Programming Model

⇒ Linear programming is a simple technique where we depict complex relationship through linear program function and then find the optimum points.

⇒ The real relationships might be much more complex but we can simplify them to linear relation.

⇒ Example, a Flipkart delivery man has 6 package to deliver in a day. The warehouse is located at point A. The 6 delivery destinations are given by U, V, W, X, Y & Z. The numbers on the lines indicate the distance between the cities. To save on fuel and time the delivery person wants to take the shortest route.



⇒ So, the delivery person will calculate different routes for going to all 6 destinations and then come up with the shortest routes. The technique of choose the shortest route is called linear programming. And the process of choosing the best route is called operation research.

⇒ Linear programming is used for obtaining the most optimal solution for a problem with given constraints. In linear programming, it formulate real life problem into a mathematical model, which involves an objective function, linear inequalities with subject to constraints.

⑥ Weighted Factor Rating Method

In this method to merge quantitative and qualitative factors are assigned weights based on relative important and weightage score for each site using a preference matrix is calculated. The site with the highest weighted score is selected as the best choice.

Example :- A new medical faculty, Health care is to be located in Bhubaneswar. The location factors, weight and scores (1 = poor, 5 = excellent) for two potential sites are shown in the following table. What is the weighted score for these sites? which is the best location.

Sl. No.	Location Factor	Weight	Scores	
			Location-1	Location-2
1.	Facility Utilization	25	3	5
2.	Total Patient Km per Month	25	4	3
3.	Average time per Emergency Trip	25	3	3
4.	Land and construction costs	15	1	2
5.	Employee Preferences.	10	5	3

Ans.
The weighted score for this particular site is calculated by multiplying each factor's weight by its score and adding the results.

weighted score location-1 = 25×3 + 25×4 + 25×3 + 15×1 + 10×5 = 315

weighted score location-2 = 25×5 + 25×3 + 25×3 + 15×2 + 10×3 = 335

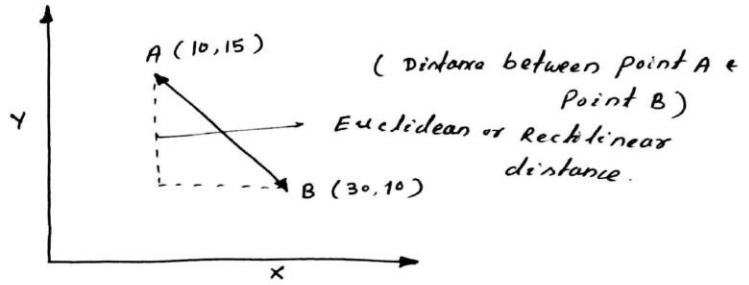
So Location '2' is the best site based on total weighted scores.

(7) Load-Distance Method

⇒ The load-distance method is a mathematical model used to evaluate location based on proximity factors.

⇒ The objective is to select a location that minimize the total weighted loads moving into and out of facility.

⇒ The distance between two points is expressed by assigning the point to grid coordinate on a map. An alternative approach is to use time rather than distance.



⇒ However, for load distance method, a rough calculation that is either Euclidean or rectilinear distance measure may be used.

⇒ The Euclidean distance is the straight line distance or shortest possible path between two points.

⇒ The point 'A' on the grid represent the supplier's location in Bhubaneswar, and the point 'B' represents the warehouse location at Khordha.

⇒ S., the distance between point 'A' & 'B' is the length of the hypotenuse of a right triangle, or

$$d_{AB} = \sqrt{(X_A - X_B)^2 + (Y_A - Y_B)^2}$$

(Euclidean: straight-line estimate of distance)

where, d_{AB} = distance between point A & B

X_A = X- coordinate of point A

Y_A = Y- coordinate of point A

X_B = X- coordinate of point B

Y_B = Y- coordinate of point B

⇒ Rectilinear distance measures distance between two points with a series of 90° turns as city blocks which is represent by dashed lone.

⇒ The distance travelled in the X-direction is the absolute value of the difference in X-coordenates. Adding this result to the absolute value of the difference in the Y-coordenates given.

$$D_{AB} = |X_A - X_B| + |Y_A - Y_B|$$

(Rectilinear: distance allowing only horizontal or vertical movement)

Example

The new health-care facility is targeted to serve seven census tracts in BBSR. The table given below shows the coordenates for the centre of each census tract, along the projected populations, measured in thousands. Customers will travel from the seven census tract centers to the new facility when they need health-care. Two location being considered for the new facility are at (5.5, 4.5 & 7,2), which are the centers of census tract 'C' & 'F'. Details of seven census tract centers, co-ordinate distance along with the population for each centre are given below. If we use the population as the loads and use rectilinear distance, which location is better in terms of its total load-distance score?

Sl. NO	Census Tract	(X, Y)	Population (l)
1	A	(2.5, 4.5)	2
2	B	(2.5, 8.5)	5
3	C	(5.5, 4.5)	10
4	D	(5,2)	7
5	E	(8,5)	10
6	F	(7, 2)	20
7	G	(9, 2.5)	14

Example (Rectilinear Distance)

Customer	Position		Load (L)
	X	Y	
Customer-1	10	10	100
Customer-2	20	20	200

$$D_{AB} = |x_A - x_B| + |y_A - y_B|$$

Perspective Location					
A (X,Y) = (5,3)		B (X,Y) = (18,13)		C (X,Y) = (30,20)	
Distance (D)	L x D	Distance (D)	L x D	Distance (D)	L x D
12	1200	11	1100	30	3000
38	7600	15	3000	4	800
Total =	8800		4100		3800

(Suitable Location.)

$|10 - 5| + |10 - 3| = 12$

$|26 - 5| + |20 - 2| = 38$

Example (Euclidean distance)

$$D_{AB} = \sqrt{(x_A - x_B)^2 + (y_A - y_B)^2}$$

Perspective Location					
A (X,Y) = (5,3)		B (X,Y) = (18,13)		C (X,Y) = (30,20)	
Distance (D)	L x D	Distance (D)	L x D	Distance (D)	L x D
8.60	860.23	8.54	854.40	22.36	2236.07
27.02	5403.70	10.63	2126.03	4.00	800.00
Total =	6263.93		2980.43		3036.07

(Suitable Location)

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Ans.

Using the formula $D_{AB} = |X_A - X_B| + |Y_A - Y_B|$

Census Tract	(X, Y)	population (l)	Locate at (5.5, 4.5)		Locate at (7, 2)	
			Distance(d)	Load Distance	Distance(d)	Load Distance
A	(2.5, 4.5)	2	3+0 = 3	6	4.5+2.5=7	14
B	(2.5, 2.5)	5	3+2 = 5	25	4.5+0.5=5	25
C	(5.5, 4.5)	10	0+0 = 0	0	1.5+2.5=4	40
D	(5, 2)	7	0.5+2.5=2	21	2+0 = 2	14
E	(8, 5)	10	2.5+0.5=3	30	1+3 = 4	40
F	(7, 2)	20	1.5+2.5=4	80	0+0 = 0	0
G	(9, 2.5)	14	3.5+2 = 5.5	77	2+0.5=2.5	35
			Total	239	Total = 168	

* Summing the scores for all tracts given a total load distance score of 239, when the facility is located at versus a load distance score of 168 at location (7,2). Therefore, the location in census tract 'F' is a better location.

Plant Layout

⇒ plant layout refers to the physical arrangement of production facilities, which are used in production.

⇒ plant layout is a plan of an optimum arrangement of facilities including personnel operating equipment, storage space, material handling equipment and all other supporting services along with the design of best structure to contain all these facilities.

⇒ plant layout refers to the arrangement of machinery equipment and other industrial facilities for achieving quickest smooth production at the least cost.

⇒ A simple, clear and comprehensive definition is given by Knowles & Thomson; the plant layout involves;

(i) planning and arranging manufacturing machinery, equipment and services for the first time in completely new plants.

(ii) the improvements in layouts already in use in order to introduce new method and improvement in manufacturing procedures.

* ⇒ Layout involves determining the space requirement for the facilities and arranging them in manner to ensure steady flow of operation with minimum over all costs.

Consideration of plant Layout :-

- ⇒ Maximum use of the available space.
- ⇒ Compatibility with the production technology and product mix.
- ⇒ Minimum movement of materials as well as men.
- ⇒ Provision of proper space for maintenance.
- ⇒ Arrangement of proper in-transit storage and staking space.
- ⇒ Promotes effective supervision.
- ⇒ Proper lighting and ventilation.
- ⇒ Provision of maximum flexibility.
- ⇒ Safety of operators and other staff.
- ⇒ Minimum handling of materials.
- ⇒ Provision for future expansion.

- ⇒ Security against fire, theft, deterioration etc.
- ⇒ Maximum flexibility to accomodate changes in production volume and product mix.

Advantages of Proper plant Layout

(i) Increase in productivity
(ii) Maximum utilization of space
(iii) Effective supervision and control
(iv) Economy in Material
(v) Improved safety and handling.
(vi) Improved working environment and morale.
(vii) Better quality control.

Objective of plant Layout (Scope)

(1) Streamline the flow of materials through the plant
(2) Facilitate the manufacturing process.
(3) Maintain high turnover of in-process inventory
(4) Minimise materials handling and cost.
(5) Effective utilization of men, equipment and space.
(6) Make effective utilization of cubic space.
(7) Flexibility of manufacturing operations and arrangement.
(8) Provide for employee convenience, safety and comfort.

(24)

(9) Minimize investment in equipment.
(10) Minimize overall production time.
(11) Maintain flexibility of arrangement and operation.
(12) Facilitate the organizational structure.
(13) Utilize labour efficiently.
(14) Reduce accidents.
(15) Allow ease of maintenance
(16) Improve productivity.

Factors Influencing plant Layout

- plant location and building
- Nature of product
- Types of Industry
- plant environment or climate
- Spatial requirements
- Repairs and Maintenance
- Balance (production, process, operation, management etc.)
- Management policy
- Human Needs. (Workers) and Safety
- Types of machinery and equipments.
- Types of materials (availability)
- Economic consideration (cost)
- production process and production volume.

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Principles of Layout

(1) Principle of Integration (Principle of Compactness)

- A good layout is one that integrates men, materials, machines and supporting service and other to get the optimum utilization of resources and maximum effectiveness.
- there should be a harmonious fusion of all the relevant factors so that the final layout looks well integrated and compact.

(2) Principle of Minimum travel (distance)

Men and materials should travel the shortest distance between operations so as to avoid waste of labour and time and minimise the cost of materials handling.

③ Principle of Usage (Principle of Space Utilization)

⇒ The good layout is one that utilise both horizontal and vertical space effectively.

⇒ Every foot of available space should be effectively utilized. This principle should receive top consideration in towns and cities where land is costly.

④ Principle of Sequence (Principle of flow)

⇒ Machinery and operations should be arranged in sequential order. This Principle is best achieved in product layout and efforts should be made to have it adopted in the process layout.

⇒ A good layout is one that makes the materials to move in forward direction towards the completion stages i.e. there should be any backtracking.

⑤ Principle of Maximum Flexibility

⇒ The layout should permit revisions with the least difficulty and at minimum cost.

⇒ The good layout is one that altered without much cost and time i.e. future requirements should be taken into account while designing the present layout.

⑥ Principle of Safety, Security and Satisfaction

⇒ A good layout is one that gives due consideration to worker safety, security, satisfaction and safeguard the plant and machinery against fire, theft etc.

⇒ The layout should contain built in provision for safety for the workmen, it should be planned on the basis of the comfort and convenience of the workmen, so that they feel satisfied.

⑦ Principle of Minimum Investment

The layout should result in saving in fixed capital investment, not by avoiding installation of the necessary facilities but by an intensive use of available facilities.

⑧ Principle of Minimum Handling

A good layout is one that reduces the material handling to the minimum.

Types of Layout

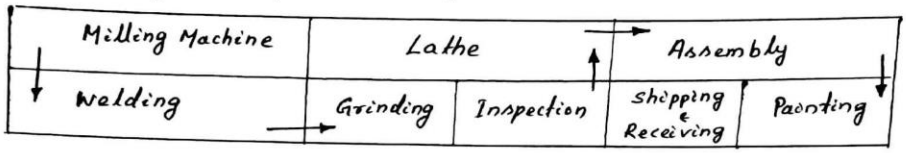
(i) Process Layout or Functional Layout or Job shop Layout
(ii) Product Layout or Line Processing Layout or Flow-line Layout
(iii) Fixed position Layout or Static Layout
(iv) Group Technology Layout or Cellular Manufacturing (CM) Layout (26)
(v) Combination Layout or Hybrid Layout

(i) Process Layout or Functional Layout or Job shop Layout

⇒ Process layout is recommended for batch production. All machines performing similar type of operations are grouped at one location in the process layout e.g. all lathes, milling machines etc. are grouped in the shop will be clustered in like group.

⇒ Thus, in process layout the arrangement of facilities are grouped according to their function.

⇒ The flow path of material through the facilities from one functional area to another vary from product to product.



(Process Layout)

Advantages:-

⇒ Reduced investment of machines as they are general purpose machines.
⇒ Greater flexibility in the production.
⇒ Better and more efficient supervision is possible through specialization.
⇒ A high degree of flexibility with regards to work distribution to machines and workers.
⇒ Greater scope for expansion as the capacities of different lines can be easily increased.
⇒ In process layout machines are better utilized and less machines are required.
⇒ Easy to handle breakdown of equipment by transferring work to another machine or station.
⇒ Full utilization of equipment.
⇒ The investment of equipment would be comparatively lower.
⇒ There is greater incentive to individual worker to increase his performance.

Disadvantages

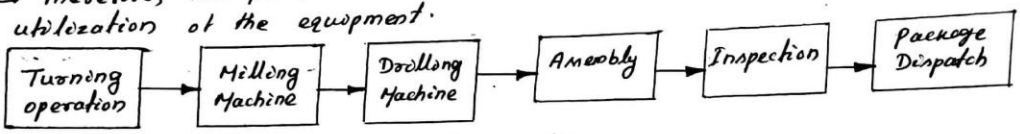
⇒ Difficulty in production control.
⇒ Difficulty in the movement of materials. Mechanical devices for material handling cannot be conveniently used, which reduces material handling efficiency.
⇒ production time is more as work-in-progress has to travel from place to place in search of machine.
⇒ Lower productivity due to number of set-ups.
⇒ Throughput (time gap between in and out in the process) time is longer.

(27)

⇒ Space and capital are tied up by work-in-process.
⇒ Process time is prolonged which reduce the inventory turnover and increases the in-process inventory.

(ii) Product Layout or Line Processing Layout or Flow-line Layout

⇒ This is also called straight-line layout or layout for serialised manufacture.
⇒ The product layout involves the arrangement of machines in one line, depending upon the sequence of operation.
⇒ The product layout is selected when the volume of production of a product is high such that a separate production line to manufacturer it can be justified.
⇒ Therefore, the production volume must be sufficient to achieve satisfactory utilization of the equipment.



(Product Layout)

Advantages

⇒ Mechanisation of material handling which reduce material handling cost.
⇒ Economy in manufacturing time.
⇒ It facilitates better production control.
⇒ It requires less floor area per unit of production.
⇒ Flow of product will be smooth.
⇒ Less in-process inventory
⇒ Throughput time is less.
⇒ Simplified production, planning and control system are possible.
⇒ Perfect line balancing which eliminates bottlenecks and idle capacity.
⇒ Manufacturing cycle is short due to uninterrupted flow of materials.
⇒ Unskilled workers can learn and manage the production.

Disadvantages

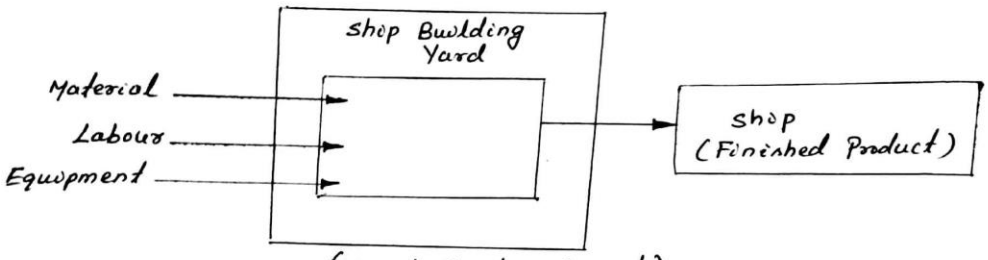
⇒ product layout is known for its inflexibility.
⇒ This type of layout is also expensive
⇒ There is difficulty of supervision.
⇒ Difficult in future expansion.
⇒ A change in product design may required major alteration in the layout.
⇒ The line output is decided by the bottleneck machine.
⇒ Any breakdown of equipment along a production line can disrupt the whole system.

(iii) Fixed Position Layout or Static Layout

➡ This is also called the project type of layout or fixed location layout.

➡ In this type of layout, the material or major components remain in a fixed location and tools, machinery, men and other materials are brought to this location.

➡ This type of layout is suitable when one or a few pieces of identical heavy products are to be manufactured and when the assembly consists of large number of heavy parts, the cost of transportation of these parts is very high.



(Fixed Position Layout)

➡ Example, manufacture of bulky and heavy products such as locomotives, ships, boilers, air craft and generators.

Advantages

➡ Men and machines can be used for a wide variety of operation producing different products.

➡ Helps in job enlargement and upgrades the skills of the operators.

➡ Greater flexibility with this type of layout.

➡ Layout capital investment is lower.

➡ The workers identify themselves with a product in which they take interest and pride in doing the job.

Disadvantages

➡ High cost of tools and machinery.

➡ Difficult to transporting a bulky product.

➡ Difficult in material handling specially for heavy products.

➡ Cost of transportation is very high.

➡ It needs highly skilled and multi-tasking workers.

(iv) Group Technology Layout or Cellular Manufacturing (CM) Layout

⇒ In Group technology or cellular manufacturing layout, machines are grouped into cells and the cells function somewhat like a product layout within a larger shop or process layout.

⇒ The basic aim of a group technology layout is to identify families of components that require similar or satisfying all the requirements of the machines are grouped into cell. Each cell is capable of satisfying all the requirements of the component family assigned to it.

⇒ Thus group layout is a combination of the product layout and process layout. It combines the advantages of both layout system.

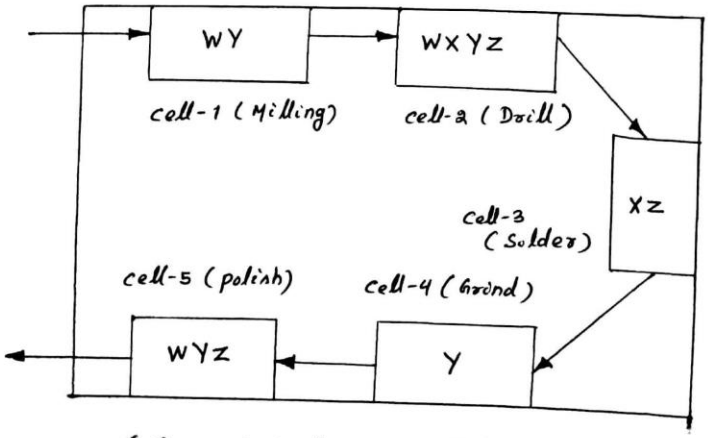
⇒ Group technology is the analysis and comparisons of items to group them into families with similar characteristics.

⇒ Group technology used to develop a hybrid between pure process layout and pure flow line (product) layout.

⇒ This technique is very useful for companies that produce variety of parts in small batches to enable them to take advantage and economics of flow line layout.

⇒ The application of group technology involves two basic steps, first is to determine component families or group and in second step in applying group technology is to arrange the plant equipment used to process a particular family of components.

⇒ In group technology layout, the objective is to minimize the sum of the cost of transportation and the cost of equipments. So this is called a multi-objective layout.



(Group Technology or Cellular Manufacturing Layout)

(30)

Advantages

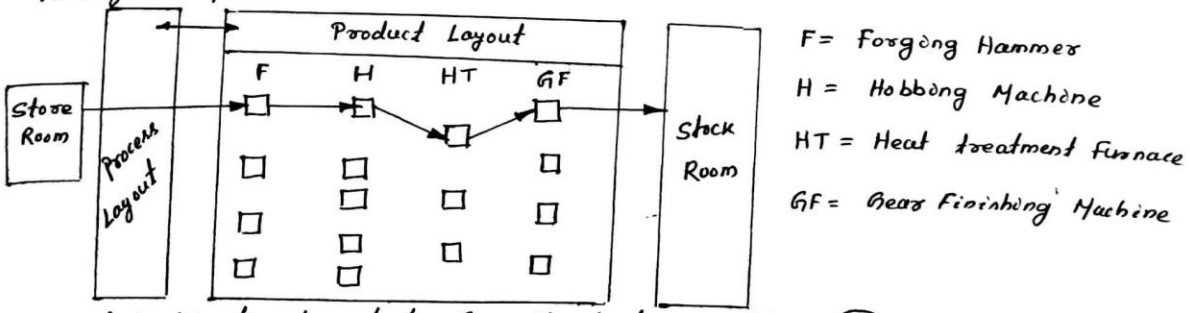
- ⇒ Lower work in process inventories
- ⇒ Reduce material handling costs
- ⇒ shorter flow times in production
- ⇒ Simplified production planning (material & labour)
- ⇒ Increase operator responsibilities
- ⇒ Improved visual control and facilitating quicker setups.
- ⇒ Improved overall performance by lowering production costs.
- ⇒ Improving on time delivery and customer service.
- ⇒ Quality also tends to improve.
- ⇒ Component standardization and rationalization
- ⇒ Reduce paper work and overall production time.

Disadvantages

- ⇒ Reduced manufacturing flexibility
- ⇒ potentially increased machine-down time
- ⇒ For duplicate pieces of equipment may be needed so that parts need not be transported between cell
- ⇒ Product mix is completely dissimilar
- ⇒ this type of layout may not be feasible for all situations.

(v) Hybrid Layout or Combination Layout

- ⇒ A combination of process and product layouts combines the advantages of both types of layout.
- ⇒ A combination layout is possible where an item is being made in different type and size.
- ⇒ Here machinery is arranged in a process layout but the process grouping is then arranged in a sequence to manufacture various types and sizes of products.
- ⇒ In combination layout, the sequence of operations remains same with the variety of product and sizes.



(Combination Layout for Gear Manufacturing Unit) (31)

Advantages

- Manufacture various types and sizes of products
- Increased product quality.
- Flexible manufacturing.
- Advantages both product and process layout, example Grocery store.
- Sequence of operations remains same with product mix.

Difference Between:

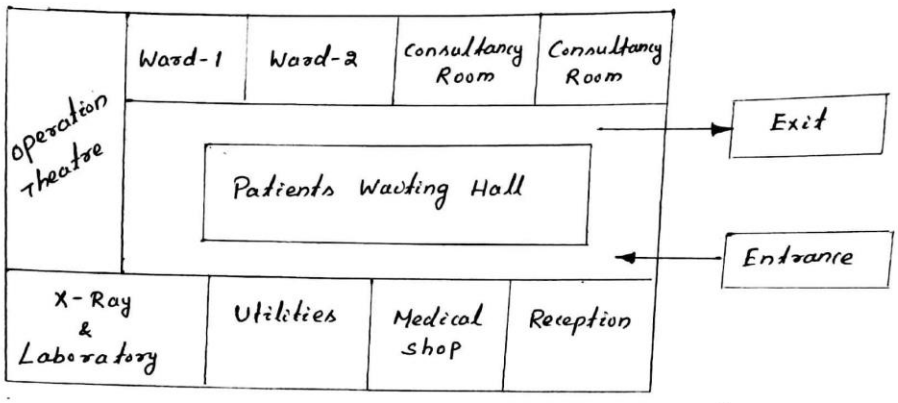
Process Layout	Product Layout
(1) Better scope of expansion.	(1) Better production control.
(2) Able to produce a large number of different products.	(2) Able to produce a small number of product efficiently.
(3) Resources used are general purpose.	(3) Resources used are specialized.
(4) Facilities are more labour intensive.	(4) Facilities are more capital intensive.
(5) Greater flexibility relative to the market.	(5) Low flexibility relative to the market.
(6) Slower processing rates.	(6) Faster processing rates.
(7) High material handling costs.	(7) Lower material handling costs.
(8) High space requirements.	(8) Lower space requirements.
(9) It leads to group technology.	(9) It leads to transfer lines,
(10) Job movement is unparately more.	(10) Job movement is comparatively more.
(11) It is meant for moderate production and more job variety.	(11) It is meant for mass production and extreme less job variety.
(12) Goal is to minimize material handling cost.	(12) Goal is to equalize work at each station.
(13) Varied skilled is required for workers.	(13) Limited skills is required for workers.
(14) Full utilization of plant.	(14) Early detection of mistakes or badly produced items.

Service Plant (facility) Layout

- Service facility bring together customers and services. Service facility layout should provide for easy entrance to these facilities from freeways and busy road or path forming a route between two places.
- Large, well organized and lighted parking areas and well designed walkways to and from parking areas are some of the requirements of service facility layout.

(39)

➡ Because of different degree of customer contact, two types of service facility layout emerge viz; those that are almost totally designed around the customer receiving and servicing function and those that are designed around the technologies, processing of physical material and production efficiency.



(Service Facility Layout - Hospital Layout)

⇒ Layout of a small hospital, some area of the layout is devoted for receiving patients, accounts, discharge patients and the dominant consideration in the application of medical technology such as surgery, radiology, laboratory tests, patients rest, patient feeding etc.

Warehouse Layout

warehouse layout consideration;

⇒ primary decision is where to locate each department relative to the dock.

⇒ the following areas must be perfectly defined when designing a warehouse layout;

(i) Loading and unloading areas
(ii) Reception area
(iii) Storage area
(iv) Picking area
(v) Dispatch area.

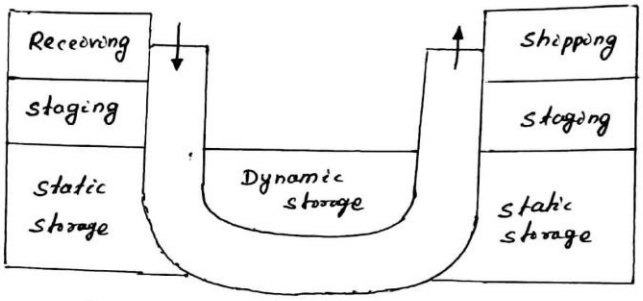
⇒ when deciding on the internal and external layout of a warehouse, there are three possible scenarios that could necessitate a different assignment of space such as;

(i) Installation of new warehouse
(ii) The extension of existing facilities.
(iii) Reorganization of those currently operating.

⇒ warehouse layout of a facility must covers all these needs;

(i) making the most of the available space

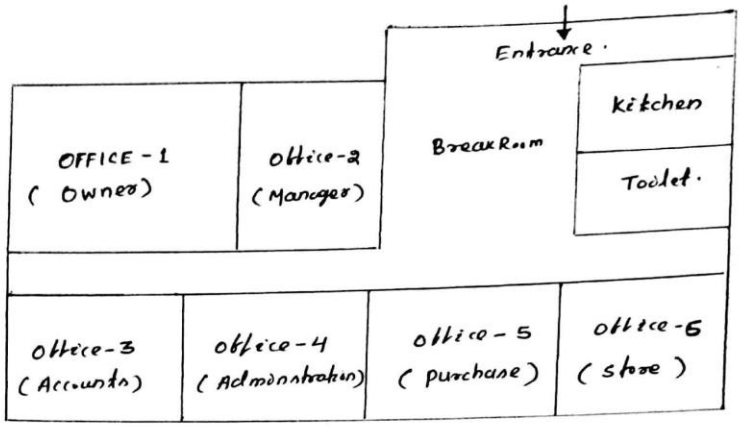
(ii) Reducing the handling of goods to a minimum.
(iii) Providing easy access to the stored product.
(iv) Having the highest rotation ratio possible.
(v) Offering maximum flexibility in the positioning of products.
(vi) Controlling the amount stored.
(vii) The useage of cross-docking modifies the traditional warehouse layout; more dock, less storage space and less order picking.



(Example: U-shape Warehouse Layout)

Office Layout

⇒ office layout is the arrangement of equipment within the available floor space.
⇒ The arrangement of space involved so that all the equipment, supplies, procedure and personal function at maximum efficiency.
⇒ office layout means the systematic arrangement of office equipment, machines and furniture and providing adequate space to office personnel for regular performance of work with efficiency.
⇒ The office layout is based on the principle of division of labour. If the principle of division of labour is applied every job of an office can be divided into many section.
⇒ The main objective of office layout are;
(i) Effective utilization of available floor space.
(ii) Office supervision is made more easy & convenient.
(iii) Good working conditions should be provided to each employees.
(iv) Employee's satisfaction
(v) Adequate space between desks, table and chairs for free movement.
(vi) Both power (electricity) and telephone service is made available whenever necessary.
(vii) Should be free from external noise and disturbance.



(Example of Office Layout)

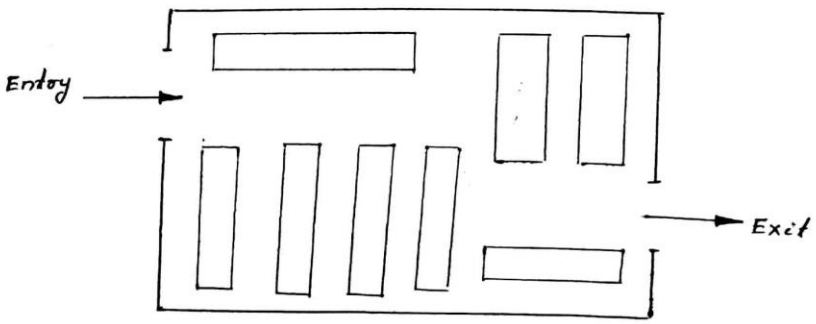
Advantages

- No waste of time and energy of office personnel.
- Promotes efficiency of staff
- Proper utilization of floor space.
- Easy supervision.
- Speed on inter-communication
- Better use of machine and equipment.

Prepared by.
Er. Manoj Kumar Rout

Retail- Store Layout

- A well-planned retail store layout allows a retailer to maximize the sales for each square foot of them allocating selling space.
- A store-layout generally shows the size and location of each department, any permanent structure, fixture locations and customer traffic pattern.
- Each floor plan and store layout will depend on the type of products sold, the building location and how much the business can afford to put into the overall store design.
- A solid floor plan is the perfect balance of ultimate customer experience and maximized revenue per square foot



35 (Straight Floor plan - Retail Store Layout)

Design of Product Layout

In product layout, equipment or departments are dedicated to a particular product line for material movement. It makes sense when the batch size of a given product or part is large relative to the number of different products or parts produced.

Assembly Line

- The assembly line refers to progressive assembly linked by some ~~form of~~ material-handling device.
- ⇒ The assembly line, some form of pacing is present and the allowable processing time equivalent for all workstations.
- ⇒ The application of assembly line includes toys, appliances, autos, clothings and wide variety of electronics components.
- ⇒ Various types of line assembly are;
  - (i) Material handling devices (belt or roller conveyor, overhead crane)
  - (ii) Line configuration (U-shape, straight, branching)
  - (iii) Pacing (mechanical, human)
  - (iv) Product mix (One product or multiple products)
  - (v) Workstation characteristics (worker may sit, stand, walk with the line or ride the line)
  - (vi) Length of the line (Few or Many workers)

Line Balancing

- ⇒ Line balancing in a layout means arrangement of machine capacity to secure relatively uniform flow at capacity operation.
- ⇒ In other words layout which has equal operation times at the successive operation in the process as whole.
- ⇒ The most common assembly-line is a moving conveyor that passes a series of workstations in a uniform time interval called the workstation cycle time.
- ⇒ The work performed at each station is made up of many bits of work, termed task, elements and work unit which are described by motion-time analysis.
- ⇒ The total work to be performed at a workstation is equal to the sum of the tasks assigned to that workstation.
- ⇒ Product layout requires line balancing and if any production line remain unbalanced machinery utilization may be poor. The machine in the line will operates only half of the time.
- ⇒ Example, a bakery would not be in balance, if the oven continuously baked loaves at the rate of 600 per hour and wrapping machine could only wrap 600 loaves per hour. So the production line required line balancing. (36)

⇒ The line-balancing problem is one of assigning all tasks to a series of workstations so that each workstation has no more than, can be done in the workstation cycle time and so that the unassigned (idle) time across all workstation is minimized.

Method of Line Balancing

(i) The one possibility in the right direction, at least as far as balancing the line is concerned, would be increased the output.

(ii) The second possibility is that another product may be made close to the first one so that some idle machines used jointly.

(iii) The third possibility may be to estimate the output of the last work station. This can be taken as the minimum output of all the intermediate work stations.

Objectives of Line Balancing

⇒ A balanced layout eliminates bottleneck operations as well as prevents the unnecessary duplication of equipment capacity.

⇒ Line balancing is a major consideration in layout because a lack of balance can most easily hinder the production.

⇒ For line balancing it is not essential that output of each operation should be same but to see that output of fastest machines should be multiple of the output of the remaining other machines.

Line Balancing Procedures

1. Draw and label a precedence diagram
2. Calculate desired cycle time required for the line.
3. Calculate theoretical minimum number of workstations.
4. Group elements into workstations, recognizing cycle time and precedence constraints
5. Calculate efficiency of the line.
6. Determine, if the theoretical minimum number of workstation or an acceptable efficiency level has been reached, if not, go back to step-4.

Formula

(i) Workstation cycle time (C) = $\frac{\text{Production time per day}}{\text{Required output per day (in units)}}$

(ii) Theoretical minimum no. of workstation (N_t) $= \dfrac{\text{Sum of task times } (T)}{\text{cycle Time } (C)}$

(iii) Desired cycle time (C_d) $= \dfrac{\text{Production time available}}{\text{Desired units of output}}$

(Actual cycle time $\leq$ Desired cycle time)

(iv) Line Balancing Performance Measures;

(a) Efficiency (E) $= \dfrac{\sum_{i=1}^{j} t_i}{n\, C_a}$

(b) Minimum no. of workstation (N) $= \dfrac{\sum_{i=1}^{j} t_i}{C_d}$

where, t_i = completion time for element 'i'
j = no. of work element
n = actual no. of workstations
C_a = actual cycle time
C_d = desired cycle time.

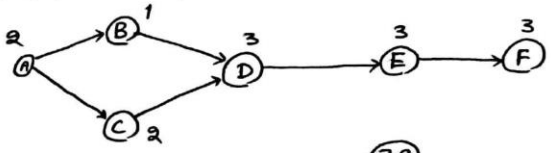
Example

The Mcdonald, burger, Bhubaneswar is revamping its order processing and burger making procem. The demand for burger is 120 per night (5:00pm to 1:00 am). In order to deliver fresh burger fast, six elements must be completed.

Work Element	Precedence	Time (Mints)
A. Receive order	----	2
B. Shape dough	A	1
C. Prepare topping	A	2
D. Assemble Burger	B, C	3
E. Bake Burger	D	3
F. Deliver Burger	E	3

Soln

Step-1; Draw & label a precedence diagram



(38)

Step-2 ; calculate the desired cycle time required for line

$$\text{Desired cycle time } (C_d) = \frac{\text{Production time available}}{\text{Desired units of output}}$$

Production time available = 8 hours × 60 = 480 min.

Desired units of output = 120 per night

$$= \frac{480}{120} = 4 \text{ mins.}$$

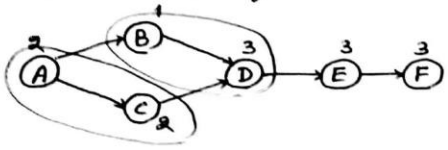
Step-3 ; calculate the theoritical minimum number of workstations.

$$N = \frac{\sum_{i=1}^{j} t_i}{C_d}$$

$$= \frac{2+1+2+3+3+3}{4} = \frac{14}{4} = 3.5 \simeq 4.$$

Step-4 ; Group element into workstations.

Recognize there are cycle time and precedence constraints.



Actual cycle time = 4 min.

Actual no. of workstations = 4.

Step-5 ; calculate the efficiency of the line.

$$E = \frac{\sum_{i=1}^{j} t_i}{n C_a} = \frac{2+1+2+3+3+3}{4 \times 4} = \frac{14}{16} = 87.5\%$$

Step-6 ; check if performance measures (. are satisfactory or not.

Actual number of workstations = 4

Efficiency of the line = 87.5%.

Theoritic number of workstations = 4.

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Problems

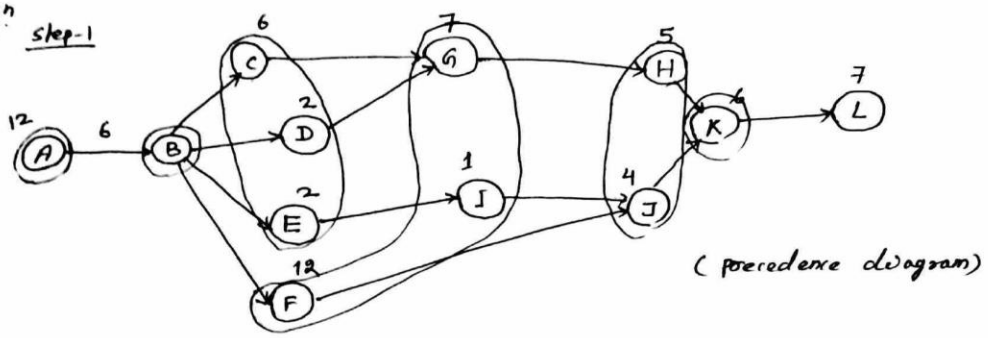
An assembly consists of the following elements as given table below;

Task	A	B	C	D	E	F	G	H	I	J	K	L
Immediate Predecessor	Nil	A	B	B	B	B	C,D	G	E	I,F	H,J	K
Task Time	12	6	6	2	2	12	7	5	1	4	6	7

The production rate required is one assembly every 15 minutes. Determine no. of workstations required so as to minimize the balance-delay.

Soln

step-1



(precedence diagram)

step-2

$$\text{cycle time} = \frac{\text{Production time per day}}{\text{output per Day}} = 15 \text{ mins.}$$

step-3

$$\text{Number of workstation} = \frac{\text{Sum of total task Times}}{\text{cycle time}} = \frac{70}{15} = 4.67 \simeq 5$$

step-4 Group element into work stations. Recognize there are cycle time and precedence constraints.

Actual cycle time = 15

Actual no. of workstation = 6

step-5

$$\text{Efficiency} = \frac{\text{Sum of all task time}}{(\text{Actual no. of workstations}) \times (\text{cycle time})} = \frac{70}{(6)(15)}$$

$$= 0.778 \text{ or } 77.78\%.$$

step-6 check if performance measures are satisfactory or not.

Actual no. of workstation = 6

Efficiency of the line = 77.78%.

Theoritic no. of workstation = 5.

Computerized Relative Allocation of Facilities Technique (CRAFT)

CRAFT algorithm was originally developed by Armour and Buffa. It is an improvement algorithm. It starts with an initial layout and improves the layout by interchanging the departments pairwise so that the transport cost is minimized. The algorithm continues until not further interchanges are possible to reduce the transportation cost. The result given by CRAFT is not optimum in terms of minimum cost of transportation. But the result will be good and close to optimum in majority of applications. Hence, CRAFT is mainly a heuristic algorithm. Unfortunately, plant layout problem comes under combinatorial category. So, usage of efficient heuristic like CRAFT is inevitable for such problem.

CRAFT requirements

1) Initial layout
2) Flow data or Load summary
3) Cost per unit distance
4) Total number of departments
5) Fixed departments Number of such departments Location of those departments
6) Area of departments.

CRAFT Procedure:

The steps of CRAFT algorithm are summarized below:

Step1. Input:

a) Number of departments
b) Number of interchangeable departments
c) Initial layout
d) Cost matrix
e) Flow matrix (Load summary)
f) Area of departments.

Step 2. Compute centroids of departments in the present layout.
Step 3. Form distance matrix using the centroids.
Step 4. Given data on flow, distance and cost, compute the total handling cost of the present layout.
Step 5. Find all the possible pairwise interchanges of departments based on common border or equal area criterion. For each possibility, interchange the corresponding centroids and compute approximate costs.
Step 6. Find the pair of departments corresponding to the minimum handling cost from among all the possible pairs of interchanges.

Inventory Management

Introduction:

- A complete list of items such as property, goods in stock, or the contents of a building.
- In the supply chain one of the key variables which has to be managed is inventory. The inventory includes a vast spectrum of materials that is being transferred, stored, consumed, produced, packaged, or sold in one way or another during a firm`s normal curse of business.
- The planning, storing, moving and accounting for inventory is the basis for all logistics

What is an Inventory?

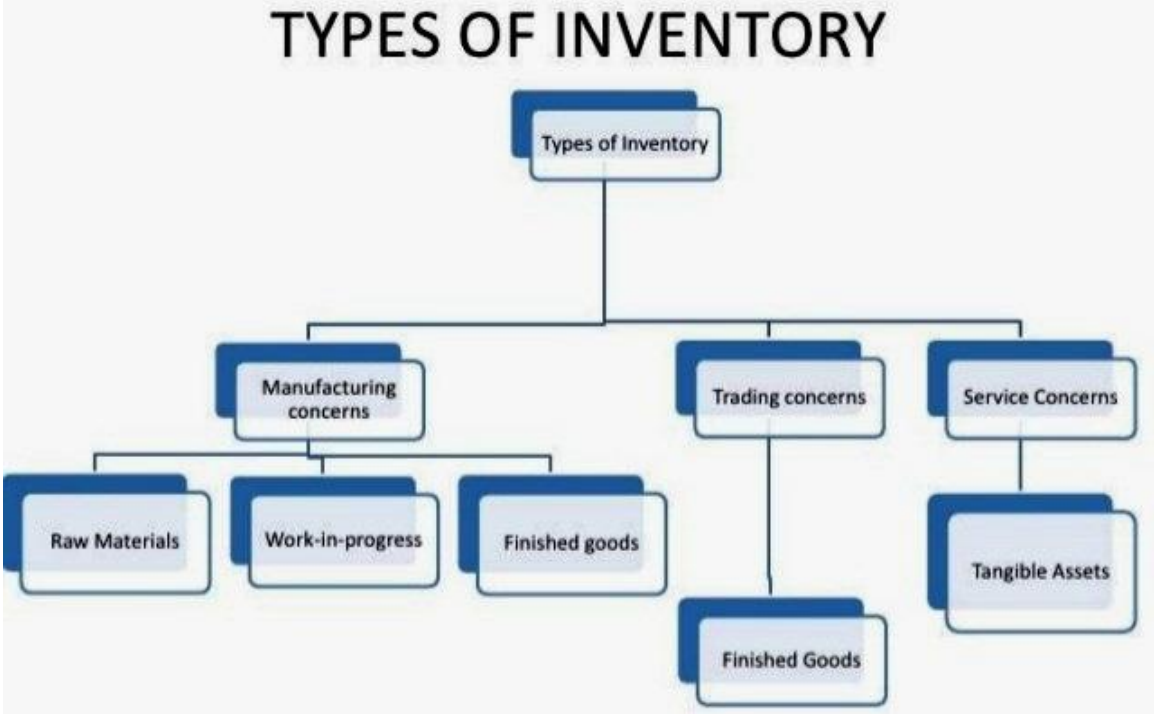
1) Inventory is an accounting term that refers to goods that are in various stages of being made ready for sale, including:
2) Finished goods (that are available to be sold)
3) Work-in-progress (meaning in the process of being made)
4) Raw materials (to be used to produce more finished goods)
5) Inventory is generally the largest current asset – items expected to sell within the next year – a company has.
6) Inventory has a financial value, which for accounting purposes is considered a floating asset. However, it may be very difficult to convert physical inventory into liquid assets, hence the inventory is very risky investment

Thus one goal in operations is to keep the level of inventory in the supply chain as to low as possible thus freeing up funds for other purposes.



Figure: Meaning of Inventory

Types of Inventory



Reasons for Inventories

i. Improve customer service -Provides immediacy in product availability

ii. Encourage production, purchase, and transportation economies

iii. Allows for long production runs
   1) Takes advantage of price-quantity discounts
   2) Allows for transport economies from larger shipment sizes
   3) Act as a hedge against price changes

iv. Allows purchasing to take place under most favorable price terms

v. Protect against uncertainties in demand and lead times -Provides a measure of safety to keep operations running when demand levels and lead times cannot be known for sure

vi. Act as a hedge against contingencies -Buffers against such events as strikes, fires, and disruptions in supply

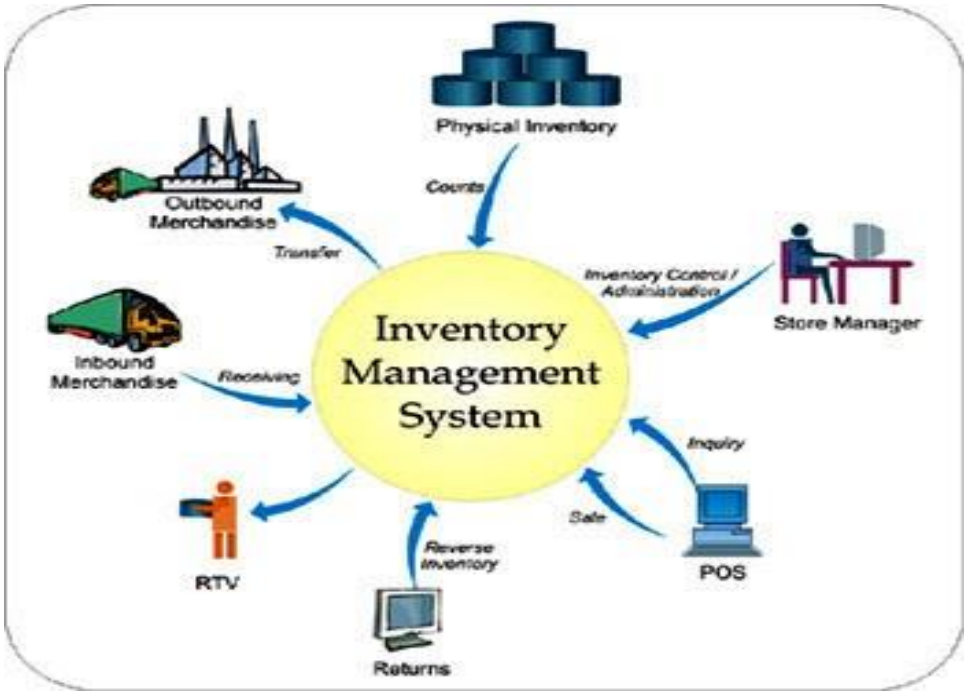


Figure: Inventory Management

Main purpose of inventory management

1) Inventory management mean methods that are used for organizing, holding and replenishment of stock. The main goal – keep the inventories on optimal level, without stockouts and excesses. For this, dependent tasks should be solved:

2) To have enough inventories to fulfill orders of outer and inner clients in a manner satisfying them. Or with other words – assure high level of customer service. Usually this customer service level is measured as availability (fill rate).

3) To minimize inventory carrying costs, first of all capital tied into inventories for maximizing the company`s profitability.

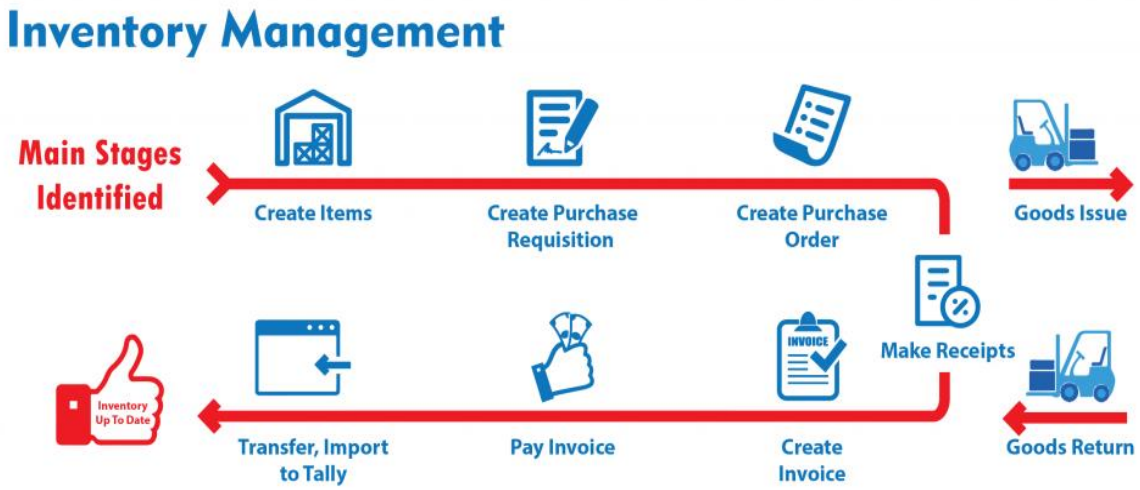


Figure: System of Inventory Management

Inventory Management Objectives

1) Good inventory management is a careful balancing act between stock availability and the cost of holding inventory.
2) Service objectives -Setting stocking levels so that there is only a specified probability of running out of stock
3) Cost objectives -Balancing conflicting costs to find the most economical replenishment quantities and timing

To ensure continuous supply of materials spares and finished goods so that production should not suffer at any time and the customer's demand should also be met.

i. To avoid both overstocking and under-stocking of inventory.
ii. To maintain investment in inventories at the optimum level as required by the operational and sales activities.
iii. To keep materials cost under control so that they contribute in reducing cost of production and overall cost.
iv. To eliminate duplication in ordering or replenishing stocks. This is possible with the help of centralizing purchases.
v. To minimize losses through deterioration, pilferage, wastages and damages.
vi. To design proper organisation for inventory management. Clear cut accountability should be fixed at various levels of the organisation.
vii. To ensure perpetual inventory control so that materials shown in stock ledgers should be actually lying in the stores.

viii. To ensure right quality goods at reasonable prices. Suitable quality standards will ensure proper quality stocks. The price analysis, the cost analysis and value analysis will ensure payment of proper prices.

ix. To facilitate furnishing of data for short term and long term planning and control of inventory.

Factors Influencing Inventory Management & Control

1) The degree of changes in the nature of the product from raw materials to final product at various stages of transformation viz., final assembly and packaging determines the nature of inventory control operation.

2) Process capability is characterized by processing time of various operations e.g. the replenishment lead time directly influence the size of inventory.

3) The capacity of production system as well as the nature of storage facilities considerably affects the inventory policy of the organization.

4) The nature of the production system influence Inventory control; It is characterized by the number of manufacturing stages and the interrelationship between various production operations e.g. in product-line system, inventory control is simpler than in job-type system.

5) Amount of Protection against Shortage influence Inventory Control; There is always variation in demand and supply of the product. The protection against such unpredictable variations can be done by means of buffer stocks.

6) Organizational Factors influence Inventory Control which related to the policies, traditions and environment of any industrial enterprise. Some of these are

- **i.** Labour relation policies of the organisation
- **ii.** Amount of capital available for stock
- **iii.** Rate of return on capital available if invested elsewhere.

7) There are several other factors related to the overall business environment of the region that influence Inventory Control viz:

- **i.** Inflation
- **ii.** Strike situation in communication facilities.
- **iii.** Wars or some other natural calamities like famines, floods, etc.
- **iv.** Difference between input and output

Effective Inventory Management

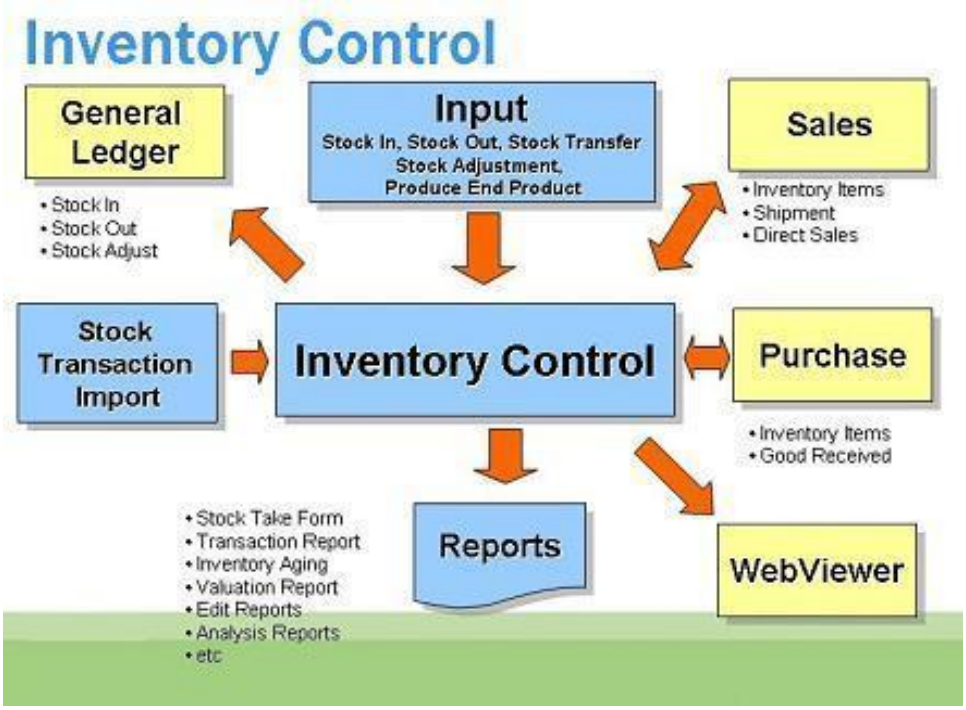


Figure: Inventory Management Control

i. Inventory management involves determining, how to order products and how much to order as well as identifying the most effective source of supply for each item in each stocking location.

ii. Inventory management includes all activities of planning, forecasting and replenishment.

iii. The main purpose of inventory management is minimization differences between customers demand and availability of items.

iv. These differences have caused by three factors:

1) customers demand fluctuations,
2) suppliers delivery time fluctuations and
3) inventory control accuracy

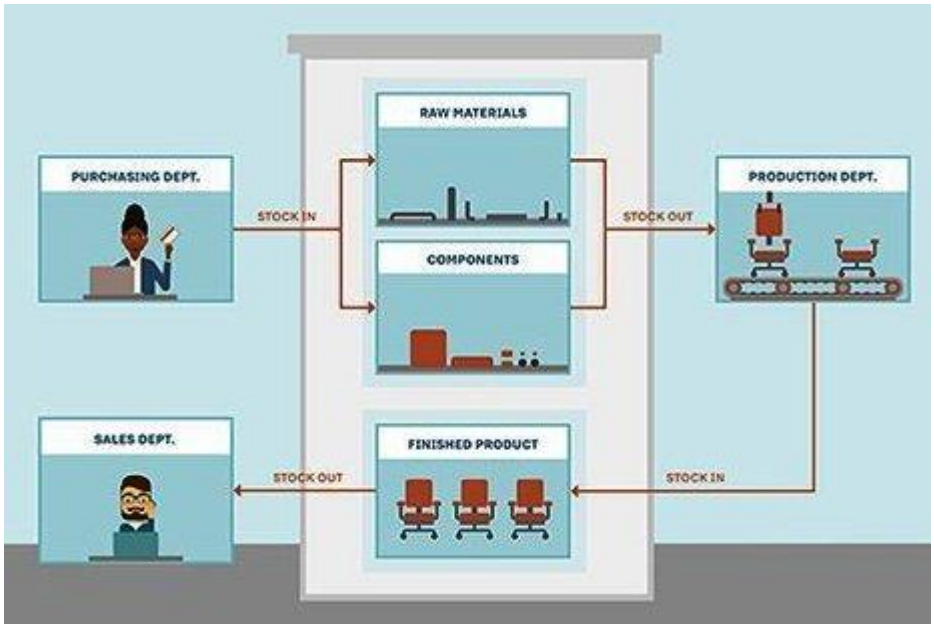


Figure: Effective Inventory Management in a Manufacturing Organization

Inventory management and control

The primary objectives of the management and control of inventory are as given below.

1) To minimize the possibility of disruption in the production schedule for want of raw materials, consumables, spares and other stores items.
2) To keep down the capital investment in inventories.
3) To ensure sufficient stock of semi-finished products so that there is no disruption in the production schedule.

To ensure adequate stock of finished product to meet the delivery requirement of the customer

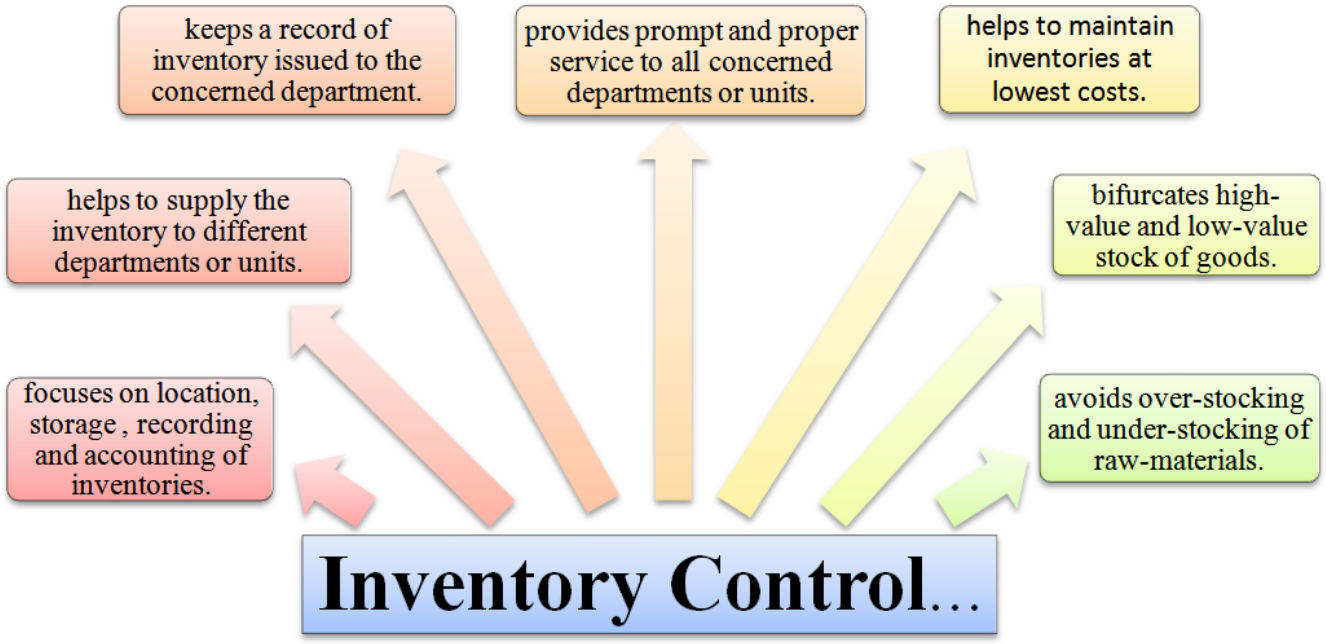


Figure: Inventory Management & Control Procedure

Inventory Management and Control Techniques

1) The inventory management and control techniques are important due to the following reasons.

2) A mismanaged inventory can lead to an unnecessary increase in the working capital. Effective inventory management leads to low storage costs, which in turn leads to an increase in the organizational profits.

3) It can help to satisfy the customers by providing them with the products they need in the swiftest manner. Poor inventory management leads to lower availability of the products and higher delivery time.

4) Item stored in inventory over a long period may spoil. This leads to unnecessary increase in the operational costs. Proper inventory management can help reduce these costs greatly.

5) If the organization has inventories scattered in various locations, it need to have a proper system to manage these inventories on the basis of demand and supply.

There are several techniques for inventories management and control. Some of them are described below;

- ABC analysis -Always Better Choice
- HML Analysis– H-High Price Items; M-Medium Price Items; L-Low Price Items
- VED analysis –vital (V), essential (E), &desirable (D).
- SDE analysis –scarce (S), difficult (D), and easy (E).
- FSN analysis- F (Fast moving), S (Slow moving), and N (Non- moving).
- Economic order quantity (EOQ)
- Just in time(JIT)

ABC Analysis -Always Better Choice

It is based on the principle that a small portion of the items may typically represent the bulk of money value of the total inventory used in the production process, while a relatively large number of items may from a small part of the money value of stores.

Under this method, the inventory is classified into three categories, such as A, B and C. These categories are based upon the inventory value and cost significance.

1. Also, the number of items and values of each category are expressed as a percentage of the total. Items of high value and small in number are termed as 'A', items of moderate value and moderate in number are termed as 'B', and items of small in value and large in number are termed as 'C'.

2. Group 'A' items need closer control while for group 'C' items control can be relaxed. However sufficient safety stock of group 'C' items is required to be ensured.

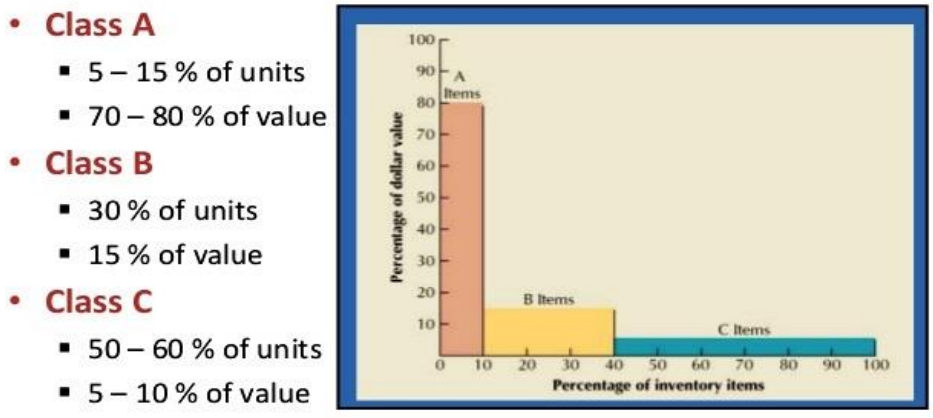


Figure: ABC Analysis

HML Analysis

The items under this analysis are classified based on their unit prices . They are categorized in three groups , which are as follows H-High Price Items; M-Medium Price Items & L-Low Price Items

Objectives of HML analysis:

1. Determine the frequency of stock verification
2. To keep control over the consumption at the department level
3. To evolve buying policy, to control purchase
4. To delegate the authority to different buyer
5. Determine the frequency of stock verification

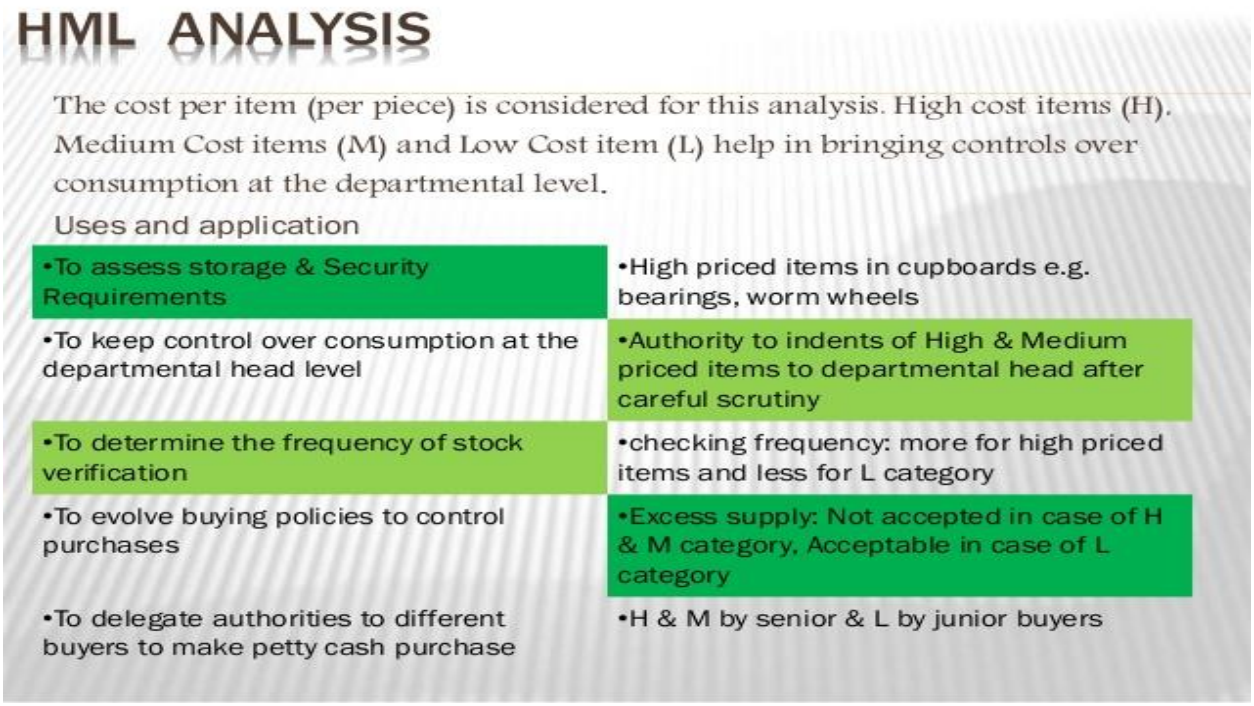


Figure: Application of HML Analysis

VED Analysis

1) VED analysis – It consists of classifying the inventory items as vital (V), essential (E), and desirable (D).

2) Vital items are those items for want of which the production comes to a complete halt.

3) These are normally long lead items and usually proprietary items.

4) Essential items are those items whose stock outs cost is very high while the desirable group are those items which does not cause serious production problems since alternatives can be used in case of stock out of these items.

SDE Analysis

1) SDE analysis – Under this analysis, items are classified as scarce (S), difficult (D), and easy (E).
2) This classification is done to decide the purchasing strategies.
3) Scarce items are those which are short in supply, imported or canalized through government agencies. Difficult items are those which are available indigenously but are not easy to procure while the easy items are those which are which are readily available in the market.

FSN Analysis

1) FSN analysis – This analysis is based on consumption figures of the items.
2) Under this analysis, inventory items are classified into three groups namely F (fast moving), S (slow moving), and N (non- moving).

Economic Order Quantity (EOQ)

- EOQ represents the most favorable quantity to be ordered each time fresh orders are placed.
- The quantity to be ordered is called economic order quantity because the purchase of this size of material is most economical.
- It is helpful to determine in advance as to how much should one buy when the stock level reaches the order level.
- If large quantities arc purchased, the carrying costs would be large. On the other hand, if small quantities are purchased at frequent intervals the ordering costs would be high.
- The economic order quantity is fixed at such a level so as to minimize the cost of ordering as well the cost of carrying the stock.
- It is the size of the order which produces the lowest cost of material ordered.

Economic order quantity (EOQ) is the ideal order quantity a company should purchase for its inventory given a set cost of production, demand rate and other variables. This is done to minimize variable inventory costs, and the equation for EOQ takes into account storage, ordering costs and shortage costs. The full equation is:

EOQ = √(2SD / H), or the square root of (2 x S x D / H).

S = Setup costs (per order, generally includes shipping and handling)
D = Demand rate (quantity sold per year)
H = Holding costs (per year, per unit)

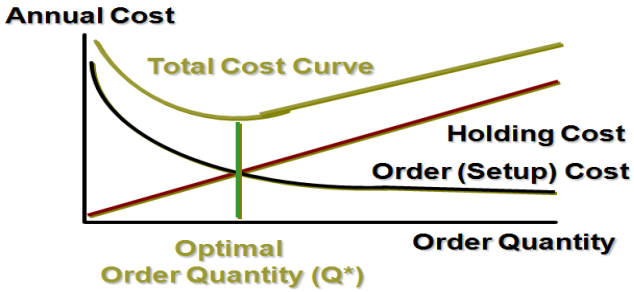


Figure: EOQ Model

Advantages of EOQ

1) The main advantage of the EOQ model is the customized recommendations provided regarding the most economical number of units per order.
2) Maintaining sufficient inventory levels to match customer demand is a balancing act for many small businesses.
3) EOQ model is that it provides specific numbers particular to the business regarding how much inventory to hold, when to re-order it and how many items to order.
4) The EOQ model requires a good understanding of algebra, effective EOQ models require detailed data to calculate several figures. The benefit to resolving the math is the ability to determine how much inventory should be attached to each order at the lowest possible costs.
5) The EOQ model assumes steady demand of a business product and immediate availability of items to be re-stocked. It does not account for seasonal or economic fluctuations.
6) Each material can be in the most economical quantity;
7) Purchasing an inventory control personnel automatically devote attention to the items that are needed only when required; and
8) Positive control can be easily exerted to maintain total inventory investment at the desired level, simply by manipulating the plant maximum and minimum values.

Disadvantages of EOQ

1) The orders are raised at irregular intervals which may not be convenient to the suppliers;
2) In case the lead time is very high supply of inventory may interpret;
3) EOQ may give you an order quantity which is much below the supplier minimum, and there is always a chance that the ordering level for an item has been reached but not noticed in which case a stock out may occur;
4) The items cannot be group and ordered at a time since the recorder points occur irregularly.

Example:
From the following particulars, calculate the Economic Order Quantity (EOQ):
Annual requirements=1,600 units
Cost of materials per units=Rs. 40
Cost of placing and receiving one order=Rs. 50
Annual carrying cost for inventory value=10%
EOQ = √(2SD / H), or the square root of (2 x S x D / H).

S = Setup costs (per order, generally includes shipping and handling)=1600
D = Demand rate (quantity sold per year)=50
H = Holding costs (per year, per unit)=40

EOQ = √(2SD / H)= √2x1600x50/40x10%=200 units.

Example:
A company makes bicycles. It produces 450 bicycles a month. It buys the tires for bicycles from a supplier at a cost of Rs.20 per tire. The company's inventory carrying cost is estimated to be 15% of cost and the ordering is Rs. 50 per order.
a .Calculate the EOQ
In this problem: D = annual demand = (2 tires per bicycle) x (450 bicycles per month) x (12 months in a year) = 10,800 tires
S = ordering cost = Rs.50 per order
H = carrying cost = (15%) x (Rs. 20 per unit) = Rs. 3.00 per unit per year
EOQ = Square root of { (2 x 10,800 x Rs 50) / Rs 3 = Square root of 400,000 = 600 tires The company should order about 600 tires each time it places an order.
b.What is the number of orders per year?
Number of orders per year = D / Q = 10,800 / 600 = 18 orders per year
c.Compute the average annual ordering cost.
Average annual ordering cost = (18 orders per year) x (Rs 50 per order) = Rs 900 per year
d.Compute the average inventory.
Average inventory = Q / 2 = 600 / 2 = 300 tires
e.What is the average annual carrying cost?
Average annual carrying cost = (average inventory) x (H) = (300 tires) x (Rs 3) = Rs 900 per year
f.Compute the total cost.
Total cost = (Average annual ordering cost) + (average annual carrying)
= (Rs 900) + (Rs 900) = Rs 1,800

MRP (Material Requirement Planning)

1) Material Requirements Planning (MRP) is a computer-based production planning and inventory control system. MRP is concerned with both production scheduling and inventory control.
2) It is a material control system that attempts to keep adequate inventory levels to assure that required materials are available when needed.
3) MRP is applicable in situations of multiple items with complex bills of materials.

Purpose of MRP:

The main purposes of MRP system are to control inventory levels. Assign operating priorities for items and plan capacity to load the production system which are;

1) **Inventory:** order the right item, order in the right quantity and order at the right time in order to receive the supplies at the right time.
2) **Priorities:** order with the right due date and keep the due date valid.
3) **Capacity:** plan for a complete load, plan an accurate load and plan for adequate time to view future load.

The major objectives of an MRP system are to simultaneously:

i. Ensure the availability of materials, components, and products for planned production and for customer delivery,
ii. Maintain the lowest possible level of inventory,
iii. Plan manufacturing activities, delivery schedules, and purchasing activities.

Objectives of MRP

The Objectives of MRP in operation management are;

a) To improve customer service by meeting delivery schedules promised and shortening delivery lead time
b) To reduce inventory cost by reducing inventory level.
c) To improve plant operating efficiency by better use of productive resources.
d) To provide the right parts at the right time to meet the schedules for completed products.
e) It determines the quantity and timing of finished goods demanded.
f) It determines the time phased requirements of the demand for materials, components and sub-assemblies over a specified planning time horizon.
g) It computes the inventories, work-in-process batch sizes and manufacturing and packing lead times.
h) It controls inventory by ordering materials and components in relation to orders received rather than ordering them from stock level point of view.

The three major inputs of an MRP system are the

1) Master Production Schedule(MPS)
2) Product Structure Records (Bill of Material File)
3) Inventory Status Records/File

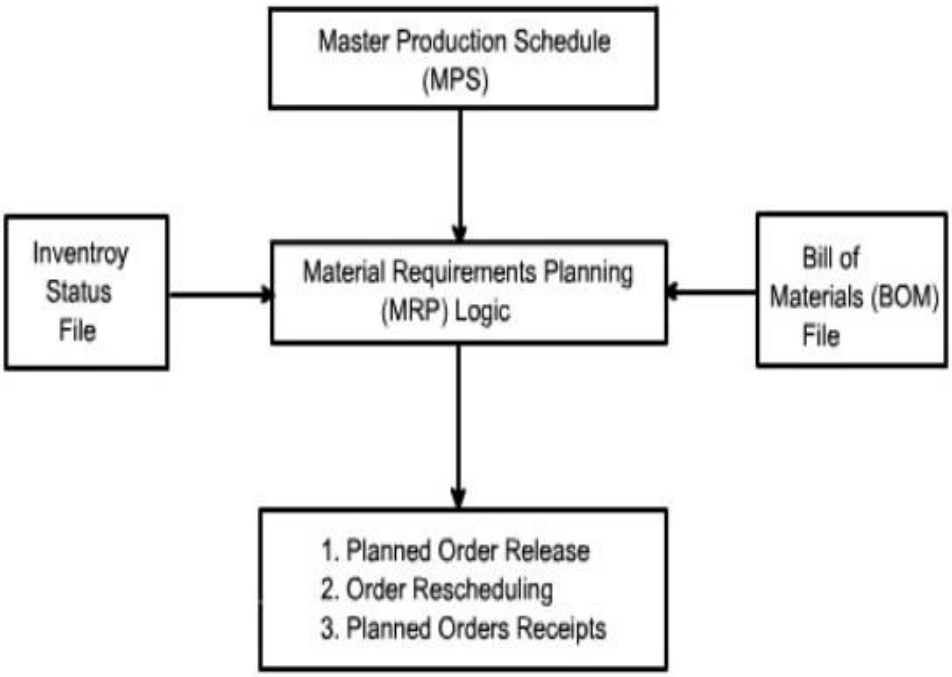


Figure: Material Requirements Planning (MRP) System

Master Production Schedule (MPS):

The demand for end items is scheduled over a number of time periods and recorded on a master production schedule (MPS). The master production schedule expresses how much of each item is wanted and when it is wanted. The MPS is developed from forecasts and firm customer orders for end items, safety stock requirements, and internal orders. MRP takes the master schedule for end items and translates it into individual time-phased component requirements.

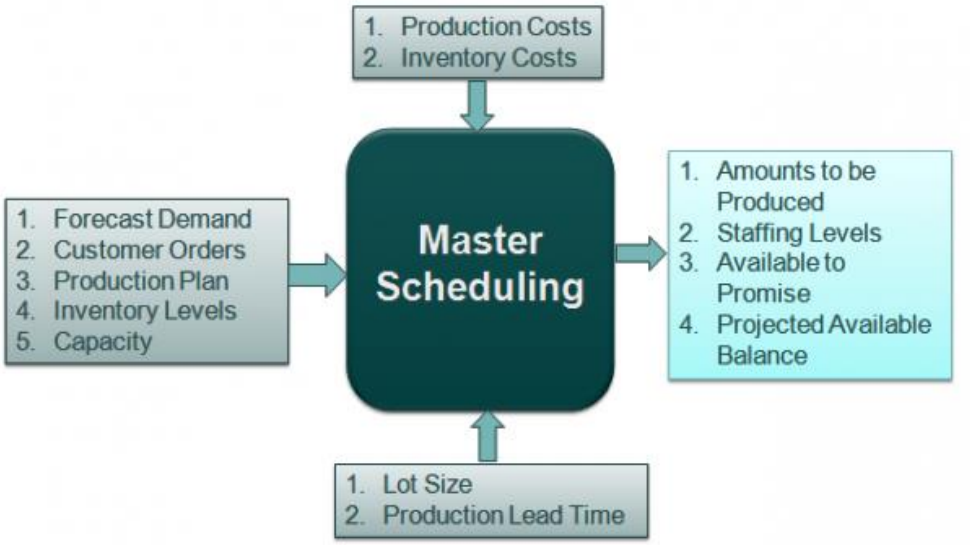


Figure: Master Production Schedule (MPS)

Product Structure Records:

The product structure records, also known as bill of material records (BOM), contain information on every item or assembly required to produce end items. Information on each item, such as part number, description, quantity per assembly, next higher assembly, lead times, and quantity per end item, must be available.

Inventory Status Records:

The inventory status records contain the status of all items in inventory, including on hand inventory and scheduled receipts. These records must be kept up to date, with each receipt, disbursement, or withdrawal documented to maintain record integrity. MRP will determine from the master production schedule and the product structure records the gross component requirements; the gross component requirements will be reduced by the available inventory as indicated in the inventory status records.

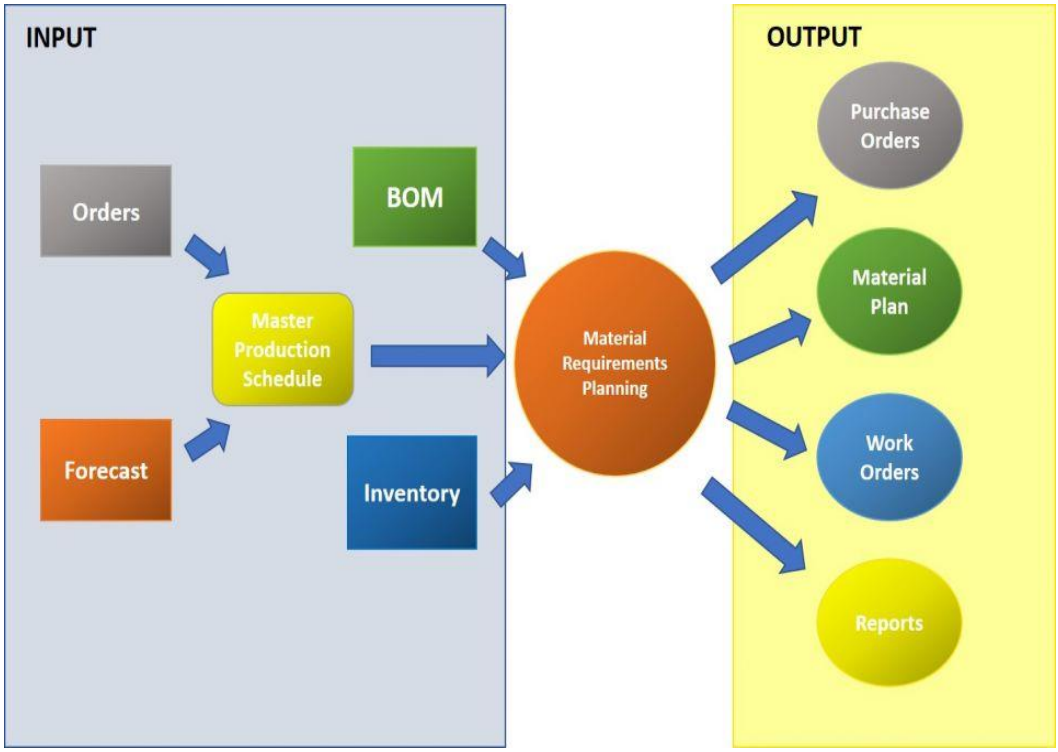


Figure: Input & Output of MRP System

MRP Procedure:

MPS procedure consolidates the independent demands of forecasts and customer orders to determine the requirements of the end products in each time bucket in the planning horizon. After netting the on-hand and on-order inventory, and offsetting the lead-time, the production schedule of the end products, MPS, is determined.

In MPS procedure, the available-to-promise (ATP) is also determined. MPS is then fed into the MRP procedure to determine the requirements of the lower level components and raw materials. The gross requirements of components are determined by calculating the planned order releases (POR) of the parents via single level BOM explosion.

The net requirements are calculated by subtracting the on-hand inventory and scheduled receipts (on-order) in each time bucket. After the consideration of lot-size, the net requirements are transformed into the planned order receipts. Planned order receipts appear in every period. Lead-time offsetting shifts the planned order receipts backward and derives the POR which are the MRP result of current item. The MRP procedure continues to explode the POR to obtain the gross requirements of its components. The MRP repeat the procedure until the POR of all the items are determined. The flow chart of the MRP procedure is described in Figure.

The net requirement in a period is determined in MRP procedure by the following formula,

Net requirement = Gross requirement – Available inventory

The available inventory for the first period is

Available inventory = On hand inventory + Scheduled receipts of the first period– Allocations – Backorders – Safety stock.

And, for the other periods

Available inventory = Projected available balance at the end of last period + Scheduled receipts of the current period

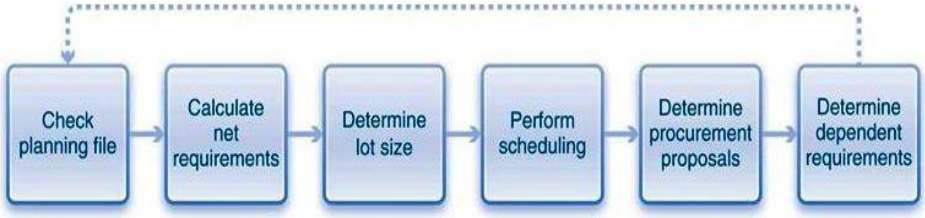


Figure: MRP Procedure

The Advantages of MRP

1) On time availability of the right materials required for production.
2) Little, if any, excess inventory
3) Timely delivery of manufactured goods to your customers
4) Optimal use of manufacturing resources
5) Decrease in capital cost due to decreased inventory levels and optimal use of production resources.
6) Collecting the business data for analysis and better planning.
7) Tracking & Forecasting Enhancement
8) Data Sharing Accessibility
9) Boost in Customer Aid
10) Easy to use, Integrated System

The Disadvantages of MRP

1) Suitable for make-to-stock manufacturers.
2) Customization Restrictions
3) Inflexible System; Not Compatible for Specific Organizations
4) Operation Process Re-Organization
5) Steep Cost for Installation/Operating
6) Material planning is highly dependent on inputs it receives from other systems or department. If input information is not correct than output for material planning will also be incorrect.
7) Material planning requires maintenance of robust database with all information pertaining inventory records, production schedule, etc. without which output again would be incorrect.
8) Material planning system requires proper training for end users, as to get maximum out of the system.
9) Material resource planning system requires substantial investment of time and capital.

JIT (Just in Time)

1) Just in time technique can be risky, especially if it is not implemented correctly, but if the organization can do it in a right way then it can be most rewarding.

2) Just in time technique involves having item received in the organization just at the time when it is needed.

3) It can be risky because there may be so many variables which may not be always perfectly predictable.

4) **Just-in-time** (**JIT**) manufacturing, also known as **just-in-time** production or the Toyota Production System (TPS), is a methodology aimed primarily at reducing **times** within production system as well as response **times** from suppliers and to customers.



Figure: Just in Time (JIT)

Objectives of JIT

The objectives of JIT are to change the manufacturing system gradually rather than drastically:

1) To be more responsive to customers,
2) To have better communication among departments and suppliers,
3) To be more flexible,
4) To achieve better quality,
5) To reduce product cost.

JIT as a Philosophy

- Elimination of waste:
- Continuous improvement
- Problems as opportunities
- Quality at the source
- Simplification
- Visual Control
- Focus on Customer Needs
- Production to Customer Demand
- Respect for Individual

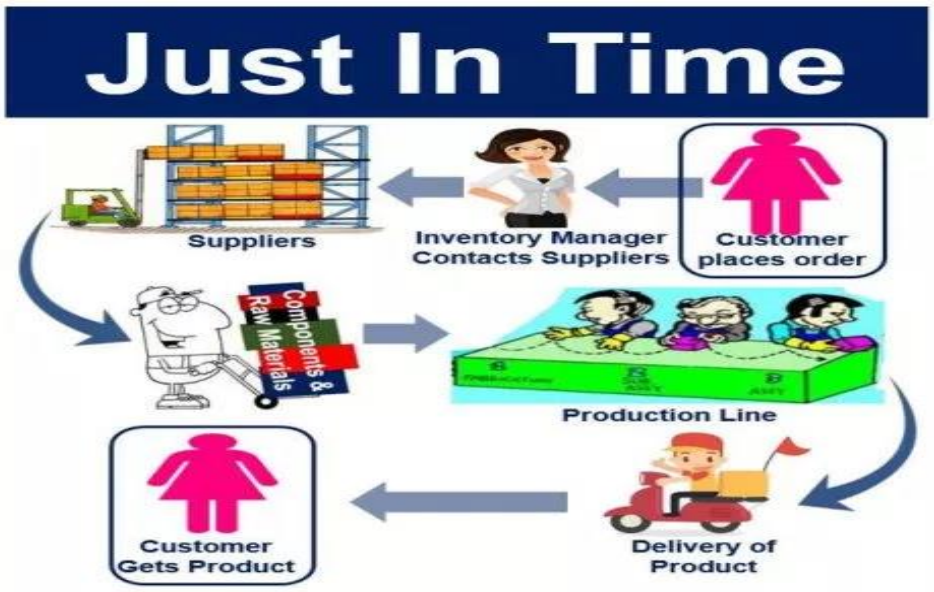


Figure: Example of JIT System

Advantages of JIT

1) There should be minimal amounts of inventory obsolescence, since the high rate of inventory turnover keeps any items from remaining in stock and becoming obsolete.
2) Since production runs are very short, it is easier to halt production of one product type and switch to a different product to meet changes in customer demand.
3) The very low inventory levels mean that inventory holding costs (such as warehouse space) are minimized.
4) The company is investing far less cash in its inventory, since less inventory is needed.
5) Less inventory can be damaged within the company, since it is not held long enough for storage-related accidents to arise. Also, having less inventory gives materials handlers more room to maneuver, so they are less likely to run into any inventory and cause damage.
6) Production mistakes can be spotted more quickly and corrected, which results in fewer products being produced that contain defects.

Disadvantages of JIT

1) A supplier that does not deliver goods to the company exactly on time and in the correct amounts could seriously impact the production process.
2) A natural disaster could interfere with the flow of goods to the company from suppliers, which could halt production almost at once.

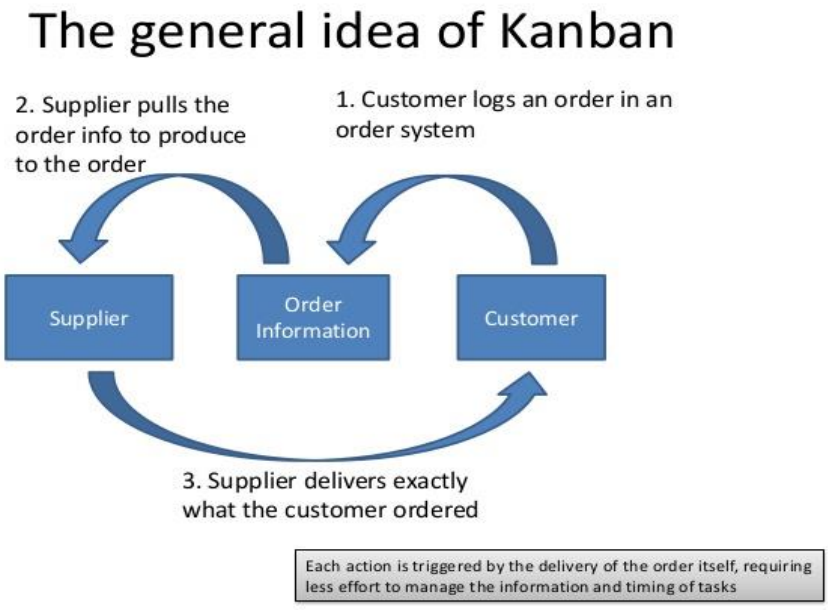
3) An investment should be made in information technology to link the computer systems of the company and its suppliers, so that they can coordinate the delivery of parts and materials.

4) A company may not be able to immediately meet the requirements of a massive and unexpected order, since it has few or no stocks of finished goods.

KANBAN (Japanese Inventory System)

Kanban (literally signboard or billboard in Japanese) is a scheduling system for lean and just-in-time (JIT) production. Kanban is a system to control the logistical chain from a production point of view, and is an inventory control system.

1) Kanban was developed by Taiichi Ohno, an industrial engineer at Toyota, as a system to improve and maintain a high level of production.
2) Problem areas are highlighted by reducing the number of kanban in circulation.
3) The Kanban Method is as an approach to incremental, evolutionary process and systems change for organizations. It uses a work-in-progress limited pull system as the core mechanism to expose system operation (or process) problems and stimulate collaboration to continuously improve the system.
4) Visualization is an important aspect of Kanban as it allows understanding the work and the workflow.



The basic principles Kanban System:

1. Start with existing process
2. The Kanban method does not prescribe a specific set of roles or process steps.
3. The Kanban method starts with existing roles and processes and stimulates continuous, incremental and evolutionary changes to the system. The Kanban method is a change management method.
4. Agree to pursue incremental, evolutionary change
5. Respect the current process, roles, responsibilities and titles
6. Leadership at all levels
7. Acts of leadership at all levels in the organization, from individual contributors to senior management, are encouraged.

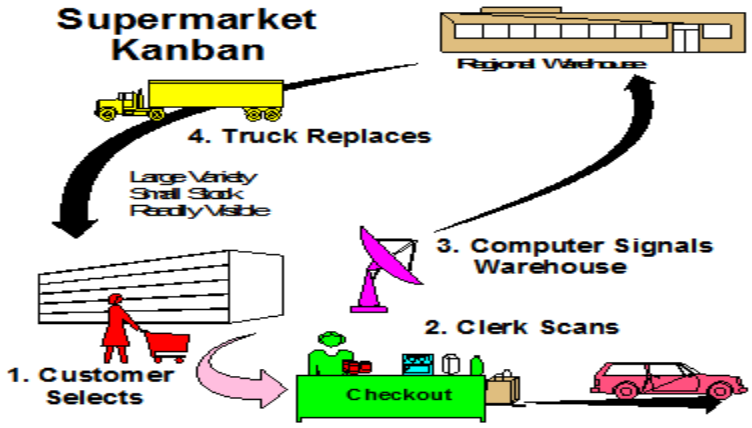


Figure: Example of kanban Scheduling of Super Market

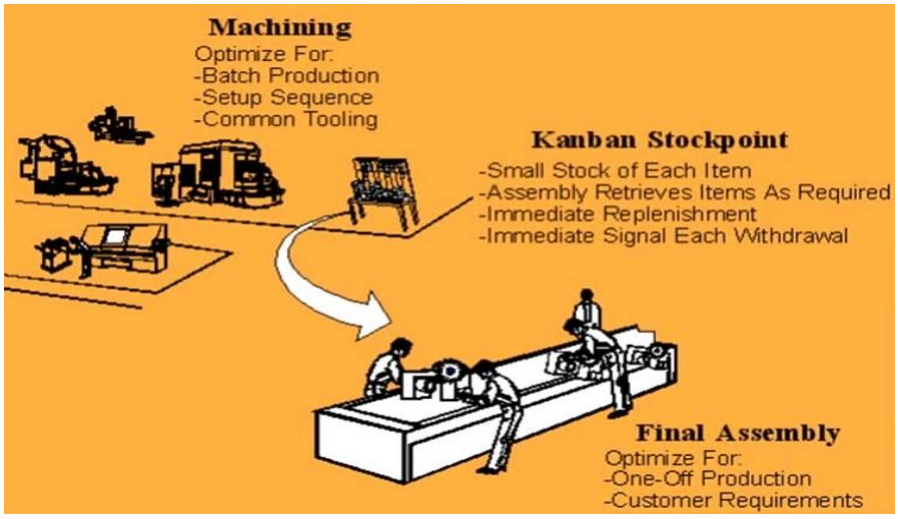


Figure: Example of kanban System in Manufacturing Environment (Assembly Line)

Types of kanban systems

In a kanban system, the workstations communicate with each other through their cards, where each container has a kanban associated with it. Economic Order Quantity is important. The two most important types of kanban are:

Production (P) Kanban: A P-kanban, when received, authorizes the workstation to produce a fixed amount of products. The P-kanban is carried on the containers that are associated with it.

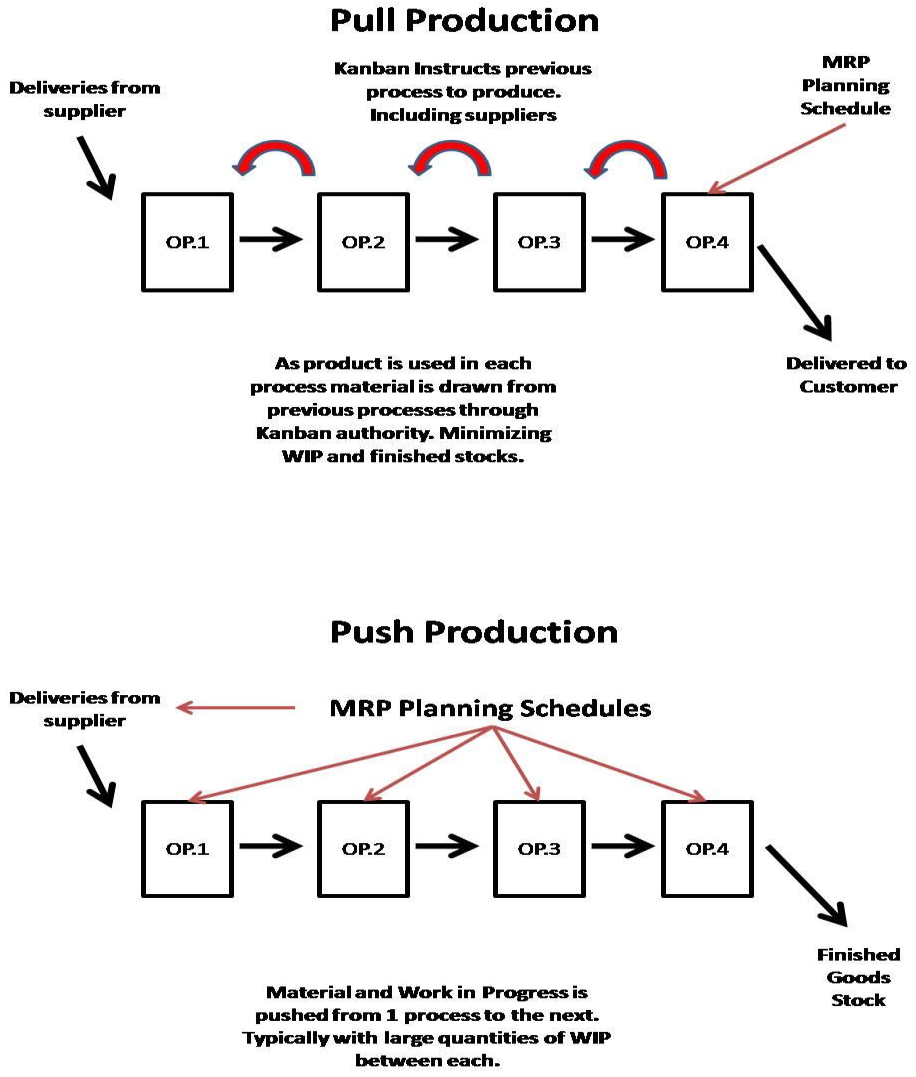


Figure: Example of Production (Pull & Push) Kanban

Transportation (T) Kanban: A T-kanban authorizes the transportation of the full container to the downstream workstation. The T-kanban is also carried on the containers that are associated with the transportation to move through the loop again.

*Kanban is a scheduling system for lean manufacturing and just-in-time manufacturing (JIT). Taiichi Ohno, an industrial engineer at Toyota, developed kanban to improve manufacturing efficiency. Kanban is one method to achieve JIT. The system takes its name from the cards that track production within a factory. For many in the automotive sector, kanban is known as the "Toyota nameplate system" and as such the term is not used by some other automakers. Toyota, for example, has six simple rules, and close monitoring of these rules is a never-ending task, thereby ensuring that the kanban does what is required.

Toyota's Six Rules

Toyota has formulated six rules for the application of kanban:

1) Each process issues requests (kanban) to its suppliers as it consumes its supplies.
2) Each process produces according to the quantity and sequence of incoming requests.
3) No items are made or transported without a request.
4) The request associated with an item is always attached to it.
5) Processes must not send out defective items, to ensure that finished products will be defect-free.
6) Limiting the number of pending requests makes the process more sensitive and reveals inefficiencies.

Kanban (cards)

Kanban cards are a key component of kanban and they signal the need to move materials within a production facility or to move materials from an outside supplier into the production facility. The kanban card is, in effect, a message that signals a depletion of product, parts, or inventory. For more production, and the kanban card signals demand for more product so kanban cards help create a demand-driven system. It help to lower inventory levels, helping companies implementing such systems be more competitive.

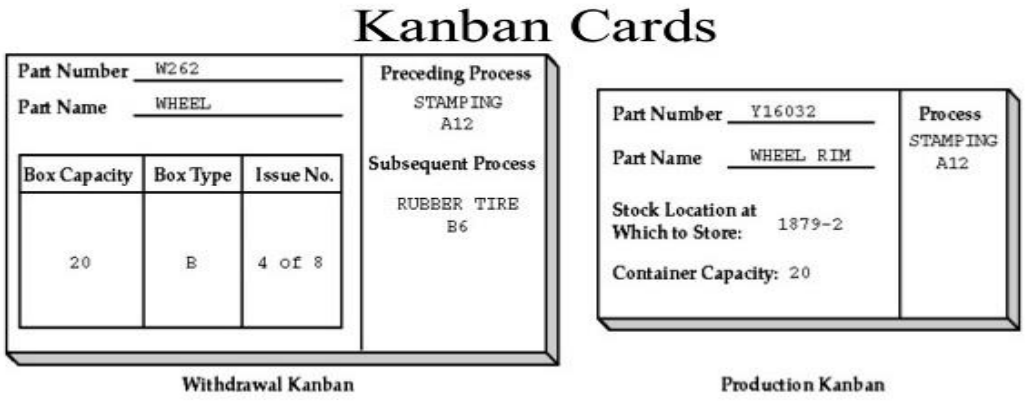


Figure : Kanban Card

Three-Bin System

An example of a simple kanban system implementation is a "three-bin system" for the supplied parts, where there is no in-house manufacturing. One bin is on the factory floor (the initial demand point), one bin is in the factory store (the inventory control point), and one bin is at the supplier. The bins usually have a removable card containing the product details and other relevant information, the classic kanban card. When the bin on the factory floor is empty (because the parts in it were used up in a manufacturing process), the empty bin and its kanban card are returned to the factory store (the inventory control point). The factory store replaces the empty bin on the factory floor with the full bin from the factory store, which also contains a kanban card. The factory store sends the empty bin with its kanban card to the supplier. The supplier's full product bin, with its kanban card, is delivered to the factory store; the supplier keeps the empty bin. This is the final step in the process. Thus, the process never runs out of product and could be described as a closed loop, in that it provides the exact amount required, with only one spare bin so there is never oversupply.

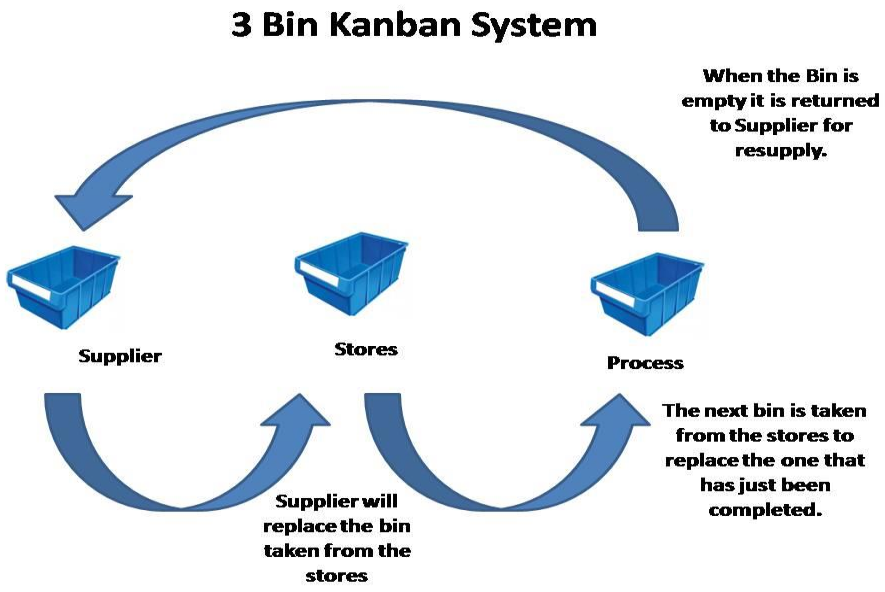


Figure: Three Bin Kanban System

Electronic kanban

Many manufacturers have implemented electronic kanban (E-kanban) systems. These help to eliminate common problems such as manual entry errors and lost cards. E-kanban systems can be integrated into enterprise resource planning (ERP) systems, enabling real-time demand signaling across the supply chain and improved visibility. Data pulled from E-kanban systems can be used to optimize inventory levels by better tracking supplier lead and replenishment times. E-kanban is a signaling system that uses

a mix of technology to trigger the movement of materials within a manufacturing or production facility. Electronic Kanban differs from traditional kanban in that it uses technology to replace traditional elements such as kanban cards with barcodes and electronic messages such as email or Electronic data interchange.

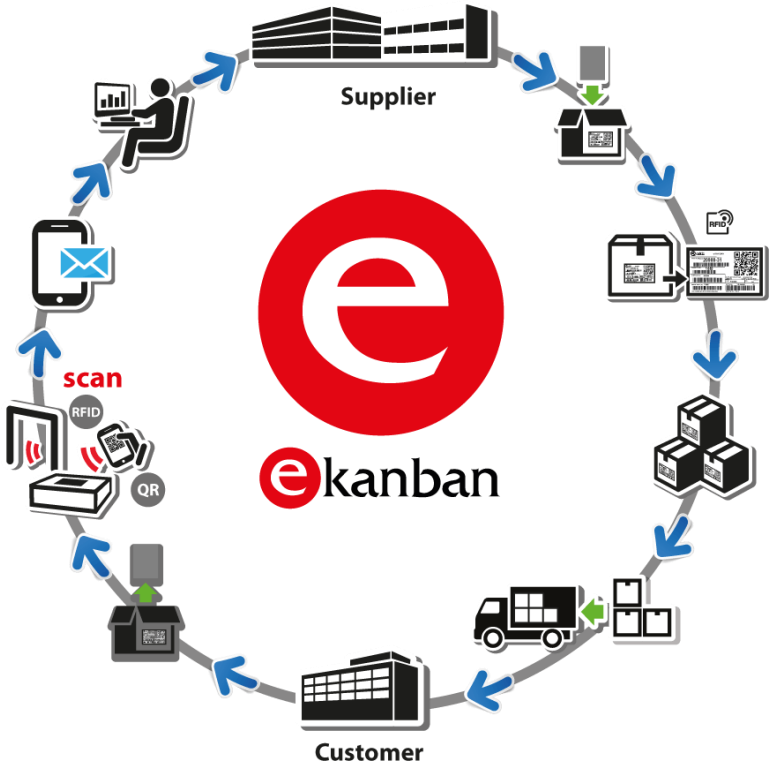


Figure: Electronic kanban

Advantages of Kanban

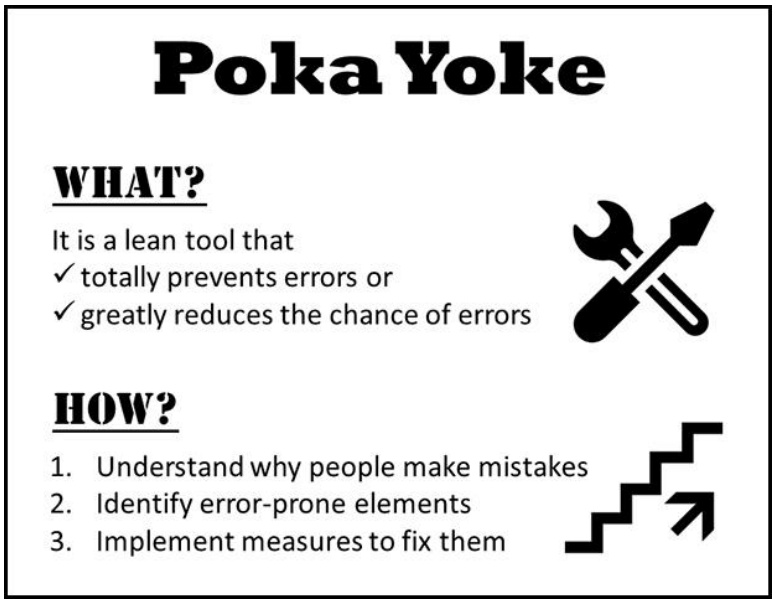
1) Optimize inventory and reduce product obsolescence (outdated)
2) Reduce wastes and scraps
3) Provide flexibility in production
4) Increased output (productivity)
5) Reduce total cost
6) Improve production flow
7) Place control at the operational level
8) Improve responsiveness to change demand
9) Better machine utilization
10) Quickly improvement for factory control and work in process (WIP) reduction efforts
11) Reduce or eliminate queue.

Disadvantages of Kanban

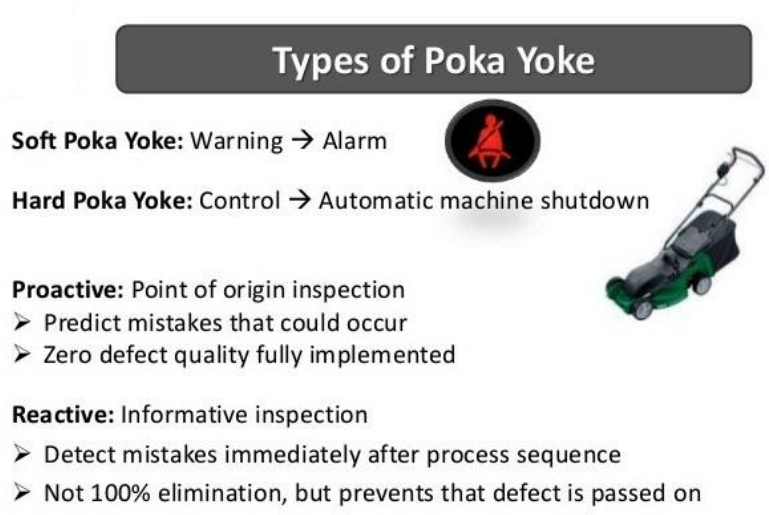
1) It is less effective in shared- resource situation.
2) Surge in mix or demand cause problem because kanban assume stable repetitive production plan.
3) Poor quality in term of scrap and rework also effect its good functioning
4) Kanban does not eliminate variability, so unpredictable and lengthy down time could disturb the whole system.
5) It is not suited for manufacturing environment with short production run.
6) Kanban not suited for highly variable demand, multi product and good quality product.
7) A break down in kanban system can result in the entire line shutting down.

Poka Yoke:

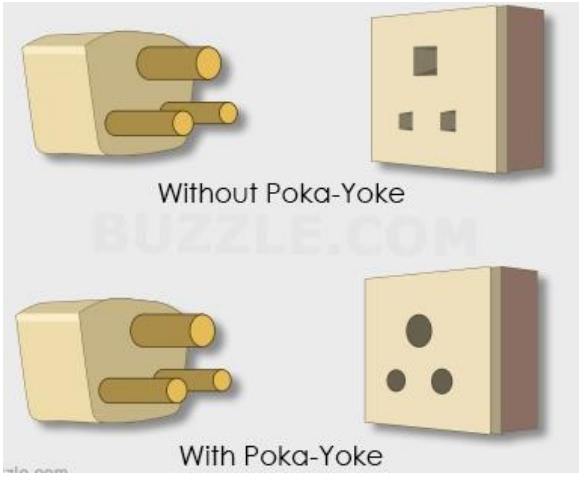
- Poka-yoke is a Japanese term that means "mistake-proofing" or "inadvertent error prevention".
- A poka-yoke is any mechanism in any process that helps an equipment operator avoid (yokeru) mistakes (poka).Poka-yoke is a technique for avoiding simple human error in the workplace.
- Also known as mistake-proofing, good-proofing, and fail-safe work methods, poka-yoke is simply a system designed to prevent inadvertent errors made by workers performing a process.
- The idea is to take over repetitive tasks that rely on memory or vigilance and guard against any errors.
- Poka-yoke can be seen as one of the three common components of Zero Defect Quality Control performed by Japanese companies.



- Dr. Shigeo Shingo, a renowned authority on quality control and efficiency, originally developed the mistake-proofing idea. Realizing its value as an effective quality control technique, he formalized its use in Japanese manufacturing as the Poka-yoke system.
- Poka-yoke is based on prediction and detection. That is, recognizing that a defect is about to occur or recognizing that a defect has occurred. Consequently, there are two basic types of poka-yoke systems.
- The control poka-yoke does not allow a process to begin or continue after an error has occurred. It takes the response to a specific type of error out of the hands of the operator.



- For example, a fixture on a machine may be equipped with a sensing device that will not allow the process to continue unless the part is properly inserted.



Example Simple Plug in System as Per Poka Yoke

- As a matter of fact, it won't fit into the drive at all unless properly inserted. A second type of poka-yoke provides some type of warning when an error occurs.

- This does not prevent the error, but immediately stops the process when an error is detected. This type of poka-yoke is useful for mass production environments with rapid processing as the device prevents mass production of scrapped material.

The potential benefits poka yoke describes as:

- elimination of set-up errors and improved quality
- decreased set-up times with associated reduction in production time and improved production capacity
- simplified and improved housekeeping
- increased safety
- lower costs
- lower skill requirements
- increased production flexibility
- improved operator attitudes.

Error is inevitable, but it should be eliminated.



Before Poka Yoke



After Poka Yoke

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Asst. Professor,
BIITM, BBSR.

(Scheduling, Project Management & Quality Management)

Module-3

Scheduling

1) Scheduling is the process of arranging, controlling and optimizing work and workloads in a production process or manufacturing process.
2) Scheduling is used to allocate plant and machinery resources, plan human resources, plan production processes and purchase materials.
3) In manufacturing, the purpose of scheduling is to minimize the production time and costs, by telling a production facility when to make, with which staff, and on which equipment.
4) Production scheduling aims to maximize the efficiency of the operation and reduce costs.
5) Scheduling may be defined as the assignment of work to the facility with the specification of time, and the sequence in which the work is to be done.
6) Scheduling deals with orders and machines. It determines which order will be taken up on which machine in which department at what time and by which operator.
7) Scheduling is the process of arranging, controlling and optimizing work and workloads in a production process. Companies use backward and forward scheduling to allocate plant and machinery resources, plan human resources, plan production processes and purchase materials.
8) Forward scheduling is planning the tasks from the date resources become available to determine the shipping date or the due date.
9) Backward scheduling is planning the tasks from the due date or required-by date to determine the start date and/or any changes in capacity required.

The benefits of production scheduling include:

- Process change-over reduction
- Inventory reduction, leveling
- Reduced scheduling effort
- Increased production efficiency
- Labor load leveling
- Accurate delivery date quotes
- Real time information

Key concepts in scheduling

A key character of scheduling is the productivity, the relation between quantity of inputs and quantity of output. Key concepts here are:

1) ***Inputs :*** Inputs are plant, labor, materials, tooling, energy and a clean environment.
2) ***Outputs :*** Outputs are the products produced in factories either for other factories or for the end buyer. The extent to which any one product is produced within any one factory is governed by transaction cost.
3) ***Output within the factory :*** The output of any one work area within the factory is an input to the next work area in that factory according to the manufacturing process. For example, the output of cutting is an input to the bending room.
4) ***Output for the next factory :*** By way of example, the output of a paper mill is an input to a print factory. The output of a petrochemicals plant is an input to an asphalt plant, a cosmetics factory and a plastics factory.
5) ***Output for the end buyer :*** Factory output goes to the consumer via a service business such as a retailer or an asphalt paving company.
6) ***Resource allocation :*** Resource allocation is assigning inputs to produce output. The aim is to maximize output with given inputs or to minimize quantity of inputs to produce required output.

Objectives Loading and Scheduling

1) Scheduling aims to achieve the required rate of o/p with a minimum delay and disruption in processing.
2) To provide adequate quarters of goods necessary to maintain finished product at levels predetermined to meet the delivery commitment.
3) The aim of loading and scheduling is to have maximum utilization of men, machines and materials by maintaining a free flow of materials along the production line.
4) To prevent unbalanced allocation of time among production departments.
5) To keep the production cost minimum.

Factors Affecting Scheduling

(A) External Factors

1) Customers demand
2) Customers delivery dates
3) Stock of goods already lying with the dealers & retailers.

(B) Internal Factors

1) Stock of finished good with firm
2) Time interval to manufacture each component, subassembly and then assembly.

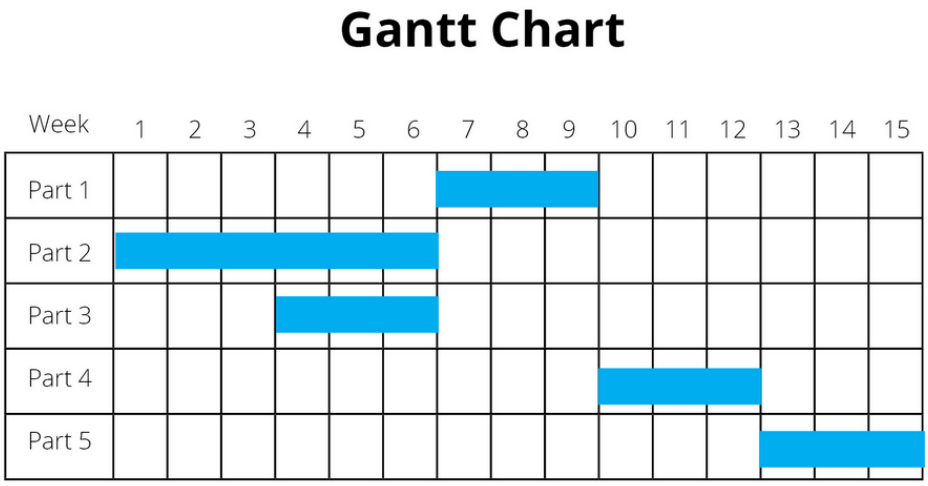
3) Availability of equipments & machinery their capacity & specification.
4) Availability of materials
5) Availability of manpower

Scheduling Procedure

Scheduling normally starts with mater schedule. The following table shows master schedule for a foundry shop.

Master Scheduling for Bakery Shop. Maximum Production Capability/Week = 100					
Order no.	Week-1	Week-2	Week-3	Week-4	Week-5
1	15	19	20	17	18
2	25	20	22	24	25

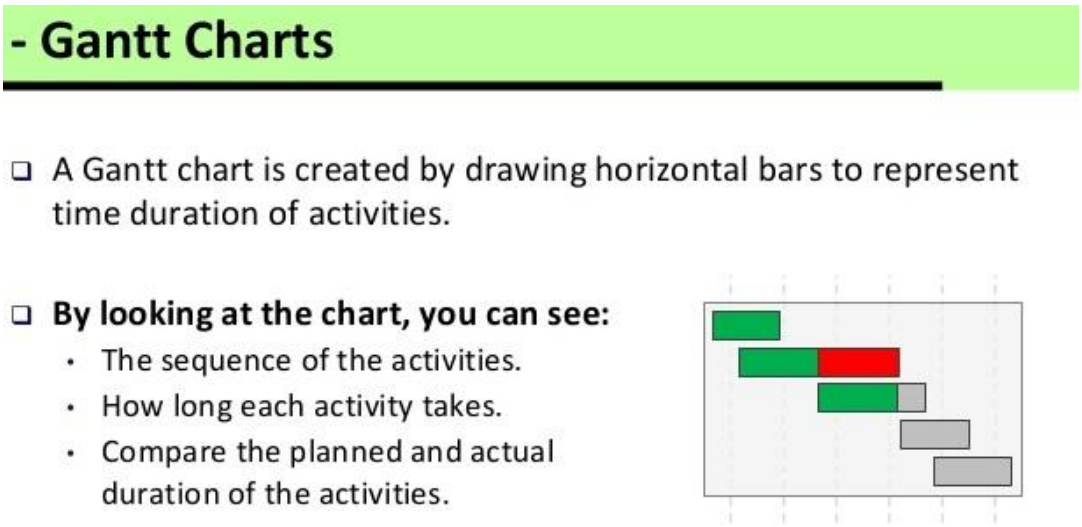
After master production schedule is made, the detailed schedules are thought of and made for each component, subassemblies, assemblies. The Gantt chart is a popular method commonly used in scheduling technique. An example of Gantt chart is shown below. The hatched zone indicates actual work load against each section.



Instead of section, it may be machine other facilities. Now a days computers are used to do this chart for different components/ machine etc. through readily available production software.

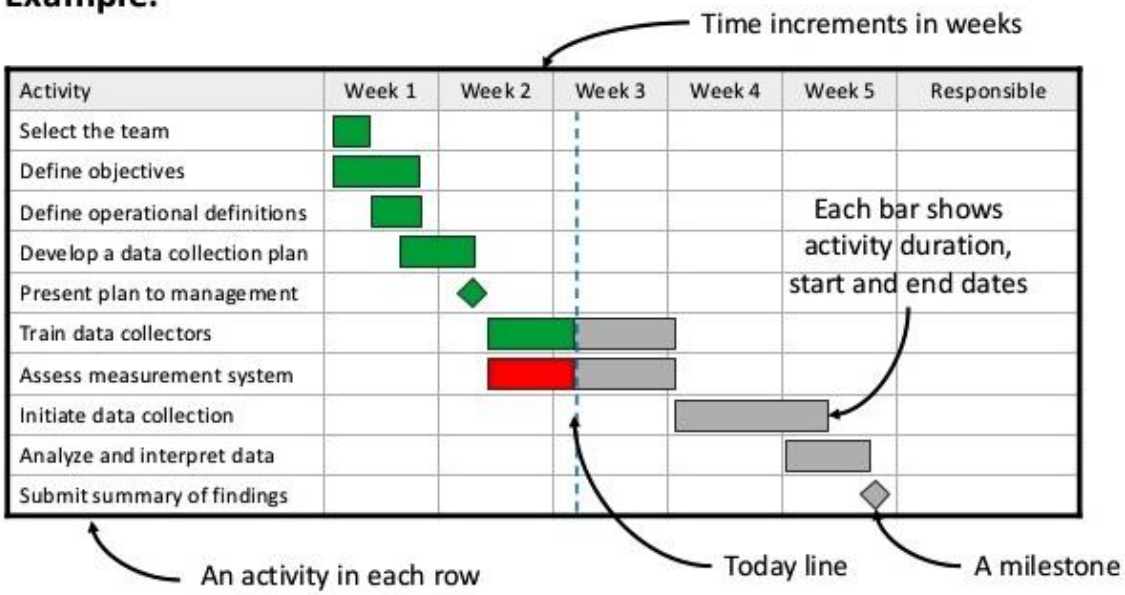
Gantt Chart:

1) A Gantt chart is a type of bar chart that illustrates a project schedule, named after its inventor, Henry Gantt (1861–1919), who designed such a chart around the years 1910–1915.
2) A Gantt chart is a type of bar chart that illustrates a project schedule. This chart lists the tasks to be performed on the vertical axis, and time intervals on the horizontal axis. The width of the horizontal bars in the graph shows the duration of each activity.
3) Gantt charts illustrate the start and finish dates of the terminal elements and summary elements of a project. Terminal elements and summary elements constitute the work breakdown structure of the project. Modern Gantt charts also show the dependency (i.e., precedence network) relationships between activities.
4) Gantt charts are graphical representations of task-based projects. The tasks in a Gantt chart are both listed in a tabular format and displayed graphically as task bars, reflecting their duration. By linking related tasks, Visio can automatically adjust the timeline when tasks are delayed or completed before schedule.
5) Hence, Gantt charts are the ideal tool to use if you are responsible for scheduling a project and tracking the duration of each of the tasks in the project to ensure the project is completed on time.
6) Gantt charts are usually created initially using an early start time approach, where each task is scheduled to start immediately when its prerequisites are complete. This method maximizes the float time available for all tasks.
7) In project management, float or slack is the amount of time that a task in a project network can be delayed without causing a delay to: subsequent tasks ("free float") & project completion date ("total float").



- Gantt Charts

Example:



Gantt Charts

A detailed Gantt chart can answer the following questions:

- What are the activities that must be accomplished?
- In what order?
- How long should they take?
- Which activities are on time and which are no?
- Who should do them?
- What are the needed resources?
- What are the key stages and milestones?
- What are the relationships between the various activities (sequential or simultaneous)?
- What is the percentage of completion?



Example:

Time Table for B-Fest Meet-2019@ BIITM

Event	Timing	Venue
Students Registration	9:00 AM to 10:00 AM	Near Entry Gate
Inaugural Meeting	10:00 AM to 10:45 AM	KDM Hall (Second Floor)
Mad AD	(10:00 AM to 11:30 PM)	Lawn & Open Stage
B-Quiz Online Test	(11:00 AM to 12:00 PM)	Computer Lab-1 (Ground Floor)
Case Study	(11:30 AM to 1:30 PM)	1st Floor (SSD & Seminar Hall)
Finance Stock Market	(12:00 PM to 2:00 PM)	Computer Lab-1 (Ground Floor)
Lunch Break 1:30 PM to 2:30 PM		
B-Quiz Final Round	2:30 PM to 4:00 PM	KDM Hall (Second Floor)
Dance Competition	2:30 PM to 5:00 PM	Open Stage
Song Competition	4:00 PM to 5:00 PM	KDM Hall (Second Floor)
Ramp shows	5:30 PM to 7:00 PM	Open Stage
Prize Distribution & Valedictory	7:00 PM to 8:00 PM	Open Stage

Gantt Chart for B-Fest Meet-2019 @ BIITM

Time / Event	9:00 AM	10:00 AM	11:00 AM	11:30 AM	12:00 AM	12:30 AM	1:00 PM	1:30 PM	2:00 PM	2:30 PM	3:00 PM	4:00 PM	5:00 PM	5:30 PM	6:00 PM	7:00 PM	8:00 PM
Students Registrations																	
Inaugural Meetings																	
Mad AD																	
Case Study																	
B-Quiz Online Test																	
Finance Stock Market																	
Lunch Break																	
B-Quiz Final Round																	
Dance Competition																	
Song Competition																	
Ramp shows																	
Prize Distribution & Valedictory																	

Project Management-concept; Project Management-Technique; PERT; CPM

PROJECT MANAGEMENT — ER. MANOJ KUMAR ROUT

Project (Definition)

→ A project is an individual or collaborative enterprise, possibly involving research or design, that is carefully planned, usually by a project team to achieve a particular aim.

→ A project may also be a set of interrelated tasks to be executed over a fixed period and within certain cost and other limitations.

→ A project is a temporary endeavor under taken to create a unique product, service or result.

→ Origin of word "project" (Latin word "pro" means forward; "jacere" means throw, which means plan and cause to move forward.

⇒ A project is a time and cost constrained operation to realize a set of defined deliverables (the scope to fulfill the projects objectives) up to quality standards and requirements.

→ Project is a unique set of co-ordinated activities, with defined starting and finishing points undertaken by an individual or organization to meet specific objectives with defined schedule, cost and performance parameters.

⇒ A project is a specific activity on which money is spent in the expectation of return.

→ So the project have a specific starting point, a specific end point and it is intended to achieve a specific objective.

⇒ In Addition, a project has a specific geographic location and it would serve a group of population.

Attributes of a Project

→ Project attributes are a collection of descriptive characteristics and parameters of some project to define key information about the project and communicate it to stakeholders.

⇒ Project attributes describe project performance and activity status, Example of project attributes are: goal, phase, duration, requirement, risk, deliverable, scope etc.

→ Project attributes serve as the basis for collecting and analyzing project data. They are used in planning, monitoring, measuring and

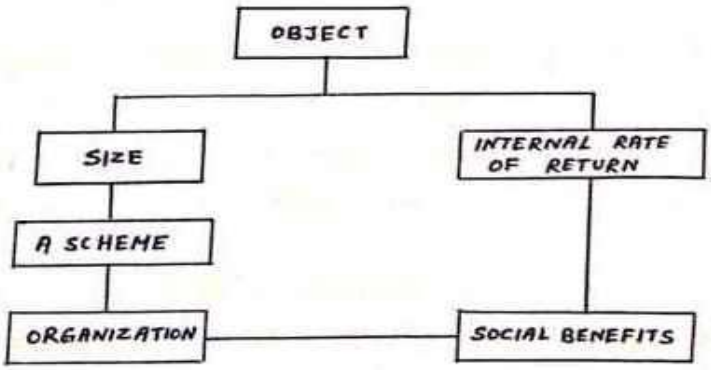
Controlling project activities.

⇒ In project attributes, project analysis uses various project attributes to explore unsolved risk, check deadline status, monitor milestones, allocate resources, manage changes and do other activities of the project management process.

⇒ Most project attributes can be organized, sorted and summarized in certain catagories, which may includes such as project duration, people involved in the project, time and costs required for completion, scope and deliverables etc.

⇒ There are ten key attributes of successful project, when an organization is lunching or considering a large project, which are;

(i) Executive Sponsorship
(ii) Strong project Governance
(iii) User Involvement
(iv) clear Company Goals
(v) Well-defined project charter
(vi) Well-defined Base Requirements
(vii) Proven Methodology
(viii) Application Software
(ix) Experienced project Manager
(x) Experienced Resources.



→ There are three Major attributes of project which are;

(i) the Input characteristics
(ii) the Ouput characteristics
(iii) Social cost Benefits characteristics.

(i) The Input characteristics

→ The input characteristics defines what the project will consume.

→ The project required energy, manpower, material, financial resources and an organisation setup as input.

(ii) The Output characteristics

→ The output characteristics of a project defines what the project will generate.

→ The project output may take the shape of good or services.

→ In either case it is essential to have a broad idea quantitative as well as qualitative of the project outputs.

(iii) Social cost Benefits characteristics

→ Every project has a social cost benefits aspect.

→ The sacrifice which the society will be called upon and the benefits which the society will get should be carefully evaluated.

Characteristics of a Project

The project have four basic characteristics, which are;

(1) Investment pattern
(2) Benefits & Gain
(3) Time Limits
(4) Location.

The characteristics features of a project are briefly described as;

→ The project has a mission or set of objectives, once the mission is achieved, the project is completed.

→ A project has to terminate at a certain time or point. It can't continue forever.

→ While the number of participants are several, the project is one single entity and its responsibility is assigned to one single agency.

→ A project call for a team work, the member of the team may come from different organizational units disciplines and from different geographic region.

→ A project has a life cycle represented by growth, maturity and decay.

→ A project is unique and no two projects are similar. Even though the plant set-up are identical.

(3)

→ Change is a natural phenomenon with every project throughout the lifespan.

→ The happening during the life cycle of a project are not fully known at any stage. As time passes the details are finalized successively.

→ A project is always customer specific.

→ A project is a complex setup things. Project varies interms of technology, equipment, material, machinery, work ethics and organizational culture.

→ A substantial portion of the work in a project is done by sub-contractors.

→ Any project is exposed to risk and uncertainty.

Project Life Cycle

The project life cycle consists of four phases which are;

(i) Project Initiation
(ii) Project planning
(iii) Project Execution
(iv) Project closure

(i) Project Initiation

→ The first phase of project is the initiation phase. During this phase a business problem or opportunity is identified and a business case providing various solution option is defined.

→ Next, a feasibility study is conducted to investigate whether each option addresses the business problem and a final recommended solution is then put forward.

→ Once the recommended solution is approved, a project is initiated to deliver the approved solution

→ Terms of references are completed outlining the objectives, scope and structure of the new project and a project manager is appointed.

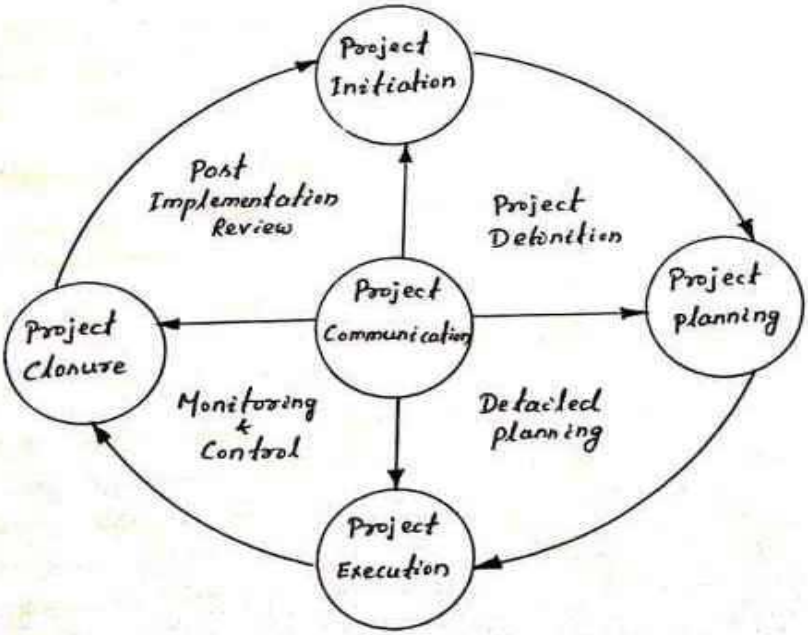
→ The project manager begins recruiting a project team and establishes a project office environment and approval is then sought to move into the detailed planning phase.

(ii) Project planning

→ Once the scope of the project has been defined, the project enters the detailed planning phase, which involves creating;

⇒ Project plan outlining the activities, tasks, dependencies and timeframes.
⇒ Creating resource plan listing the labour, equipment and materials required.
⇒ Creating a financial plan identifying the labour, equipment and materials costs.
⇒ Involved quality plan providing quality targets, assurance and control measures.
⇒ Risk plan highlighting potential risks and actions to be taken to mitigate those risks.
⇒ Acceptance plan listing the criteria to be met to gain customer acceptance.
⇒ Communication plan describing the information needed to inform stakeholders.
⇒ Involved procurement plan identifying products to be sourced from external suppliers.

At this point the project will have been planned in detail and is ready to be executed.



[Four Phases of Project Life cycle]

ER. MANOJ KUMAR ROUT

(iii) Project Execution

→ This phase involves implementing the plans created during the project planning phase. While each plan is being executed, a series of management processes are undertaken to monitor and control the deliverables being output by the project.

→ This includes identifying change, risks and issues, reviewing deliverable quality and measuring each deliverable produced against the acceptance criteria.

→ Once all of the deliverables have been produced and the customer has accepted the final solution, the project is ready for closure.

(iv) Project closure

→ Project closure involves releasing the final deliverables to the customer handing over project documentation to the business, terminating supplier contracts, releasing project resources and communicating the closure of the project to all stakeholders.

→ The last remaining step is to undertake a post implementation review to quantify the level of project success and identify any lessons learnt for future projects.

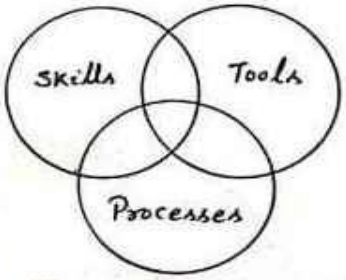
→ project closure is the last phase in the project life cycle and must be conducted formally so that the business benefits delivered by project are fully realize by the customer.

Project Management (Definition)

Project management is the skill, tool and management processes required to undertake a project successfully. It incorporates;

→ A set of skills, specialist knowledge, skills and experience are required to reduce the level of risk within a project and thereby enhance its likelihood of success.

→ A suite of Tools, various types of tools are used by project managers to improve their chances of success. Example include document templates, registers, planning software, modelling software, audit checklists and review forms.



[Project Management components]

⑥

⇒ A series of Processes, various processes and techniques are required to monitor and control time, cost, quality and scope on projects. Example, include time management, cost management, quality management, change management, risk management and issue management.

⇒ Project management is harnessing the resources to achieve the following;

(i) It must get completed
(ii) It Must be completed within budget
(iii) It must get completed within allocated time
(iv) It must perform to satisfaction.

⇒ Project management is an organised venture for managing projects. It involves scientific application of modern tools and techniques in planning, financing, implementing, monitoring, controlling and co-ordinating unique activities or tasks to produce desirable outputs in accordance with the predetermined objectives within the constraints of time and cost.

⇒ The project management executes non routine activities on a time frame, once project is completed, the whole activities comes to an end.

Project Management Principles

The project management principles depends upon the following principles which are stated below;

(1) The Commitment Principle: A fair and mutual commitment must exist between the sponsor and the project team before the project can succeed.

(2) The Success Principle: The measure for project success must be confirmed and agreed upon before the project can start and before activities can be assigned.

(3) The tetrad trade-off Principle: Scope, quality, time and cost must all be attainable and must exist in equilibrium.

(4) The strategy Principle: A strategy includes planning and implementation and a definite series of sequential activities that must be in place before the project can begin.

(5) The Control Principle: policies and procedures must be devised to control behaviours and ensure commitment.

(7)

⑥ The Single-Point Responsibility Principle: One person needs to be in charge. This individual will be the point of contact between the sponsor and the team.

⑦ The Cultural Environment Principle: There must be a supportive culture and environment in order for the project to succeed. Management should work to foster this.

The methodology for setting up projects and applying project management principles follows the following guidelines;

(i) Define the objective, to minimize the risk of getting right track, management must clarify the objective of the project well advance by defining management's intent in undertaking the project, outlining the scope of the project and describing the end results of the project and its permanent effects.

(ii) Establish a project organization, this includes appointment of an experienced manager to run project, organization of project management function & responsibilities, assignment of limited number of staffs and maintenance of balance between functional head of departments and project manager.

(iii) Install project control, special project controls over time, cost and quality are very different compared to routine reports. These includes; Time control (CPM & PERT), Cost control and Quality Control.

Project Management Activities

The project management activities includes the following which are given below;

① Work breakdown structure (WBS), which decomposes project into various levels of detailed tasks.

② Dependency Analysis, order the project tasks established by WBS, determining those, which must be done in sequential order and others, which can go on simultaneously.

③ Network Development. Portrays ordered tasks graphically using a network diagram.

④ Resource Commitment / Allocation, Commits the appropriate individual who has the proper skills and expertise to the tasks....

... requiring those skills. Allocate those resources overtime to determine the build up and the phase out of the resources over the life of the project.

⑤ Time Estimates, estimates based on one of several technique ranging from forcast method to quantitative method, the constant method or the unit of work method. Two categories of time are considered; (i) Effort: Energy exerted
(ii) calender: Elapsed duration.

⑥ Budgeting, Allocates the project development cost spread over the duration of the project.

⑦ Status Reporting, takes the baselines developed above (schedules, resource loading and budgets) and turns them into a work-in-progress reports which track the plan against the actual.

The Project Management Process

→ Project management in a process of leading a team of capable people in planning and implementing a series of related activities that need to be accomplished on a specific date with a limited budget. Because of its nature, co-ordinating all these activities requires a process approach.

→ Project management process are guides that can help you to focus on what need to be done at particular points in a project, phase sub phase or work package.

→ To manage the complexity, the project need to be de-constructed into manageable, interrelated parts or processes by separating the project into different management process, the project manager has chance to control the outcomes and manage challenges.

→ A system approach requires the identification of the processes that make up the entire project management frame work. This framework helps understand the basic structure required to properly manage a project, by identifying elements that need close supervision and careful analysis.

→ There are nine management processes on a development project. They these are designed to help manage the different elements of a project and different project may have different needs from each process.

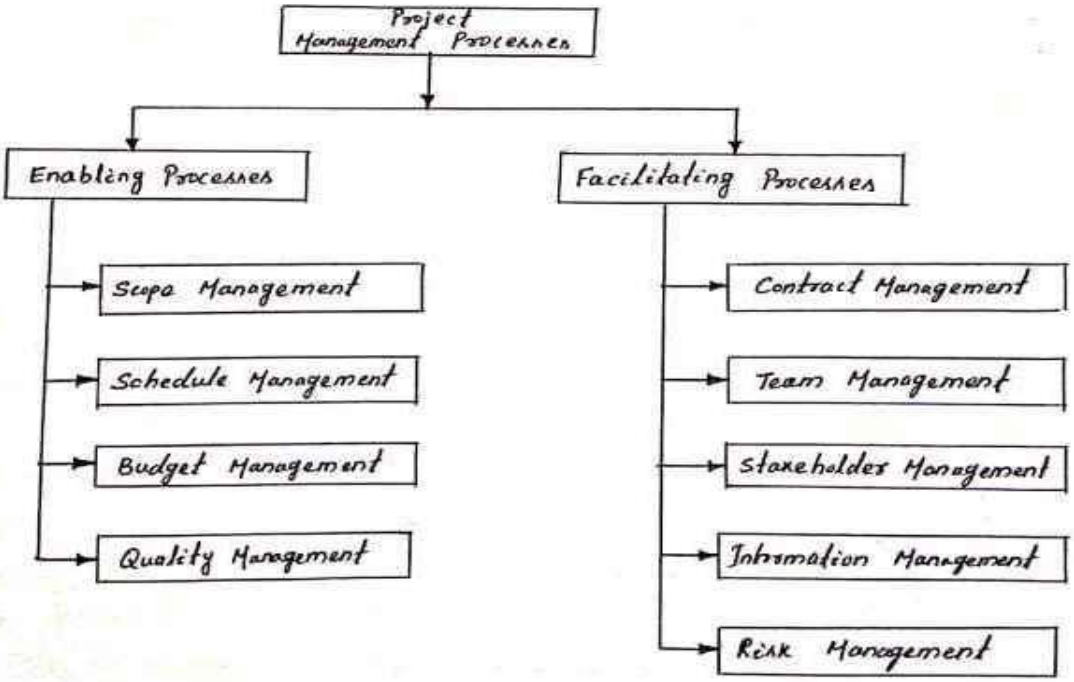
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⇒ The nine project management processes are;

(i) Scope Management
(ii) Schedule Management
(iii) Budget Management
(iv) Quality Management
(v) Team Management
(vi) Stakeholder Management
(vii) Information Management
(viii) Risk Management
(ix) Contract Management

⇒ The project management processes interrelated with the project management phases during the entire project management cycle. The project management processes are divided into two major groups:

(a) Enabling Processes
(b) Facilitating Processes.



⇒ Project management processes are overlapping activities that occur at varying levels of intensity throughout each phase of the project. A process is defined as a set of activities that must be performed to achieve a goal.

(10)

Enabling Processes

Enabling processes include scope, schedule, budget and quality. They are enabling because they lead to specific objectives of the project and are the basis to define a project success on time under budget as requested by the donor and by the quality needed by the beneficiaries.

Scope Management

- The process involved in defining and controlling what is or is not included in the project.
- It is the way to describe the boundaries of the project.
- It defines what the project will deliver and what it will not deliver
- It helps to manage any changes to the projects.

Schedule Management

- This process includes the actions required to ensure the timely completion of the project.
- It is the development of a project schedule that contain project activities.
- It is a communication tool that informs project stakeholders, status of the project and gives project team information in the form of graphs and chart.

Budget Management

- It required to ensure the project is completed within the approved budget.
- This area receives a lot of scrutiny during and after the project is completed.
- It manage the financial resources, measures the efficiency and organization probity.

Quality Management

- Quality management is the process to ensure that the project will satisfy the needs of the beneficiaries.
- Quality is defined as a commitment to deliver the project outputs and meet the expectations of the beneficiaries.
- It develops a quality management plan which identifies the quality standards that are relevant to the project.

(11)

Facilitating Processes

The facilitating process areas are team, stakeholder, information, risk and contract management. They are facilitating areas because they assist and make possible for the project to achieve its objectives.

Team Management

During the definition of the project activities a list is created that identifies the skills needed by the project. These range from highly technical to administrative and support functions. The project team is after all the team responsible for the project and the project needs to be clear in acquiring the skills it needs.

Stakeholder Management

Stakeholder management is one of the areas that receives the least amount of thought and planning in development projects. This is due to limited understanding and agreement on who are the stakeholders and their role in the project. Stakeholders are all the people who have an interest in the project and they are the most critical element for the success of the project. They include donors, beneficiaries, Local government, partner organization and anyone who will be impacted by the project.

Information Management

Information management required to ensure timely and appropriate generation, collection, dissemination, storage and ultimate disposition of project information. This is done by via reports, email, telephone, meeting and presentation by project manager. The information management plan contains a list or description of all information that needs to be communicated by project, it identifies who will be responsible for collecting, editing and distributing the information.

Risk Management

Risk management includes the processes concerned with identifying, analyzing and responding to project risk. Risk in projects is defined as something that may happen and if it does, will have an adverse impact on the project. There are four stages to risk management planning, they are risk identification, risk analysis and quantification, risk response, risk monitoring and control.

(12)

Contract Management

Contract management includes the processes required to acquire goods and services needed by the project from third parties for most projects the procurement process is usually managed by a support or administrative function of the organization. The role of the project is to supply as detailed as possible, all the procurement requirements including all the technical specifications, quantity and the date when they will be needed, this is created in a project procurement plan. Contract management consists of four steps, develop the resource plan, implement the plan, review and update the plan.

Benefits of Project Management

(1) Better efficiency in delivering Services: Project management provides a roadmap that is easily followed and leads to project completion.

(2) Improved / Increase / Enhanced customer satisfaction: whenever you get a project done on time and under budget, the client walk away happy. Smart project management provides the tool that enable client / manager relationship to continue.

(3) Enhanced Effectiveness in delivering Services: the same strategies that allowed you to successfully complete one project will serve you many time over.

(4) Improved Growth and Development within your team: positive results not only command respect but more often that not inspire your team to continue to look for ways to perform more efficiently.

(5) Greater standing & Competitive edge: It isn't only a good benefit of project management within the workplace but outside of it as well: word travels fast and there is nothing like superior performance to secure place in the market place.

(6) Opportunities to expand your services: A by product of greater standing. Great performance leads to more opportunities to succeed.

(7) Better Flexibility: One of the greatest benefits of project management is that it allow for flexibility. project management allow to map out the strategy to see the completion of project.

(8) Increased Risk Assessment: project management provides a red flag at the right time, before you start working on project completion

(13)

(9) Increase in Quality: Goes hand-in-hand with enhanced effectiveness

(10) Increase in Quantity: An increase in quantity is often the result of better efficiency, a simple reminder regarding the benefits of project management.

Need Identification of Project Idea

Identifying a new worthwhile project is a complex problem. It involves careful study from many different angle. Following are some of the sources from which new project ideas may emerge.

(i) Performance of existing Industries:

Performance of existing industries provide a good indication about the health of a particular industry. An analysis of the profitability and break even point of different industries will offer adequate information about the financial health of different industrial sectors. Though these provide an overall picture of industrial health, one should not be simply carried away by the present performance alone.

(ii) Availability of Raw materials:

Easy availability of good quality raw materials at cheaper price is a definite indication that some project that some project make use of those raw materials may be thought of. For example availability of minerals may give lead to chemical industries.

(iii) Availability of Skilled Labour:

Based on the locally available skilled labour force, suitable industries that can make better use of the skilled manpower can be defined.

(iv) Import / Export Statistics:

Import / export statistics may reveal the potential that remain untapped. Higher proportion of import of a particular product and increasing trend in its import indicates that a product, which can serve as an import substitute can be produced locally. Similarly higher proportion of export of a particular product and increasing trend in its export indicates high export potential for the product.

(v) Price Trend:

The trend in the price of various product / services may give an indication about the demand - supply relationship. If the general price level is rising during the past few years and if the rise in price level of a particular product is steeper than the rise in general price level, it may indicate a demand-supply gap.

(14)

(vi) Data from Various Sources:

Various publications of Government, banks, financial institutions, consultancy organization, manufacturer's association, export promotion councils, research institutions and international agencies contain data and statistic which may indicate prospective ventures of the industry that are performing well and opportunities exist for new investment.

(vii) Research Laboratories:

Research laboratories that are engaged in identifying new product/ processes often offer new avenues of commercial exploitation.

(viii) Consumption Abroad:

Those enterpreneurs who are willing to take higher risks can identify project for the manufacture of products or supply of services which are new to the country, but extensively used abroad. So observing the consumption pattern abroad will help to identify projects with export potential.

(ix) Identifying Unfulfilled Psychological Needs:

For well established, multi-brand product groups, there may be unsatisfied psychological needs, though the physical needs of the consumer might have been satisfied. Consumer goods like cosmetics, bathing soaps, tooth-paste etc, come under this group.

(x) Plan Outlays & Government Guidelines:

Government's plan of outlays to different sectors provide useful pointers towards possible investment opportunities, which indicate the potential demand for good and services by the different sectors of the economy. The Department of Industrial Development, Govt. of India, publishes guidelines to industries annually which is a valuable source of information to identify the scope of new investments.

(xi) Analysis of Economic & Social Trend:

An analysis of the economic and social trend of the society will be very much helpful in identifying and projecting the demands for various goods and services. For example, the growing desire for leisure point to investment opportunity in recreational activities, rest-houses, resorts etc.

(xii) Possibility of Reviving Sick Units:

An industry that has become weak/sick might still have the capacity to become a financially viable proposition provided the reason for the weakness/ sickness are due to factors that are internal to organization. An enterpre-neurial skill can takeover a weak/sick unit, revive it and make it to turn around.

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Difference Between Project Management & Manufacturing or Service

Project Management	Manufacturing or Service
① Non repetitive process	① Repetitive process.
② No Revenues generated.	② Revenues and profit or losses.
③ Multi-skilled or highly specialized manpower required for short duration.	③ Limited skill manpower required with huge learning effects.
④ It involves scope, cost, time and performance.	④ It involves cost reduced, profit generated and quality of products or Services.
⑤ Essential, involves may sub contracting agencies.	⑤ Generally avoid use of sub contracting agencies.
⑥ Special purpose of equipment required for a short duration of time.	⑥ Same pieces of equipments are continuously used.
⑦ Very high risk involved as generally no chance of recursion.	⑦ Generally avoid use of improvement always there in case of manufacturing or Services.
⑧ Radical improvement to face the existing competitors.	⑧ Incremental improvement to reduce cost or add to value
⑨ Fixed, ceases with attainment of objectives.	⑨ Continuous in nature, ceases in special situation like divestment.
⑩ Creation of new things.	⑩ Maintenance of existing things.
⑪ It is used for Future.	⑪ It is concern with present.
⑫ Example:- Building of Road, bridges, Rocket & Missile and Industrial projects etc.	⑫ Example:- steel plant, chemical plant, Refinery, Food Industries etc.

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Project Selection

Project selection is the first important part of project portfolio management. All these projects need resources partially or fully provided by the organization itself. Since the resources are limited not all of the projects, it would like to pursue can be staffed or funded adequately. So projects in different areas will compete with eachother in order to get support of the organization in terms of staffing and funding.

Project selection is a process to access each project idea and select the project with the highest priority. Selection of project based on various benefits such as economic, social, cultural and bio-diversity. The generic process of project selection is divided into four types which are;

(a) Identification of Projects
(b) Evaluation & Prioritization of projects
(c) Selection & Initiation of Projects
(d) Review of Projects.

(a) Identification of Projects

→ The first step of this process, identification, requires a clearly defined and communication strategy.

→ Set up a strategy development process that contains project identification and project selection as an integral part.

→ Most organizations identifying investment projects within strategy development process, but delegate the identification of customer projects to their key account and sales departments.

(b) Evaluation & Prioritization of Projects

Central part of the project selection process is evaluation and prioritization of identified, which involves several methods and these methods requires a certain minimum level of planning for each one of the projects to be evaluated. We need to know the following;

(i) project life cycle duration, in number of accounting periods.
(ii) Expected project cost per accounting period.
(iii) Expected project revenue per accounting period,
(iv) Overall risk values of the project to be evaluated.

There are a couple of method available for evaluation & prioritization of projects which are;

(a) Net present value (NPV) method
(b) Internal Rate of Return (IRR) method
(c) Benefit/ cost Ratio (BCR) method. (17)

(d) Opportunity cost (OC) method
(e) Payback Period (PP) method
(f) Initial Risk Assessment method

(c) Selection & Initiation of projects

⇒ project selection and initiation is the step that naturally follows evaluation and prioritization. A particularly delicate step of project initiation turns out to be the staffing of project team.

⇒ In case of project selection, resources are scarce and in most organization appear to be the most limiting factor in project selection.

⇒ In multi project management (many projects), having too many staff members working in multi-tasking mode i.e. on two or more projects at the same time, decreases overall productivity of the organization.

⇒ On a medium / Long term scale, it seems to be the better option to initiate project in a way so that the team can focus and work on one project at a time, thus avoiding disturbances of one project by the others. So it needs clear prioritization of the selected project based on evaluation.

(d) Review of Projects

⇒ After project selection it need to regularly review projects that are under way in order to find out, if they are still in-line with our strategy.

⇒ Thus, the first way of checking them is repeating the initial evaluation with more accurate estimates as they become available.

⇒ The second way is holding regular project management review meeting in order to identify major problem on a per-project basis via project status reports.

⇒ The minimum requirements of project management reviews along each project's life cycle are as follow; (from the perspective of a project owner)

(i) Acceptance of feasibility studies
(ii) Request for proposal (RFP) or Request for Quotation (RFQ)
(iii) Vendor selection / Signature of contract
(iv) Design Freeze / Approval of detailed planning documents.
(v) Preliminary Acceptance
(vi) Final Acceptance

(From the perspective of a Supplier)

(i) Bid / No bid decision
(ii) Bid Approval
(iii) Signature of contract
(iv) Order approval for sub-contractors.
(v) Declaration "ready for preliminary acceptance".
(vi) Project closure.

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Project Organization

→ An Organization is defined as a system in which individuals and groups operating at different level perform the tasks is assigned to them in the framework of delegated authority and responsibility which are rationally co-ordinated to achieve the desired organizational goals.

→ An Organization involves;

(i) A determination and an enumeration of the activities necessary for the achievement of the goals of an enterprise.

(ii) Grouping of these activities and assigning authority & responsibility to a particular position.

(iii) A co-ordination of authority relationship, so that the efforts and individuals and directed towards achieving the corporate goals.

Importants of Organization

An organization is the foundation of management. The basic features of organization involves the followings;

→ It encourages specialisation and ensures higher productivity.

→ It streamlines the process of activities and ensures their smooth functioning.

→ It fastens co-ordination of various activities in an integrated manner towards the attainment of specific objectives.

→ It facilitates precise and effective delegation of authority.

→ It ensures proper direction, motivation, co-ordination and control.

⇒ It aids the expansion and growth of an enterprise. A sound organizational plan avoids all the pitfalls of rapid growth.

→ It provides for the optimum use of technology / technological improvements of manpower for higher growth.

Principles of Project Organization

→ The organizational goal should be formulated for the business as whole and organization should be framed to achieve that goal. Thus departmental goals should be developed so that ultimate common goal should be attained.

→ The organization should be framed in a manner such that every individual get work according to his ability, skills and knowledge.

→ For every given work or responsibility there must be provision of authority to get that workdone. The manager can delegate his authority...

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... to his subordinates to complete the task but responsibility to complete the work.

⇒ There should be unity of command in the organization. An employee should be controlled by one boss. He should get order from one superior and should report to the same superior.

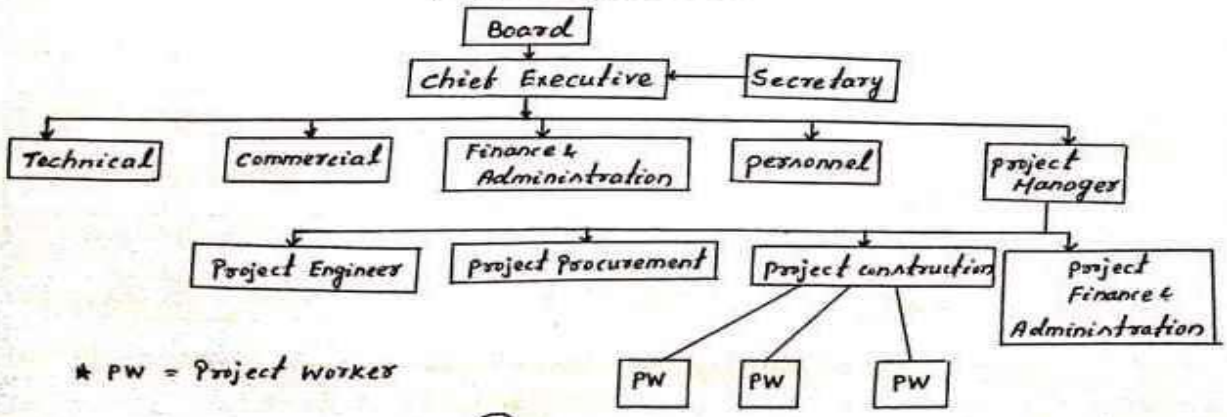
⇒ There should be proper span of control - Span of control is the number of subordinate reporting directly to a manager - the number of subordinate should be in such manner so that supervision can be done effectively.

⇒ There should be proper chain of supervision from top level to lower level in vertical direction, which also shown the direction of communication in the organization.

⇒ The principles of project organization are based on the following factors;

(i) Objective of project
(ii) Specialisation
(iii) Co-ordination of project team
(iv) clear unbroken line of Authority
(v) Responsibility
(vi) Efficiency of team
(vii) Delegation
(viii) Span of control
(ix) Balance
(x) Communication
(xi) Personal ability
(xii) Flexibility
(xiii) Grouping
(xiv) Definiteness
(xv) Continuity.

Project Organization



* PW = Project Worker

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There are three different structures in which people can be organised to work on project which are;

① Functional type of project organization
② Pure project organization
③ Combined or Matrix type project organization.

① Functional Type of Project Organization

⇒ This type, as one of the possible forms of realizing a project in the organization, represents the possibility of its realizing in one existing functional part of the enterprise.

⇒ In this type functional dimensions of the existing organization are used. The major advantages of functional organization are;

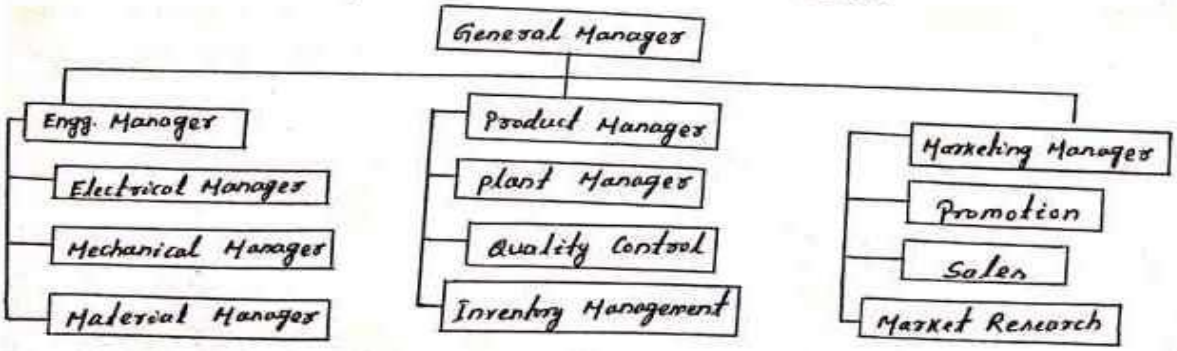
(i) There is a maximal flexibility in using the staff. In case that the correct functional department of the organization is selected for realizing the project, the department will have primary and administrative base for individuals with technical knowledge in the fields relevant for the project.

(ii) With the broad basis of technical staff available to the functional department, if it is the case, the people can be easily moved from one project to the other one.

(iii) Experts in the department can be grouped to exchange knowledge and experiences they possess. Thus the project team has the access to any technical knowledge existing in that functional group for solving problems.

(iv) Functional departments also serve as a basis of technological continuity when some experts decide to quit the project team and the enterprise too.

(v) The functional department possesses the organized way of advancing individuals as experts in these functional fields.



(Functional Type of the Project Management Organization)

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③ Pure Project Organization

⇒ The pure project organization is at the other end of the spectrum of organizational possibilities for project management.

⇒ The essential characteristic of this approach is that the project is separated from the home organization.

⇒ It becomes an independent segment with its special technical staff, its own administration, connected with the home organization by weakened links which are monitored in the periodical reports on the project advancement and some exceeding.

⇒ The basic advantages of pure project organization are;

(i) The project manager is fully responsible and authorized for the project.

(ii) The complete labor, engaged in the project is directly responsible to the project manager.

(iii) In case of realizing complex projects, the functional structure is bypassed and the project manager communicates directly with the top management structure.

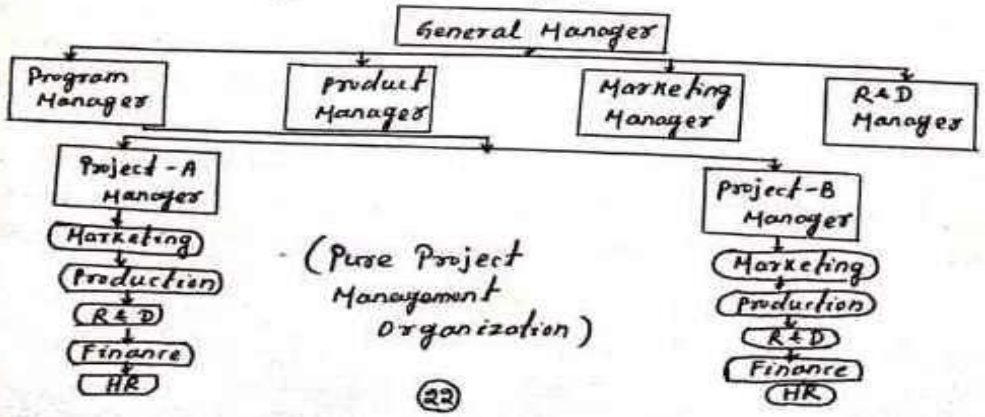
(iv) If several, similar projects are realized successfully, the pure project organization can enable permanent, more or less expert staff which can develop necessary skills for some technologies.

(v) The project team, having a strong and it's own identity, has a tendency of developing the high level of communication and exchange and experience among its member.

(vi) As the authority is centralized, the possibility of fast decision making is increased.

(vii) The pure project organization is structurally simple and flexible, it enables its relatively simple application and understanding.

(viii) This type of the organization structure has a tendency to support the holistic approach to the project.



(Pure Project Management Organization)

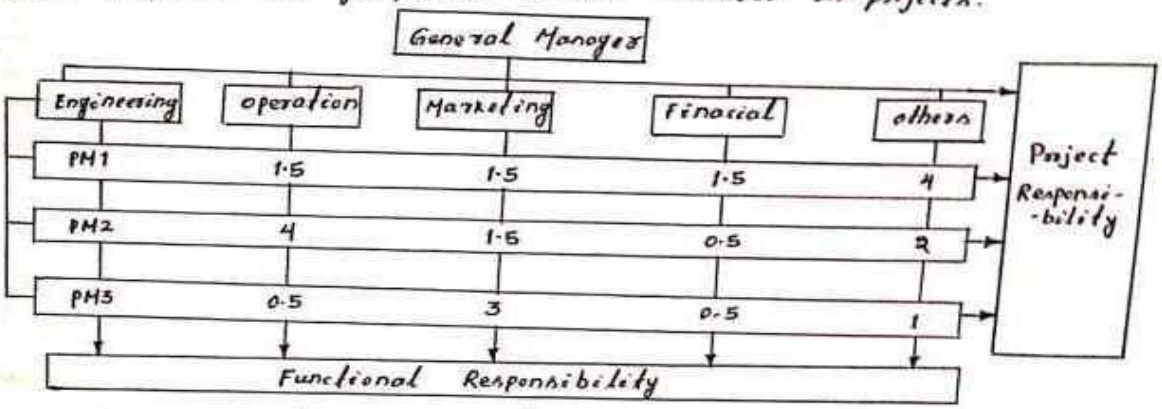
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iii) Combined or Matrix type Project Organization

→ The matrix type project organization can be considered as the combination of functional type and pure project organization.

→ The matrix project organization is balanced between these extremes which is nothing else but the balance of the cited approaches where there are many different mixtures of project and functional responsibilities.

→ For example, in cases when project require the group work, before all, it is usual to prefer the group work to their transfer in projects.



(Matrix Type Project Organization)

→ The project is paid central attention, as with pure matrix organi-zation and its realization as planned within the framework of in advance defined budget, specifications and quality.

→ The fact that the project organization includes functional departments temporary taking over workers and their skills from these departments, draws the logical conclusion that this enables the use of all resources from all functional departments.

→ The team members are not so much afraid for their destiny after finishing the project, even in case of their strong association with the project because they are the personnel of the home department.

→ The client's needs is equally fast as with the project approach, but the matrix is more flexible because it is included into the organi-zation which already functions.

→ With this type of organization, management will have the possibility to use the existing administrative staff.

→ Contrary to the pure project organization representing the extreme in the spectrum of possible varieties, the matrix organization tries to include the wide field of these extreme approaches.

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Functional Type Orgn	Pure Project Organization	Matrix Type Organization
⇒ This structure is used for firms that sell & produce standard - -products.	⇒ This type of organization structure usually takes up projects of huge value requires several years of engineering.	⇒ This is a sort of a hybrid organization, a mix of functional type & pure project management type.
⇒ Each functional group is focussed on performance of its own activities in support of the main purpose or mission of the organization.	⇒ There will be different team working for different projects. Each team dedi- -cated to a special project.	⇒ It remains the functional expertise of the functional structure as also the project & customer focus of the project type structure.
⇒ In this the team members usually to their regular jobs & serve part time on the project task.	⇒ This type of project is not cost effective as deploying the staff from one project to another, even when there is no work in the project is not possible.	⇒ The project manager should monitor the assignment & make reallocations when- -ever required.
⇒ Since the member will work for their functional manager does not have the complete authority over the team problems.	⇒ It calls for an accurate planning & efficient control system to ensure optimum resource utilization, and the authority controlled by the manager only.	⇒ The project manager should monitor the assign- -ments over the matrix type organization as workload divided into various activities related to project.
Advantages		
⇒ Activities and resp- -onsibilities are clearly defined.	⇒ Strict control on resources.	⇒ Optimum utilization of resources, technical expertise of different department.
⇒ people develop respec- -tive in their functional areas.	⇒ Quick response to the customer need.	⇒ Better communication and customer focus.
Disadvantages		
⇒ There is no definite customer focus, slow response and it is isolated from rest of the environment.	⇒ Since people are drawn from different functional areas, people do not show interest in improving their knowledge of the project.	⇒ In this there are two managers functional and project which need a clear balance of power.

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Project Feasibility Analysis

→ Project feasibility analysis is a formal investigation of an opertunity leading to rational decision making to committe investment.

→ Such investigation comprises of market analysis, technical analysis, financial analysis, economical analysis, ecological analysis and social probl analysis etc.

→ The objective of the project feasibility analysis is to identify the existing strength and weakness of the project.

→ The feasibility analysis is to provide the base guide lines on technical, economical, commercial and environmental parameter of a project.

→ The feasibility analysis describes the optimization process and justified assumption and selection with a better alternative solution and define the clear boundaries of solution such as.

→ It defines the basic terms of reference of a project.

→ It describes the nature and complexcity of a project.

→ It provides the general view on investment range of the project.

→ It always provides a chance to revise the action.

→ It helps to setting of the operation by choosing an appropriate technology for the project.

→ It is an approach that makes strong base of every project.

→ It helps to determing and analysing the alternative approaches to production process and outcomes.

→ The project feasibility analysis are done on the following:

(i) Technical Feasibility.
(ii) Commercial Feasibility
(iii) Financial Feasibility.
(iv) Economic Feasibility.
(v) Ecological Feasibility.

(i) Technical Feasibility

→ It is a description of a project including specification relating to which physical, mechanical & chemical etc properties used in the project.

→ It is a description of selecting manufacturing process showing detail flow chart and presenting alternative process which may be consider and justification of the adaption of the selected process.

→ Determination of plant size, production & process failure.

(85)

⇒ An identification of plant location and an assessment of its desireable-lity in term of its distance from the raw material sources and market place.
⇒ A design of plant layout, an idea of cost of construction of the proposed building and land equipment.
⇒ The important questions raised during technical analysis are;
(1) Whether the preliminary tests and studies have been done?
(2) Whether the availability input have been established.
(3) Whether the production / operation process chosen is suitable.
(4) Whether the equipments & machines chosen are appropriate.
(5) Whether the work schedules have been drawn up.
(6) Whether the technology proposed to be employed is appropriate from the social point of view.

(ii) Commercial Feasibility~

⇒ It is a method of screening project idea through evaluating project feasibility in terms of the market.
⇒ A brief market description including the market area, method of transportation and channel of distribution etc is to be analysis.
⇒ It is an analysis of past & present demand determination of quality, value of consumption and identification of major consumer product.
⇒ It is an analysis of past and present supply sources as well as information for determination of the competitive position of the product such as selling price, quality and marketing practice of competitors.
⇒ The commercial feasibility analysis requires wide variety of information and appropriate method related to:
(1) Import & Exports.
(2) Structure of competition
(3) past & present supply position.
(4) Demand structure.
(5) production possibilities and constraints
(6) Cost structure
(7) Consumption trends in the past & present level.
(8) Customer behaviour and requirements.
(9) Marketing policies and distribution channels.
(10) Administrative, technical and legal constraints.

(26)

(iii) Financial Feasibility

⇒ This is the study and preparation of financial statement so that project may be evaluated commercial profit followed by the finance such as.

→ For new project, the statement too total project cost, initial capital requirement and cash flow relative to the project schedule.

→ For all projects financial projection for future period including income statement cash flow and balance sheets.

⇒ For all projects, financial projection setting the assumptions as to collection period of sales, inventory level, payment period for purch--ases and expenses. The element of production cost selling and admin--istrative and financial expenses.

→ For all projects the financial analysis show the return of investment.

→ For all projects it's in necessary to do a sensitive analysis to identify the item which have a sub-financial impact for profitabi--lity or pomible risk analysis.

⇒ The aspects that have been looked into while conducting financial feasi--bility are;

(1) Investment outlay & cost of project
(2) Cost of capital
(3) cash flows of the project
(4) projected financial position
(5) projected profitability.
(6) Break even point.
(7) Level of risk.

(iv) Economic Feasibility

⇒ Economic feasibility can be defined as the systematic evaluation of a concern's social performance and economic performance.

⇒ Economic feasibility analysis such as foreign exchange savings, development of backward areas, defence requirement, self reliance etc.

→ It analyses the feasibility of the proposed project to generate economic benefits, economic growth and infrastructure development.

⇒ A benefit cost analysis and a breakeven analysis are used while evaluating the economic feasibility of new industrial projects.

⇒ Economic feasibility is also referred to as the socio-economic benefits where the cost of the project is concerned with judging....

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....

a project from a larger social point of view. The social cost benefit analysis focuses towards:

(1) Contribution of project towards fulfillment of certain merits like self sufficiency, employment and social contribution.

(2) Impact of project on the level of saving and investment in the society.

(3) Impact of project on the distribution of income in the society.

(4) Direct economic benefits and costs of the project measured in terms of shadow prices and not market prices.

(V) Ecological Feasibility

Ecological feasibility analysis should be done particularly for major projects which have significant ecological implications like power plants, irrigation schemes and environmental pollution industries like bulk drugs, chemical and leather processing. The important questions raised during ecological analysis are;

(1) what is the likely damage caused by the project to the environment?

(2) what is the cost of restoration measures required to ensure that, the damages to the environment is contained within acceptable limits?

Project Environment Analysis

⇒ Project environment means surroundings or persons, things, places, regions, even atmosphere surrounding a project.

⇒ The project environment refers to all external forces which have a bearing on the initiation and implementation of a project.

⇒ Project environment consists of many external factors including economic, social, cultural, political, legal and technological factors.

⇒ These factors being external are beyond the control of the project manager and the success of the project will depend to a very large extent on its adaptability to the environment.

⇒ The environment, it poses threats to a project, it offers immense opportunities also for implementation, thus it is interesting to study how each of the constituents of environment influence the project and how they are in turn influenced by the project.

⇒ Some of the important factors of project environment analysis are;

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(i) Economic Environment

→ Economic environment refers to all those economic factors which influence a project.

→ Economic environment consists of factors such as:

(1) Growth Strategy :- growth rate of saving, investment, output and employment.

(2) Economic System :- capitalism, socialism, mixed economy, economic planning, human resource, national income and per capita income.

(3) Financial & Fiscal system :- price stability, price & distribution control, economic reforms and adequate infrastructural facilities.

(ii) Social Environment

→ The social environment is made up of the attitudes, desires, expectations, degree of intelligence and education, beliefs and customs of people in a given group or society.

→ Social desires, expectations and pressures gave rise to laws and laws in turn, influences a project.

→ The social factors includes; attitudes of people to work, attitude to wealth, family & customs, religion & marriage, intelligence & education, ethics personal conduct, social status, social mobility, social margi-nality, demographic factors and social responsibilities.

(iii) Political Environment

→ It is a system of a country which decides, promotes, encourages, directs and controls the project activities of a country.

→ A political environment is very stable, honest efficient & dynamic which ensures political participation of the people & ensure personal security to the citizen as a primary factor of project development & implementation.

(iv) Technological Environment

→ The technology changes are very fast in the project which is unable to co-operate with technological changes may not come into existance.

→ Technology contributes to the emergence of affluent societies.

→ Technological advancement increases both production & productivity.

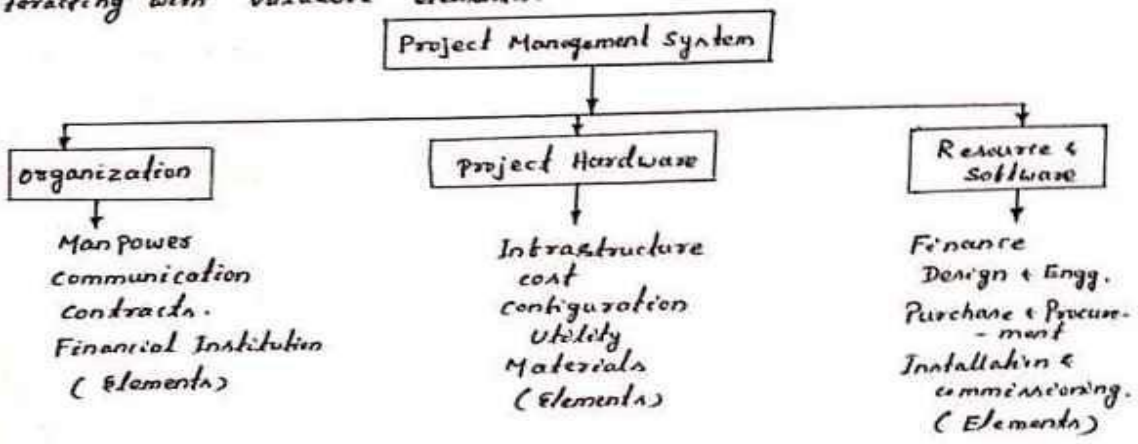
→ Advancement generate in technology bring a new employments.

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Design of Project Management System

The design of project management system involving working on different levels such as organization, project hardware, Resources & software which interacting with valuable elements.



According to Lewis, the project management consists of seven components which are;

(1) project planning System
(2) project controlling System.
(3) Project Techniques & Execution System.
(4) Project information System.
(5) Project Organization System
(6) Cultural System
(7) Human Resource System.

(1) Project planning System

⇒ Project planning comprises to define the project, creating a work braxedown structure, estimating activities, sequencing activities, calculating critical path, preparing schedules, preparing resource plans, getting approvals and compiling a project chapter.

⇒ A clear project definition, an objectives are critical to success of the projects. The following actions helps, define the problem opportunity which are;

(i) Get from the client a clear definition of the problem to be solved by the project or the opportunity of the project will take Advantages.

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(ii) Determine the clients need & wants. It might taxes sometimes to help the client, the distinguish needs & wants. but it is important to understand them because during the planning and budgeting, processing some wants might have to be sacrifies in favour of needs when time and money are needed.

(2) Project Controlling System

- Making the periodical project report.
- Reviewing the progress.
- Analysing the status of project.
- Management decision regarding objective & resource allocation.

(3) Project Techniques & Execution System

For completion of a project, it use some techniques and methods such as PERT, CPM, GERT, scheduling and costing designs. the project execution plan involves construction plan, work packaging plan, procedure plan and human resource plan.

(4) Project Information System

Implementation of project work in an organization, the information system plays a vital Role. In case of Information, data are collected then fed into the computer, processed and distributed at such large time intervals as to make the control of project.

(5) Project Organization System

- the project organization must define the levels of authority, responsibility and accountability of participants.
- An organization lead by the project manager is set up for the purpose of coordinated efforts of all participants.

(6) Cultural System

The culture of an organization is the totally of the values, traditions, beliefs and behaviours of the participants of project organization to avoid troubles.

(7) Human Resources System

Human resource system is most important aspect of project management. A project manager need very good inter personnel skill such as taking responsibility of project, motivation, lead the project team, good communication skill, deal with needed resources and mobilization of team where needed. (32)

Project Work System

→ The project work system must be defined the completion of condition, what will have to do and not to do when the project is finished.

→ It brings the major criteria to success of the project.

→ So the project work system not only the project but also the responsibilities of project manager, which is major against the objectives the project work system must be follow certain principles which are;

(i) Specific
(ii) Measurable
(iii) Agreed Upon
(iv) Realistic
(v) Time (cost) limited

(i) **Specific** :- This work system must be clean and well define that any one with a basic knowledge of the project area can understand them. They must precisely define what the project will do & not to do.

(ii) **Measurable** :- The work system must be define as a measurable term. If they can't be measure, they are too antiguous and you need to define them more clearly.

(iii) **Agreed Upon** :- A project manager, client & customer must agree on the project work system. They are must be agreement that the end result should solve the problem.

(iv) **Realistic** :- The project work system must be possible to achieve given the available resources, knowledge, skills and time. It might take some time & energy to negotiate the project work system which are realistic in nature.

(v) **Time (cost) Limited** :- The work system need to be framed within clear time goals. Defined how much time is available and if there is any flexibility, so the workSystem are excessive can be determined to the project and the company.

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Work Breakdown Structure (WBS)

→ It is a process in which, how the complex project work system can be converted into simple and a managlable task, usually a project manager use this method for simplifying the project execution, such as;

(i) Accurate and readable project organization.
(ii) Accurate assignment project organization.
(iii) Indicates the project milestone and control point.
(iv) Helps to indicate cost time and risk.
(v) Illustrate or explains the project scope.

→ Project breakdown structure is a hierarchy of system by breaking to overall work into individual system at level-1 and individual system into sub-system at level-2.

→ The work breakdown structure is the foundation for project planning and control.

→ WBS is the connecting point for work and cost estimates, schedule information, actual work effort / cost expenditures and accountability.

→ The WBS can be structured in either of two way. The first approach structure the WBS primarily from a deliverables perspective, in that the highest level (level-1) entries represent the major deliverables that the project is committed to create.

→ The second approach is from a life cycle perspective, in that the highest level entries in the WBS correspond to the major phases of the life cycle.

→ It is true that you can't complete your project planning without a WBS, but it is true that the WBS is the only planning you must do.

→ Once the WBS is completed, it must develop a dependency network, estimate activity duration, acquire & assign resources, calculate and refine the schedule, and baseline the plan.

→ step to create a WBS;
(i) Identify the major deliverables.
(ii) Break each deliverable into smaller components
(iii) Continue to break task down into manageable work packages.
(iv) Work packages can then be further broken down into individual tasks that can be used for planning and management purposes.

→ WBS is the foundation for project planning & control. It is the connecting point of work and cost estimates, schedule information, actual work effort vs cost expenditures and accountability. It must exist before the project manager can plan these related & vital aspects of the project.

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Project Execution plan

→ The project execution plan is the prime role of a manager to implement and execute in a proper way for the enterprises project. this gives about the merits and demerits with the other experts in the project. there are several methods of project execution plan which are discuss below.

→ Assigning people to all project roles :- Confirm the individuals who will perform the project work and negotiable agreements with them & their managers to assure they will be available to work on the project team.

→ Introducing team members to each others to the project :- Help people begin developing interpersonnel relationship with each other and help them appriciate the overall purpose of the project & how the different parts will interact and support each other.

→ Giving an explaining task to all team members :- Describe to all members, what work they are responsible for producing and how team members will coordinate their efforts.

→ Defining how the team will perform its essential function :- Decide how the team will handle routine communication, make different project decision and resolve conflicts, develop any procedure that may be require to guide performance on there functions.

→ Setting of necessary tracking system :- Decide which system and accounts you will use to track schedules, work effort and expenditure.

→ Announcing the project to the Organization :- Let the project audience know that your project exist, what it will produce and when it will begin and end.

→ project execution plan involved four subplans, which are

(i) Contracting plan
(ii) Work packaging plan
(iii) Organization plan
(iv) System & procedure plan

(i) Contracting plan

The first step for preparation of a project execution plan. the owner engaged some agencies with whom they can share responsibility. The contracting plan involves determination of a no. of alternative, since there are so many possible arrangements in terms of sharing of responsibility. types of reimbursement and general condition of contract.

(ii) Work Packaging plan

→ It is define by brief statements of activity description, activity resources of skill and expertise, activity estimates of effort & duration, activity schedule, activity risk and activity budget.

→ Work packages are assigned a work authorisation or control account.

→ Estimate of work packages are used in earned value, management to calculate the planned value. Progress made in the work package is used to calculate the early value.

→ Actual cost charged to work package are used in work variance analysis.

→ A work package in a project is the smallest division of work where it still retains the characteristics of a project.

→ Thus, when a project is progressively divided into systems and the system into subsystem, a stage is reached where, further division into components will strip of its character, the work at that stage can be considered to be a work package.

→ Work packaging plan refers to the identification of these packages, grouped them as they are, inorder to form viable contracts.

→ The work package represents a project in its smallest form. By chasing a work package, it will be chasing a project.

Advantages

→ Time & cost target can be attached to each work package.

→ Work packaging enables better organisation and management of project.

→ Easy to schedule, budget, award the contract on the most competitive term.

→ Entrusted to a single responsibility centre of execution without interference.

→ Work package is the smallest deliverable unit include design, procurement & construction and is recognisable as an individual entity.

→ It ensure all agencies in a project think and channline their effort in one direction for completion of the packages.

→ Several or Individual work package combined together to form a contract with the scope of work defined in terms of self contained work packages.

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(iii) Organization plan

⇒ An organization can become more self regulating it is in on taskforce or projectized.

⇒ Several standard organization arrangements are possible, ranging from functional organization to pure organization and an owner has to choose his own arrangements depending on the project size, complexity work packages, type and no. of contracts.

⇒ The owner can deliberate on the form of organization to be adopted so that interest of the project is best served.

(iv) System & Procedure plan

⇒ In project management organization a routine system and procedure so that no intervention / interference is required in the day to day operation of a system.

⇒ There are some routine subsystem of project management for which appropriate procedures can be conceived right at the start of the project initiation to completion which are;

① contract management ② Manpower Management, ③ Time Management, ④ Finance Management, ⑤ Material Management, ⑥ Cost Management, ⑦ Communication management, ⑧ Configuration management etc.

Project Procedure Manual

Each entrepreneur prepares a project procedure manual to involve all the employees regarding rule, regulation, guidelines and updating report of the project in a particular time. The entrepreneur prepares it through the help of project manager and some technical, professional and experience employees. The project ~~prod~~ procedure manual in terms the following datas;

(i) The accurate & correct information according to the available position of the project.

(ii) It provide the minimum & maximum turned over of the product manually.

(iii) It represents the accurate and updating marketing statistics.

(iv) It brings the design and demand product in the recent time which are expected by the society or customer.

(v) It brings some time changes the rules and regulation and smooth functioning of the project. (37)

(vi) There is a standing committee of the project to rectify and renew the project manual.

(vii) The project procedure manual is systematically changed and inform to all employees to get the reliable training for the future benefit of the project.

A project procedure manual is to be prepared in such a way that the interacting agencies are able to see their roles and mutual relationships in presence of the common goal.

Preparation of Project Procedure Manual :-

It should start with each project management, sub-system. A system decomposition of each system has to be carried out on each system to identify the need of project procedure manual to be worked up

(i) Contract Management

The procedure involves;

- → Prequalification procedure for general condition for agreement.
- → Tender procedure
- → Procedure for Tender evaluation
- → Procedure for Signing of Agreement
- → Billing & payment procedure for contracting agencies.
- → change order procedure
- → Measurement procedure for completing work.
- → Work inspection & acceptance procedure.
- → completed work takeover procedure.

(ii) Configuration Management

The procedure should be followed;

- → procedure for the project scope in terms of work breakdown structure.
- → Procedure for finalising basic engineering or design basis.
- → Equipment numbering & control procedure.
- → Design revision procedure.
- → Value engineering procedure.
- → Technical Audit procedure.

(iii) Communication Management

It can be managed by the following procedures;

- → Procedure for correspondance & distribution of mail.
- → Filing & reporting procedure
- → Procedure for meeting.
- → procedure for data logging. (38)

→ procedure for letter and general information
→ Suggession skill.

(iv) Material Management

The material management is done by the following steps;
→ Equipment management & numbering of the equipment.
→ obtaining required license and clearance.
→ Ordering condition of raw material & equipment.
→ Material status.
→ procedure for purchase order
→ Quality assurance and inspection.
→ Custom clearance
→ Packaging, marking & despatch of the product.
→ Warehouse management
→ Procedure for insurance & claims.
→ Billing & payment procedures.

(v) Time Management

It involves the following step;
→ preparation of work breakdown structure, workload assessment, numbering work package.
→ Making of a proper project schedule.
→ project review & program management.
→ Revision of the project schedule obtaining feedback and updating the data.
→ Reporting to the management.
→ Work cracking & follow up.

(vi) Cost Management

The cost management is done by the following procedure;
→ project cost estimation procedure.
→ procedure for cost updation and revision.
→ procedure for value engineering & ongoing cost reduction.
→ procedure for cost and productivity audits and reporting.
→ procedure for cost reporting.

(vii) Manpower Management

It involves the following steps;
→ Manpower requirement forecasting procedure.
→ Procedure for requisitioning manpower. (39)

→ Recruitment procedure
→ Procedure for training or Orientation
→ procedure for performance evaluation
→ Procedure for delegation of authority.
→ Gen Counselling procedure
→ Staff mobilization & demobilization procedure

(viii) Finance Management (Fund)

It involved the following steps:

→ Finalization of expenditure budget
→ procedure for forcasting fund requirement
→ General terms of payment.
→ Fund control procedure.
→ procedure for expenditure audits.
→ procedure for requisition & approval of additional funds.

Project Scheduling

⇒ A project scheduling refers to the process of laying out all the actual activity of the project in the time order in which they are to be perform keeping in view of the logical sequence of the activities.

⇒ A project manager maintain and follow the project schedule to proper control and smooth functioning of the project.

→ According to the project schedule the jobs to be segregated by the manager to the sub-ordinate employees as a result each staff have to complete in a particular schedule as per these duty and responsibilities.

→ The project schedule also proves the efficiency, skill, experience and performance of employees.

⇒ Further time the project manager also segregate the duties according to the skill and performance of sub-ordinate employees.

→ The organization gets better, suitable and appropriate output by running the organization through proper work schedule.

→ These responsibilities are given to the experience project manager because of smooth operation and no disturbances among the employees.

→ The project schedule provides a graphical representation of predicted task, milestone, dependency, resource, requirement, task, duration and dead line.

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⇒ A logical sequence of authority of a project would be as follows;

(i) Company Registration
(ii) Obtaining Industrial License.
(iii) Appointment of consultant / project member
(iv) Resource mobilization
(v) Land aquisition and site development
(vi) Preparing civil work design, plans and estimate and giving the construction work to the civil contractors.
(vii) Preparing design specification and placing order for plant and machinary.
(viii) Transport of machinary to the project site.
(ix) starting the plant and taking a trail run.
(x) Commissioning regular production of product.

⇒ the project schedule is expressed by the following methods or techniques;

(1) Bar chart.
(2) LOB (Line of Balance)
(3) Network Techniques (PERT, CPM & GERT)

(1) Bar Chart

⇒ the bar chart is a graphical representation showing various activities involve in the project.

⇒ the bar chart has two co-ordinates axis, one axis represent the activity and other represent the time requered for completion of the individual activity.

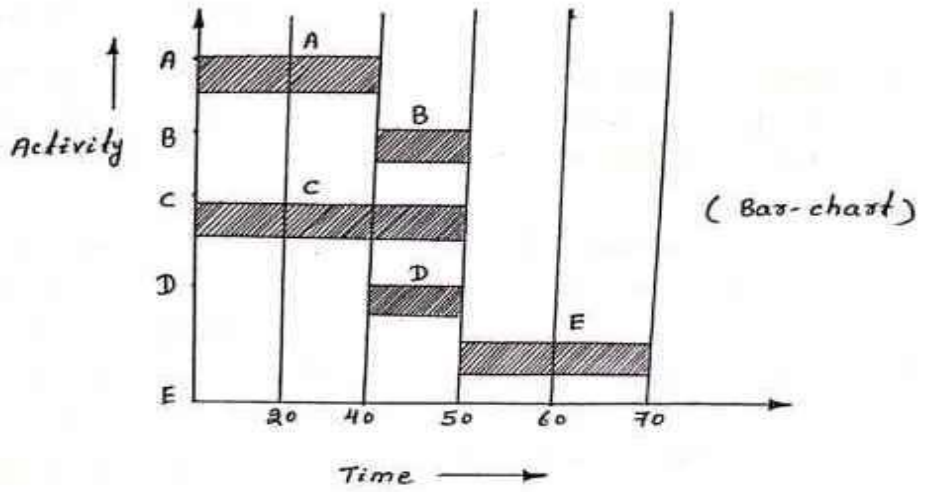
⇒ the bar chart is mainly concern with two tasks;

(i) To visualization the temporary relation of individual process for all project member.

(ii) It allows the project manager to manage the dates of individual project process.

⇒ An individual process of the project is represented by a single colour bar. Process with dates that have never been accepted by the project manager are represented by thin or lightly colour bar, where as process with dates agreed are accepted by the project manager represented by bold or dark bar.

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(Bar-chart)

⇒ Besides there the data changes made necessary by the definition of new dependence the project member responsible for a process may also propose a date change there process on their own.

⇒ As a project manager you have to decide on all of these date change proposals.

⇒ As a project manager also you may define the dependencies between the process, you may specify that the process may only start after another process has finished.

⇒ Bar charts are used to present counts of discrete or categorical data and are ideal for nominal or ordinal data scales with fewer than ten categories (levels of data). The count of each particular category is represented by a bar, which is either horizontal & vertical.

⇒ Bar charts are highly versatile and many different types have been developed to help interpret more complicated data sets. The most common types are;

(i) Clustered or Grouped Bar charts :- When data categories are sub-divided, it can use a clustered or group bar chart to show the information relating to the subgroups.

(ii) Stacked Bar chart :- It represent subdivided data in a stacked bar chart, where the different sub groups are stacked on top of one another. It is used to highlight percentage data, where all bars would be the same height representative of 100%.

(iii) Bar chart with Added Effects :- As with other chart types (pie-charts) there are many effects (cylindrical bar, conical bar etc.) that can add to bar chart to seemingly make it more interesting.

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(2) Line of Balance (LOB)

→ Line of balance (LOB) process is employeed when the repetative process exist within the contract workscope. The manufacturing of parts and amembling of units in the factory are two thing for use line of balance.

→ It is a management control process for collecting, measuring and presenting facts relating to time, cost and accomplishment of measure against a specific plane.

→ It shows the process, status, background, timing of project activity. Some measuring tools that help as follows;

(i) Comparing actual progress with a formal objectives plane.

(ii) Examining only the deviations from establish plane with respect to remainder of the project.

(iii) Receiving timely information, concerning trouble area and indicating areas where appropriate correct action is required.

(iv) Forecasting future performance.

→ The line of balance is a graphic device that enables a manager to see at a single glance which many activities comprising a complex operations.

→ The line of balance chart comprises only one feature of the whole phylosophy which include numerous danger signal controlls for all various level of management concern.

Advantages

→ Easy to draw and read
→ Useful for providing overview of project activities.
→ Good for static environment
→ It is vastly used and calls for no special knowledge of mathematics.

Disadvantages

→ It don't provide methods for optimising.
→ It is difficult to update when there are many changes.
→ Not suitable for medium and large size projects.
→ When there are changes between the plan and the actual achievement, bar chart becomes quickly absolute.
→ The chart don't equal time with cost hence time cost relationship can not be derived from this.

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③ Network Techniques

→ The network is a systematic representation of the essential charaties of the project. The PERT, CPM & GERT are most widely used network techniques.

⇒ The project manager has to apply various types of network techniques to complete the task successfully. According to the update technique, the project manager informs to the subordinate and implement the plan & procedure, so he follows the rules of certain technique, such as;

(i) Introduction to the technique
(ii) Project & companies organizational structure.
(iii) Project Organization
(iv) planning the project.
(v) Quality & Reliability in the management project.
(vi) Project & Procurement
(vii) Examining the project
(viii) Controlling the time & cash
(ix) The network & bar chart
(x) Resource analysis
(xi) Line of balance
(xii) Some practical consideration.

⇒ The main objectives of network techniques are;

(1) Helpful in planning, scheduling & controlling of activities
(2) Interrelationship of various activities.
(3) Cost control
(4) Reduce maintenance time
(5) Control of resources.
(6) Avoiding delays, interruptions.

⇒ In otherwords, a network is a graphical representation of interrelationship of various activities of a project.

⇒ These techniques are very useful for planning, scheduling and executing large project which involves coordination of variety of complex & inter related activities, estimating resource requirements and time for each activity and establishing interrelationship amongst the activities.

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PERT (Program Evaluation and Review Technique)

⇒ It uses event oriented network in which the successive events are joint by the arrows.

⇒ It is prefered for the project date non repetative and in which time for various activities can't be precisely time for various activities can't be precisely pre-experience.

⇒ There is no significant past experience to guide. Example, launching of new product in the market by the company resource and development of new war weapons, launching of satelite etc.

⇒ The main objective in the analysis through PERT is to find out;

(i) Useful technique in project planning & control.
(ii) Gives idea about the sequence of activities & their times.
(iii) Mensioned delays & interruptions.
(iv) Help in coordenating the various parts of the overall jobs.
(v) It shows the way how a project can be finished earlier than the oregonal schedule.

⇒ PERT is a recognised formula to determine activity duration from the three point estimate such as optimistic, most likely & pessimistic.

⇒ It produces a weighted average learning to either the optomistic or the pesimistic, depending on the size of the variance.

⇒ In PERT, there are three time estimation an the project manager interested in completing the project in minimum possible time. The three times are;

(i) optomistic time estimation (T_O)
(ii) Most likely time estimation (T_M)
(iii) Pessimistic time estimation (T_P)

So the Expected time (T_E) for the activity in calculated by;

$$T_E = \frac{T_O + 4T_M + T_P}{6}$$

Advantages

⇒ Easy to understand the activities in a project.
⇒ Increasing effeciency, decreasing cost & maximizing profits.
⇒ It uses statistical analysis.
⇒ It permits effective planning & control.
⇒ It provide update information.

Disadvantages

⇒ It is not emphasis on cost of project
⇒ Doesn't help routine planning of recurring events.
⇒ Errors in time estimates under PERT.
⇒ It may not hold good in a peculiar situation.
⇒ Doesn't considers matter of resource required for activities of a project.

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CPM (Critical path Method)

→ It uses activity oriented network which consists of a number of well recognized job, task or activities.

→ Each activities is represented by arrow and the activities are joint together by events.

→ CPM is generally use for the simple repetative type of projects for which the activity time and cost are certainly and previously known.

→ project like construction of building bridge, Road, physical verification of store at handle by CPM.

→ The Critical path Method or Critical path Analysis, is a mathematically based algorithm for scheduling a set of project activities. It is an important tool for effective project management.

→ CPM is commonly used with all forms of projects, including construction, software development, research projects, product development, engineering and plant maintenance etc.

→ The essential technique for using CPM is to construct a model of the project that includes;

(i) A list of all activities required to complete the project (also known as Work breakdown structure)

(ii) The time (duration) that each activity will take to completion.

(iii) The dependencies between the activities.

→ CPM calculates the longest path of planned activities to the end of the project and also determine the earliest & latest that each activity can start and finish without making the project longer.

Advantages

→ Critical activities causes no delay to project.

→ CPM brings more prominently into planning & control process.

→ CPM network is drawn like a PERT network so CPM may be superior to PERT

→ Time required for activities is reduced due to additional resources.

→ project crash cost analysis is to reduce the total project completion time while minimising the cost of crashing.

Disadvantages

→ The precise known time for each activity which may not be true in real situation.

→ It doesn't make use of statistical analysis.

→ It requires repetition of the evaluation of the project each time a change is introduced to the network.

→ It can not serve as a dynamic controlling device.

→ This is a very difficult and cumbersome process.

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Comparison

CPM	PERT
① It is a deterministic Model	① It is a probabilistic Model.
② The Result is ascertained in a manner of certainty.	② The Result estimates in a manner of probability.
③ It deals with the concept of crashing.	③ It doesn't deal with concept of crashing.
④ It deals activities of precise well known time.	④ It deals with the activities of uncertain time.
⑤ Used for repetitive jobs like construction of residentials.	⑤ Used for non-repetitive jobs like planning and scheduling of research programmes.
⑥ It is activity oriented, where results calculated on the basis of activities.	⑥ It is event oriented, where result calculated on the basis of events.
⑦ Doesn't make use of dummy activity.	⑦ It uses dummy activities to represent the proper sequencing of the activities.
⑧ It deals with cost of a project schedule and their minimization.	⑧ It is nothing to do with cost of a project.
⑨ One type of time estimation that is precisely known.	⑨ Three types of time estimation and find out the expected time of each activity.
⑩ It can't be used as a control devices as it requires repetition of the entire evaluation of the project, each time the changes are introduced to the work.	⑩ It is used as a control device as it assists the management in controlling a project by constant review of the delays in the activities.
⑪ It don't use statistical devices for determination time.	⑪ It use the statistical devices for determination of time.

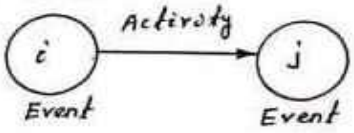
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Terms Related to Network Techniques (Definitions)

Activity :- It is physical indentifiable part of a project which requred time and resources for execution. An activity is represented by an arrow. which have head & tail.

Event :- The begining and the end point of the activity are called events, or node event is a point in time, it don't consume any resources. It is represent by a circle. The head event in called as 'jth' event, as always a node higher than the tail event, called 'ith' event.

For example:- Making the pattern of impeller, is an activity, starting a pattern of impeller is an event, completion of pattern of impeller is an event.



Path :- An unbroken chain of activity are connecting the initial event to some other event is called as path.

Network :- It is the graphical representation of logically & sequencially connected arrow and nodes connected represent activity and events of a project. while drawing network following points should be kept in mind, which are;

(a) Each activity can be represented by one and only arrow but in some situation where an activity is further sub divided into segment, each segment will be represented by separated arrow.

(b) Time flown from left to right arrow and pointing in opposite direction are to be avoided.

(c) Arrows should be kept straight and not curve.

(d) Angles between arrows should be as large as possible.

(e) Arrows should not cross each other.

(f) Each activity must have a tail and head event (two or more activity may have the same tail and head events.)

(g) An event is not complete until all the activities flowing into it are completed.

(h) No subsequent activity can begin until its tail event is completed.

(i) In a network diagram there should be only one initial event and final event.

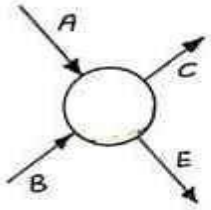
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Dummy Activity

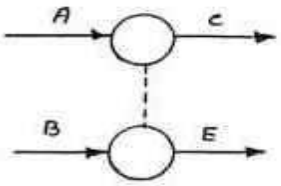
→ An activity which only determine dependency on one activity, an other but doesn't consume any time in called dummy activity.

→ The dummy activity in represented by dotted line.

→ Example:- Lets assume start of activity 'C' depends upon completion of activity 'A' & 'B', but start of activity 'E' depends upon the completion of only 'B'.



Fig(1)



Fig(2)

→ For case, Fig(1) will be a faulty representation. For this 'd' is connected by a dummy activity 'B' as shown in fig(2).

→ A dummy activity in introduce in the network for two basic reasons;

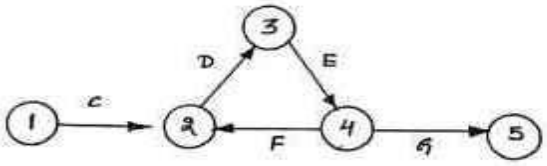
(a) Determine the precise logic of the precedence of activity such a dummy activity in called logical dummy.

(b) To comply with the rule that not two or more activities can have the same tail and head event, such dummy in called gramatical dummy.

Looping / cycling :-

→ Sometimes due to faulty network sequence, looping or cycling in form in the net work.

→ In the fig. activity 'D' can't starts until 'F' is completed, which inturn depends upon the completion of 'E', but 'E' depends upon the completion of 'D', thus the network can't be produced.



→ This situation can be avoided by checking the precedence relationship of activities and by numbering them in a logical sequence.

Numbering the events by Fulkerson's Rule

After the network in drawn in a logical sequence every event in anign a number which in placed the node circle. The number sequence should be such as to reflect the flow of network. The rule provided by Fulkerson in used for the purpose of numbering. It involves the following steps:

(1) The initial event which has all outgoing arrows, with no incoming arrows in number as one. (49)

③ Delete all the arrows coming out from node-1. This will convert some more node (at least one) into initial events, number these 2,3,.....

⑤ Delete all the arrows going out from these number. Events to create more initial event. Assign a next numbers to these events.

④ Continue until the final or terminal load which has all arrow coming in with number arrow going out in numbered.

Critical path of a Network

→ The critical path of a network gives the shortest time in which the whole project can be completed. It is the change of activity with the longest time duration, these activities are called critical activities. These critical in the sences that delay in any of them results in delay of complication of the project.

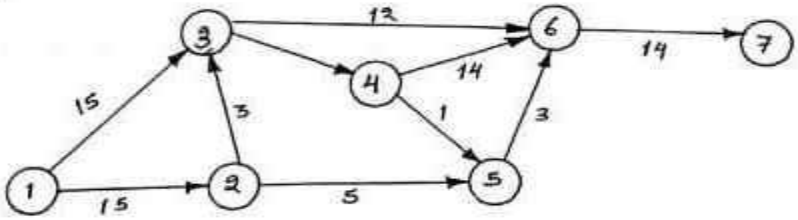
→ The critical path analysis consist of the following steps:

(i) Calculating the time schedule for each activity. It involve the determination of the time by which an activity must begin and time before, it must be completed. It include calculation of earliest stod and earliest finish.

(ii) Calculate the time schedule for the completion of the entire project.

(iii) Identify the critical activities and find the critical path. Critical activity are the ones with must be started and completed in schedule or else the project may get delay.

The path containing these activities in the critical path and is the longest path in terms of duration.



Activity: 1-2, 1-3, 2-3, 2-5, 3-4, 3-6, 4-5, 4-6, 5-6, 6-7

Duration (Week): 15, 15, 3, 5, 8, 12, 1, 14, 3, 14

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Earliest start time (E)

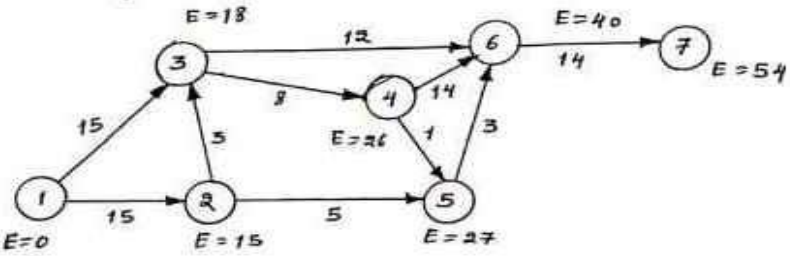
⇒ The earliest starts time for an activities represents the time at which an activity can began at the earliest.

⇒ It assume that all the preceding activity at there earliest time.

⇒ The earliest occurance time of each event can be determened by prceding progressively from left to right and account to the following rule.

⇒ If only one activity converses on a event, its earliest start time 'E' is goven by 'E' of the tail event of the activity + activity duration. If more than one activity converses on it. 'E' via all the path would computed at the highest value choosen and put around the note.

⇒ The earliest occuring time of event-1 is always zero.



Latest Finish time (L)

⇒ The latest finish time of an activity represents the latest by which an activity must be completed in order that the project may not be delay beyond its targeted completion time.

⇒ This is calculated by preceding progressively from the end event to the start event. The 'L' of the last event is equals to its 'E'.

⇒ 'L' for the other events are computed by the following rules.

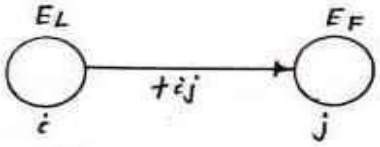
⇒ If only one activity starting from an event compute 'L' by substracting activity duration from 'L' of its head event, if more than one activity starts from an event compute 'L', via all the paths and choose the smallest and put it around the event.

Earliest Finish Time

The earliest finish time is calculated as T_{EF} is equals.

$$T_{EF} = E + t_{ij}$$

$$T_{LS} = L - t_{ij}$$



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Total Float

It is the difference between maximum available to perform the activity and activity duration.

∴ Max. time available = L-E for an activity.

Total float = (L-E) - t_{ij}
= (L - t_{ij}) - E or L - (E + t_{ij})
= (T_{LS} - E) or (L - T_{EF})

Free Float

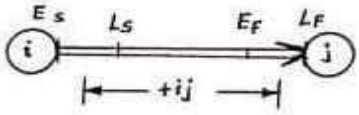
→ Free float is the time by which completion of an activity can be delay without delaying its immediate succession.

⇒ It is the portion of the total float within which an activity can be manipulate with effecting the float of subsequent activity and it is computed by :

$(FF)_{\text{of activity } ij}$ = TF - (L-E) of event 'j' or head event.
↑ slack

Independent Float

It is that portion of total float within which an activity can be delayed for start with effecting the float of preceding activity. The independant float = T_F (L-E) of tail event 'i'.



Interfering Float

It is that part of the total float which causes reduction in the float of successeding activity. In otherword, it can be defined an different between the latest finished time of the activity under consideration and earliest start time of the following activity or zero, whichever is larger.

Interfering float = $T_F - E_F$ = L - E of head event.

Slack

→ It is the time by which occurance of an event can be delayed. It is denoted as 'S'

So. $\boxed{S = L - E}$ of the event

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Sub-critical Activity

→ Activity have been next higher float when the critical activity is known as sub-critical activity. It need / demand normal attention, but a large freedom of action.

→ The path connecting these activity are known as sub-critical activity.

→ critical activity the activity having float value zero is known as critical path.

Supercritical Activity

An activity having negative float is known as supercritical activity. these activity demand very special attention and action.

GERT (Graphical Evaluation and Review Technique)

⇒ GERT is a technoque applied to stochastic networks. Stochastic networks are characterized by logical nodes, probabilistic activity realization and additive stochastic parameters on transmittances (arcs).

⇒ The characteristics of GERT involves;

(i) A probability that a branch of network is indeed part of a realization of the network.

(ii) An elapsed time of time interval associated with the branch, if the branch is part of the realization of the network.

⇒ The stochastic network consist of a set of branches and nodes which describe the network for one experiment.

⇒ A node of a stochastic network will have input side & output side. The inner side of the node is called as receiving side or contributive side. the output side of the node is called emitting side or distributive side.

⇒ GERT will derive both the probability that a node is realized and the conditional moment generating function of the elapsed time required to transverse between any two nodes.

⇒ The GERT network has the following elements;

(i) Logical nodes

(ii) Transmittance (arc) properties.

Input Section of Logical node

Exclusive-OR (⋈) :- The realization of any branches leading into the node causes, the node to be realized at a given time. Here only one of the branches leading into the node.

(53)

Inclusive-OR (◁) :- the smallest of completion times of the activities leading into the inclusive-OR node is taken the time of realization. (any branches)

AND (◻) :- The largest of the completion times of the activities leading into the AND node is taken as the time of realization. (for all branches)

Output Section of Logical nodes

Deterministic (D) :- If a node is realized, then all branches emanating from the node are considered for analysis.

Probabilistic (▷) :- If a node is realized, then only one branches emanating from the node is considered for analysis.

Step to obtain solution using GERT

- ⇒ Convert a qualitative description of a system or problem to a model in network form.
- ⇒ Collect necessary data to describe the transmittances (arcs) of network.
- ⇒ Apply with topology equation to determine the equivalent function or functions of the network.
- ⇒ Convert the equivalent function into the following performance measures;
  - (i) The probability that a specific node is realized.
  - (ii) The moment generating function of the time associated with a node, if it is realized.
- ⇒ Make inferences concerning the system and the study, from the information obtained in step-4.

Application of GERT

- ⇒ The solution of complex probability problems.
- ⇒ The development of moment generating functions for several probability laws.
- ⇒ The analysis of stochastic processes.
- ⇒ To find the throughput time of a product whose assembly network has stochastic nature.
- ⇒ To find the Launching time of a missile where the sequence of activity is in the form of a stochastic network.

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Gantt chart / Time chart

⇒ The Gantt chart consists of starting and ending time of all critical activities in succession in the CPM network.

⇒ The schedule of the activities of a project can be represented in the form of calender with zero datum using time chart / Gantt chart.

⇒ The Gantt chart is essentially and most commonly used technique of scheduling for small and medium sized projects.

⇒ In this chart, the jobs, activities or work packages are listed virtually as per their sequence and each of them allotted a line denoting the estimated time to complete the particular jobs as per calender days or months.

⇒ In Gantt chart, the total float and free float of each critical activity is zero. So the critical activities will not have any cushion / slack time to postpone them.

⇒ But in case of non-critical activity will have no cushion, so it can be scheduled between its earliest start time and latest completion time, which will be represented by dotted lines.

⇒ Hence it has several options of schedule as listed below;

(a) starting it at its earliest start time and finish it at its earliest completion time.

(b) starting it at its latest start time and finishing at its latest completion time.

(c) starting it at any time beyond its earliest start time such that it is completed on or before its latest completion time.

⇒ Hence, in practice the following two types of schedules are followed;

(1) Earliest start schedule for non-critical activities.

(2) Latest start schedule for non-critical activities.

⇒ A parallel line is drawn for each activities indicating the actual progress done up-to-date on the job. Monthly requirements of materials, plant, machinery, cash flow, manpower requirements are last in the figure.

_____ Planned Activity

----- Progress of Activity

SL No.	Activity	JAN	FEB	MARCH	APR	MAY	JUN
1	A						
2	B						
3	C						
4	D						
5	E						
	Man power	10	12	8	15	10	12

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Advantages

- Gantt chart provide pictorial representation of project status.
- Project status given or provide at any point of time.
- Better understanding of technical complexities.
- Overall performance of the activities can be judged.
- The technique is popular among project personnel & management authority due to very quick without going through the status reports and figure.

Disadvantages

- Not possible to identify problem areas, when a project runs behind schedule.
- Interaction and nature of dependence of one activity on another is not reflected in the Gantt chart.
- Gantt charts become very lengthy for big project
- Modification of Gantt chart become a difficult job, if the activities need to be rescheduled, change in priorities, change in design or delay in execution.

Crashing & Resource Sharing

⇒ The execution of a project needs sometime and time, both of which are scares for the management, but the relation between the two is obviously and inverse one, so it is required to make a trade-off between the time and cost of the project.

⇒ The objective of crashing need work is to determine the optimum project schedule. Basically there are three steps in crashing meet work;

(i) choose the cheapest way to save time
(ii) Evaluate cost increases against possible savings.
(iii) Take cost advantages of delay.

Crashing Technique

⇒ The crashing is started by selecting the least cost slope activity on the critical path. The selected activity is crast to minimum duration, so the critical path is determined again.

⇒ project duration and total project costs are updated.

⇒ the process is continue until the critical activities with cost slope less then or equal to the indirect cost are crast.

⇒ It is necessary to expedite the project, to accelerate development to reach an earlier completion date and the process of accelerating a project is referred to as crashing.

⇒ Crashing a project directly related to resource commitment. The more resources we are willing to expend, the faster we can push the project finish.

⇒ When we put additional resources, then normal time can be reduced to a minimum level. this is called crashing of time.

⇒ When a resource is shared by two or more activities it is called resource sharing. This reduce cost of using a resource.

Reasons to Crash a project

(a) The initial schedule may be too pessimistic
(b) Market needs change and the project is in demand earlier than anticipated.
(c) the project has slipped considerably behind schedule.
(d) The contractual situation provides even more incentive to avoid schedule slippage.

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Project Monitoring & control System

Project Monitoring & Control

this is the process compairing actual performance to plan to determine the variances, evaluate posible alternatives and take appropriate correctly action. It is the ability to control a project is directly tied to the effect--iveness of the project plan.

Project planning

⇒ The functional manager and line supervisors develop for their own use a set of sub-activities controled by a detail checklist to help their activities.

⇒ Evaluate the problem to the lowest level of management that can make the descision and take action. Never present a problem without an appropriate solution.

⇒ Be sure that schedule progress, cost-expenditure and scope performance are calculated and reported using methods consistent with the way or plan was established.

⇒ If you manage several project at once you may wish to rank them, so you can handle regular schedule projects differently from first track schedule projects.

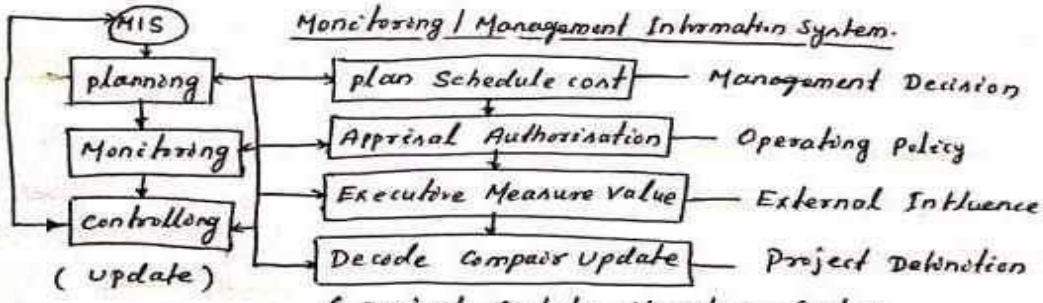
Monitoring & Control

⇒ Project monitoring & control are the steps taken to establish standard of performance for each organizational unit.

⇒ It collects information of the actual achievement of the project.

⇒ Then procesing this information into simple reports that compare planed and actual progress, so as to understood and interprete the result quickly.

⇒ Making necessary action to control or report as necessary.



Project Management Information System (PMIS)

⇒ PMIS is a system for managing the information needed to execute to a project.

⇒ A PMIS is a web-based centralized database created and used by the project team.

⇒ It monitor the progress of the project by relevant, accurate and timely information.

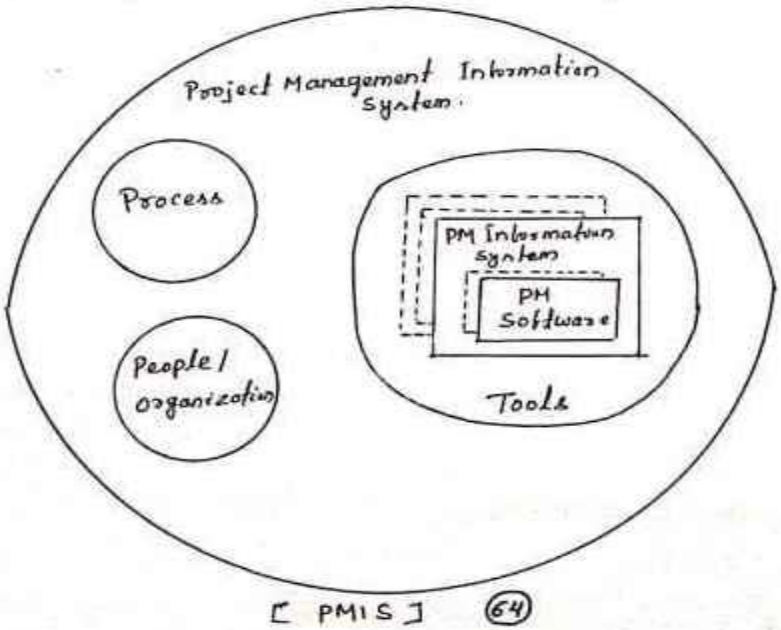
⇒ The components of a PMIS includes:

(i) the program & projects (cost, time, scope & quality)
(ii) the team (people, organization & their roles)
(iii) Manage Agreement (contracts, permits, approvals & commitments)
(iv) Manage Documents.
(v) Produce standard & custom reports.
(vi) Guides collaboration & communicates best practices with policies.

⇒ A PMIS provide information so the team has a common understanding of the facts a prerequisite for collaboration.

⇒ In PMIS, information is the input & output of managers who gather, validate, integrate, record, add experience, make judgments and then given directions.

⇒ The voice of authority from a committed owner is essential to a successful PMIS. There is always a bumpy startup while the team adjust to the routine discipline of entering and sharing information.



[PMIS] (64)

→ PMIS system can be interfaced with different software used by other organization to minimize the chores of data entry.

→ The PMIS software helpful in monitoring and controlling a project. its defined by the system consisting of tools and techniques used to gather, integrate and disseminate the outputs of project management powers.

→ PMIS maintain project status from the initial idea for a new facility to its completion.

→ The PMIS may include procedures for quality control or quality assurance program, post evaluation data and include checklist to meet regulatory requirements.

→ PMIS will have a file structure that is the complete project central filing system. It will provide storage, retrieval and distribution of project documentation, written documents and drawings.

→ The function of PMIS to assist project team in the execution of planned activities. the information should answer the followings;

(i) what is the current status of the project term of schedule & cost?
(ii) How much more will it cost to complete the project?
(iii) when will the project finish
(iv) Are there any potential problems that need to be addressed now.
(vi) what & who caused the project time or cost overrun?
(vi) If there is a cost overrun at present, what is the timely forecast of the cost overrun at completion of the project?

Computerized PMIS

→ When the size of the project increases it becomes difficult at times and even impossible to plan, schedule, budget & control project activities using manual techniques.

→ It is therefore, necessary to have computerized PMIS for projects of bigger size and complex nature.

→ The organizational activities are gather and their data are collected feed into the computer along with software for monitoring and controlling the project management.

→ The softwares used in project management are;

(i) Insta plan III
(ii) MS Project
(iii) YOJANA
(iv) PRISM
(v) PRIMAVERA
(vi) HTPM.

Advantages of Computerized PMIS

- It can analysis the problem at higher speed and no. of permutation and combination can be handle with ease then the manual techniques.
- Computer can store and process large volume of data.
- Precise & accuracy in result.
- It reduces the human resource requirement considerly and hence improve the effiecency and economy of the project.
- The project manager can himself directly interact the computer and analyse the problems rather than they depending upon to many of his subordinates, he can plan properly and arrive at a particular conclusion.

Responsibilities of Project Manager

- The project manager is the person responsible for managing the project.
- The project manager is the person responsible for accomplishing the project objectives within the constraints of the project. He is responsible for outcome of the project.
- The project manager involved with planning, controlling, monitoring and manging and directing the assigned project, resources to best need project objectives.
- The project manager controls & monitoring tripple constraints such as, project scope, time & cost in managing competing project requirements.
- The project manager examines the organizational culture & determine whether the project management is recognised as a valid role with accountability & authority for managing the project.
- The project manager collects metric data and reports on project progress and other project specific information to stakeholders.
- The project manager is responsible for identifying, monitoring and responding to the risk.
- The project manager is responsible to the project stakeholders for delivering a project objectives within scope, schedule, cost and quality.
- The reporting structure of a project manages changes, depends on organi-zational structure. He may reports to a functional manager to a project manager.

Quality or Traits of Project Manager

- Leadership
- Intluencing
- Decision making skill
- Alterness & Quickness
- Good Communicator
- Negotiating skill
- Time management skill
- Flexibility & Versability
- Presentation skill
- Financial skill
- Risk management skill.
- Ability to take suggestions.
- Qualified & knowledge of project management
- Familiarity with organization
- Conflict resolving skill.
- Resource allocation skill.

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Basic of Supply Chain Management:

Definition:

1) Supply Chain Management can be defined as the management of flow of products and services, which begins from the origin of products and ends at the product's consumption. It also comprises movement and storage of raw materials that are involved in work in progress, inventory and fully furnished goods.
2) The main objective of supply chain management is to monitor and relate production, distribution, and shipment of products and services. This can be done by companies with a very good and tight hold over internal inventories, production, distribution, internal productions and sales.
3) A supply chain is the alignment of firms that bring products or services to market.
4) A supply chain consists of all stages involved, directly or indirectly, in fulfilling a customer request. The supply chain not only includes the manufacturer and suppliers, but also transporters, warehouses, retailers, and customers themselves.
5) Supply chain management is the coordination of production, inventory, location, and transportation among the participants in a supply chain to achieve the best mix of responsiveness and efficiency for the market being served.
6) A supply chain is a network of facilities and distribution options that performs the functions of procurement of materials, transformation of these materials into intermediate and finished products, and the distribution of these finished products to customers.

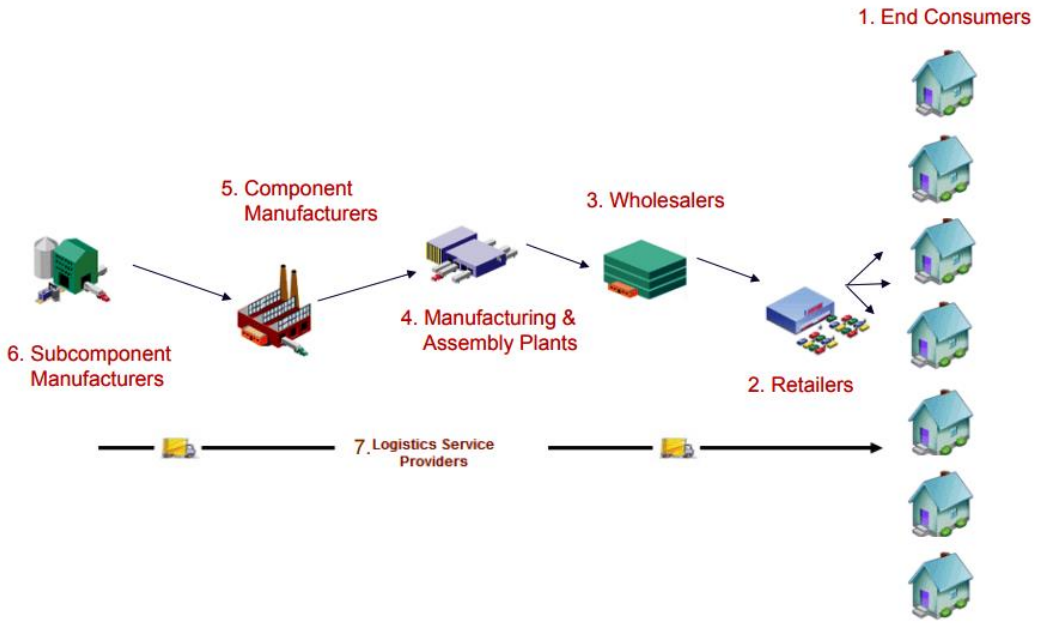


Figure: Supply Chain Management

Goals of Supply Chain Management:

1) Supply chain partners work collaboratively at different levels to maximize resource productivity, construct standardized processes, remove duplicate efforts and minimize inventory levels.
2) Minimization of supply chain expenses is very essential, especially when there are economic uncertainties in companies regarding their wish to conserve capital.
3) Cost efficient and cheap products are necessary, but supply chain managers need to concentrate on value creation for their customers.
4) Exceeding the customers' expectations on a regular basis is the best way to satisfy them.
5) Increased expectations of clients for higher product variety, customized goods, off-season availability of inventory and rapid fulfillment at a cost comparable to in-store offerings should be matched.
6) To meet consumer expectations, merchants need to leverage inventory as a shared resource and utilize the distributed order management technology to complete orders from the optimal node in the supply chain.
7) Supply chain management aims at contributing to the financial success of an enterprise

Supply Chain Management – Process:

Supply chain management is a process used by companies to ensure that their supply chain is efficient and cost-effective. A supply chain is the collection of steps that a company takes to transform raw materials into a final product. The five basic components of supply chain management are discussed below:

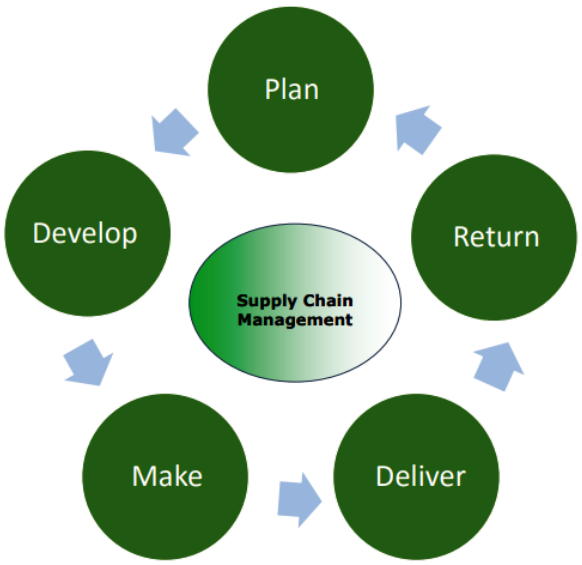


Figure: Supply Chain Management Process

Plan: The initial stage of the supply chain process is the planning stage. We need to develop a plan or strategy in order to address how the products and services will satisfy the demands and necessities of the customers. In this stage, the planning should mainly focus on designing a strategy that yields maximum profit.

Develop (Source): In this stage, we mainly concentrate on building a strong relationship with suppliers of the raw materials required for production. This involves not only identifying dependable suppliers but also determining different planning methods for shipping, delivery, and payment of the product. So in this stage, the supply chain managers need to construct a set of pricing, delivery and payment processes with suppliers and also create the metrics for controlling and improving the relationships.

Make: The third step in the supply chain management process is the manufacturing or making of products that were demanded by the customer. In this stage, the products are designed, produced, tested, packaged, and synchronized for delivery. This stage is considered as the most metric-intensive unit of the supply chain, where firms can gauge the quality levels, production output and worker productivity.

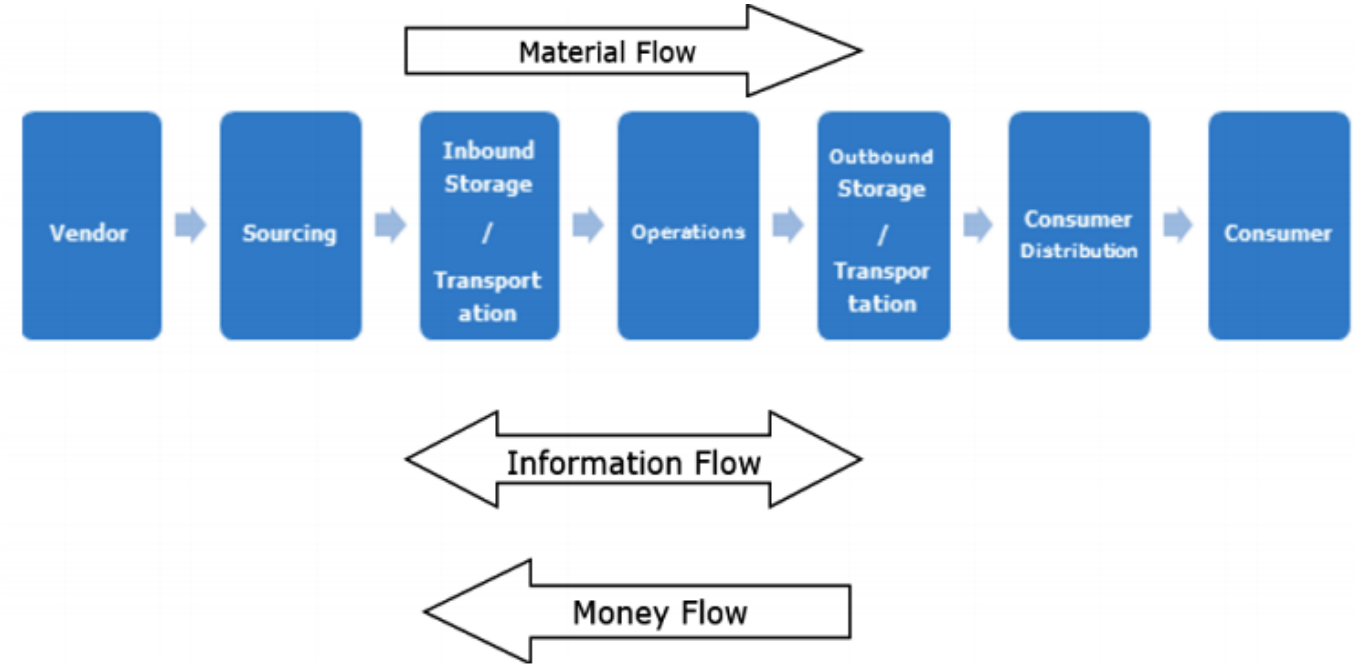
Deliver: The fourth stage is the delivery stage. Here the products are delivered to the customer at the destined location by the supplier. This stage is basically the logistics phase, where customer orders are accepted and delivery of the goods is planned.

Return: The last and final stage of supply chain management is referred as the return. In the stage, defective or damaged goods are returned to the supplier by the customer. Here, the companies need to deal with customer queries and respond to their complaints etc.

Supply Chain Management – Process Flow:

Supply chain management can be defined as a systematic flow of materials, goods, and related information among suppliers, companies, retailers, and consumers. There are three different types of flow in supply chain management:

1) Material flow
2) Information/Data flow
3) Money flow

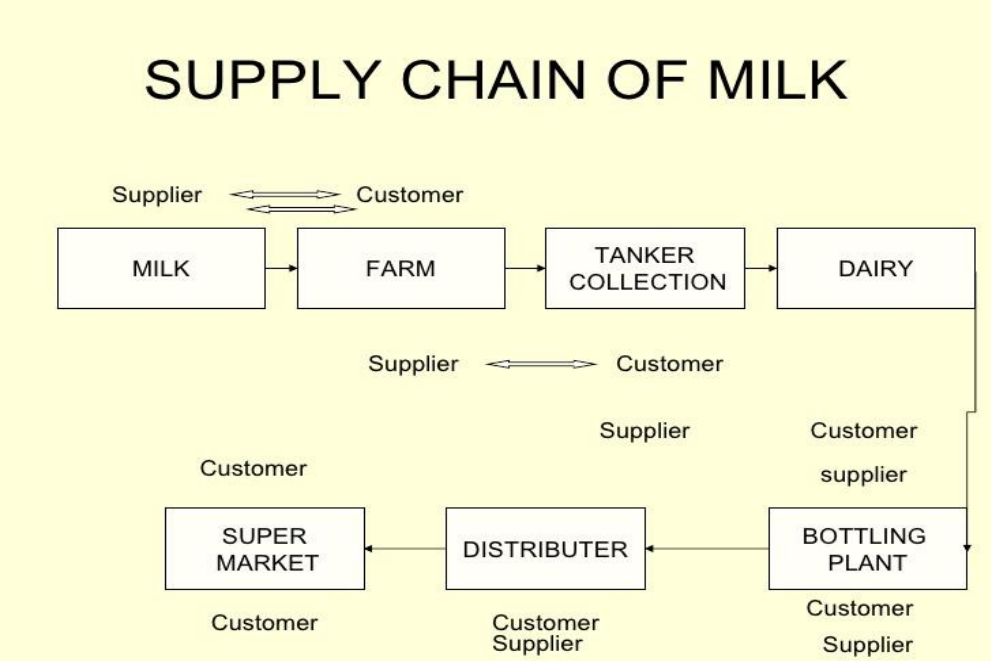


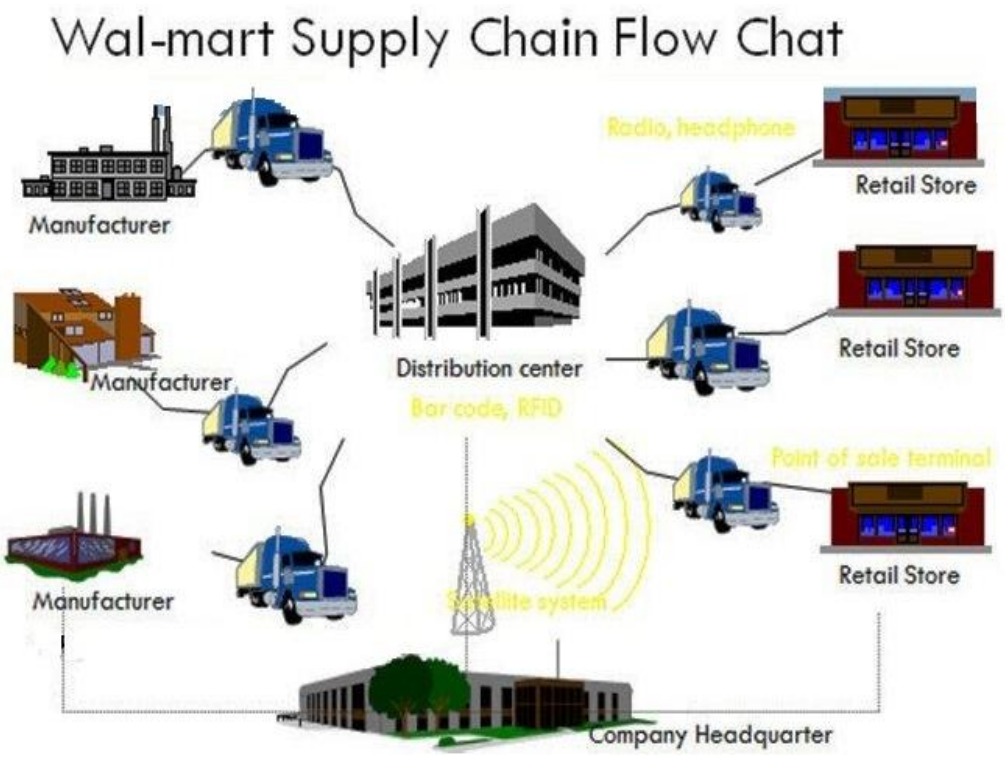
Supply Chain Management–Advantages:

The key benefits of supply chain management are as follows:

1) Develops better customer relationship and service.
2) Creates better delivery mechanisms for products and services in demand with minimum delay.
3) Improvises productivity and business functions.
4) Minimizes warehouse and transportation costs.
5) Minimizes direct and indirect costs.
6) Assists in achieving shipping of right products to the right place at the right time.
7) Enhances inventory management, supporting the successful execution of just-intime stock models.
8) Assists companies in adapting to the challenges of globalization, economic upheaval, expanding consumer expectations, and related differences.
9) Assists companies in minimizing waste, driving out costs, and achieving efficiencies throughout the supply chain process.

Example of Supply Chain Management





Quality Management-Concept:

Quality:

Quality has been the most exploited word but at the same time most miss-understood word. Quality is an off shoot of the work we do. It is a bi-product of an act. It shows the level of commitment in doing our activity. Examples such as: High quality at low price, Quality Hawaii chappal, High class quality etc., are being mentioned.

Definition: The Quality is defined in many ways:

Quality is Excellence: When quality is defined as excellence, it loses its measurability. Each person understands to the level of his own excellence and involves in his work. It is often misunderstood that high cost is high quality. Judgmental in nature. Ex. (Rolex watches, BMW automobiles).

Quality is Value: With this definition the performance and features or the usefulness of the products are compared to only the cost of price of the product. Many a times the utility/ possession value is more than the value of the product. Ex: the features of the product are compared to the cost of the product.

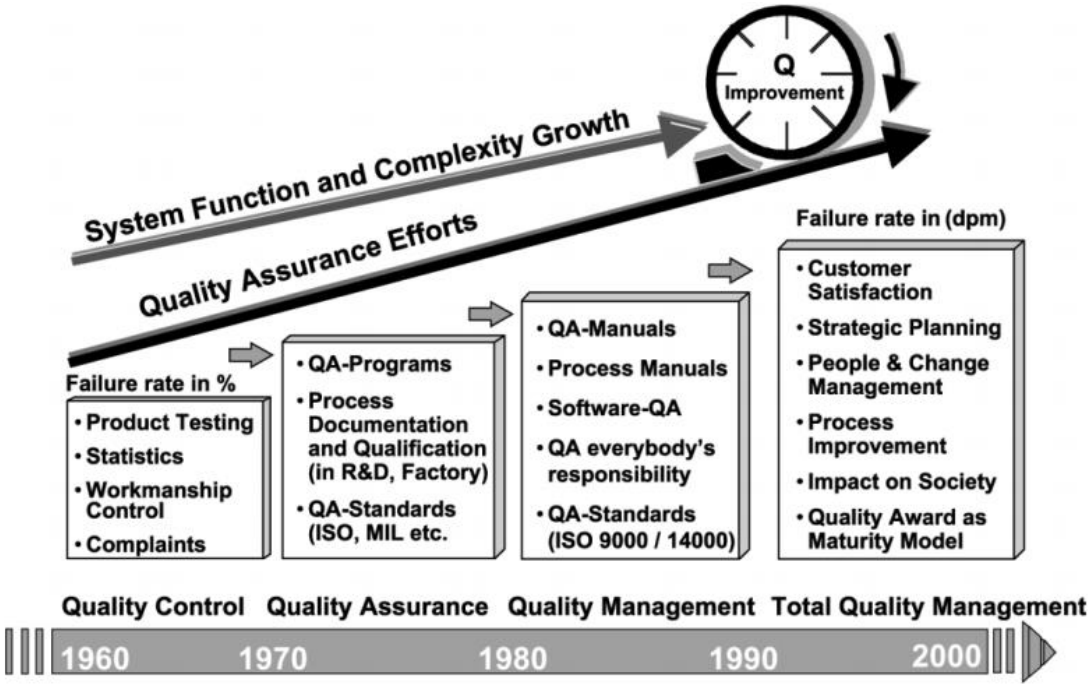
Quality is Conformance to Requirements: This definition has a manufacturing orientation. It requires that the customer gives the specification and the products are manufactured to that requirement.

Need for Quality:

1) Good quality of goods and services can provide an organization with competitive edge.
2) Good quality reduces costs due to product returns, rework and scrap.
3) Good quality increases productivity, profits and other measures of success such as brand image, product image and company goodwill.
4) Most importantly, good quality generates satisfied customers today and tomorrow.
5) Good quality creates an atmosphere for high employee morale, which improves productivity.

Evolution of Quality:

Before the concepts and ideas of TQM were formalised, much work had taken place over the centuries to reach this stage. This section charts the evolution, from inspection through to the present day concepts of total quality.



Quality Design or Design for Quality (DFQ):

The term quality of a part (or product or component) should refer to the product features that meet customers' needs and satisfaction and to avoidance from deficiencies that would minimize the chance of failure of the part. The quality in eight basic dimensions for a manufactured part which is outlined in Table below;

Sl. No.	Dimensions	Description
1	**Performance**	Does the product perform to its standards? Does the product provide the intended service?
2	**Features**	What additional benefits may be added to the product? Will there be any tangible or non-tangible benefit?
3	**Reliability**	Is the product consistent? Will it perform well over its lifetime and perform consistently?
4	**Durability**	How durable is the product? Will it last with daily use?
5	**Conformance**	Does your product meet with any agreed internal and national specifications?
6	**Serviceability**	Is the product easy to service?
7	**Aesthetics**	Is the product appealing to the eye?
8	**Perceived Quality**	What sort of quality perception does the marketing team want to convey in the marketing message? Will price charged reflect the quality of the product?

Importance of Design for Quality:

1) Design is more responsible for the quality than anything else. The designers determine the number of component in a specific part/product, decide which are to be procured externally, design the rest of the components and specify indirectly how they can be manufactured, determine how the parts must be assembled, and specify the overall function of the components in the final assembled part.
2) In other words, the designers largely influence the entire procurement, manufacturing and assembly cycles of any small part or large component.
3) Although manufacturing processes are often linked to the final quality of a part, both design and manufacturing are responsible for the final quality inherited by a part or component.
4) If the quality is envisaged appropriately in the design procedure, the quality in manufacturing can also be ensured at lesser expenses and the cost of inspection reduces significantly. This leads to the concept of Design for Quality.

Strategy to implement Design for Quality:

Following are a few frequently used techniques that are used to ensure design for quality.

Understand past quality issues: The root causes of any past quality issue should be realized and resolved thoroughly with the help of a multi-functional team having representatives from all the departments.

Designing the product rightly in the first time: It is always suggested to take utmost care so as to design the product right from the first time. Further, standard manufacturing techniques must be followed so that the quality in manufacturing can also be obtained from the first time itself.

Simplify the Design: Simplify the design such that the product can be built from the smallest number of parts.

Minimize Cumulative effect of Part Quality and Quantity:The quality of a product or component can be approximated by the average quality level of the parts following the expression as:

$$Q_P=(Q_a)^{n+1}$$

where $\mathbf{Q_p}$ refers to the quality level of the product, $\mathbf{Q_a}$ is the average quality level of parts and **n** is the number of parts in the product.

Select Parts for Quality: Too often parts are selected for functionality and cost. However to ensure quality by design, parts must also be selected for quality.

Optimize processing: Be sure that the manufacturing process selected is robust enough and can produce high quality products in production quantities. Also automating the process can be a good option.

Reuse Proven Design and Part: Use proven standard parts and design features that have been used successfully before and would be most likely to minimize risk and assure quality. A key goal for the designer should be to use proven design, parts and modules.

Document thoroughly and completely: In the rush to develop products, many designers fail to document every aspect of the design thoroughly so it is duty of developer to go for proper documentation of product completely from every aspects.

Implement incentives that reward quality: Many a times there are a lot of incentives for achieving the production deadline. Similar incentives should be defined to meet quality standards as well.

Utilize Quality Function Deployment: Quality function deployment (QFD) can be used define products to capture the voice of the customer the first time without the cost and risk of changing the design. QFD is a tool for systematically translating the requirements of the customer into product design specifications and resource prioritization.

Benefits of Design for Quality (DFQ):

1) The DFQ process allows the engineer to identify, plan for and manage factors that impact the robustness and reliability of the products in the design process.
2) DFQ reduces or eliminates the cost of quality that can be envisaged as the cost incurred in the inspection and rework, in the procurement of replacement materials.
3) Appropriate DFQ procedure can also avoid defects and errors, scrap, degradation of factory/machine capacity, re-qualifications/re-certifications expenses, and overhead demands
4) Improved and consistent quality of parts provide better appeal to the customers that obviously lead to greater stability of the manufacturing shops and can create greater amount of opportunities.

Control Chart(X, R, P):

What is a Control Chart?

1) A control chart is a statistical tool used to distinguish between variation in a process resulting from common causes and variation resulting from special causes.
2) It presents a graphic display of process stability or instability over time.
3) Control Charts differentiate between these two types of variation.
   One goal of using a Control Chart is to achieve and maintain process stability.

4) Process stability is defined as a state in which a process has displayed a certain degree of consistency in the past and is expected to continue to do so in the future.

Why Use Control Charts?

i. Monitor process variation over time
ii. Differentiate between special cause and common cause variation
iii. Assess effectiveness of changes
iv. Communicate process performance

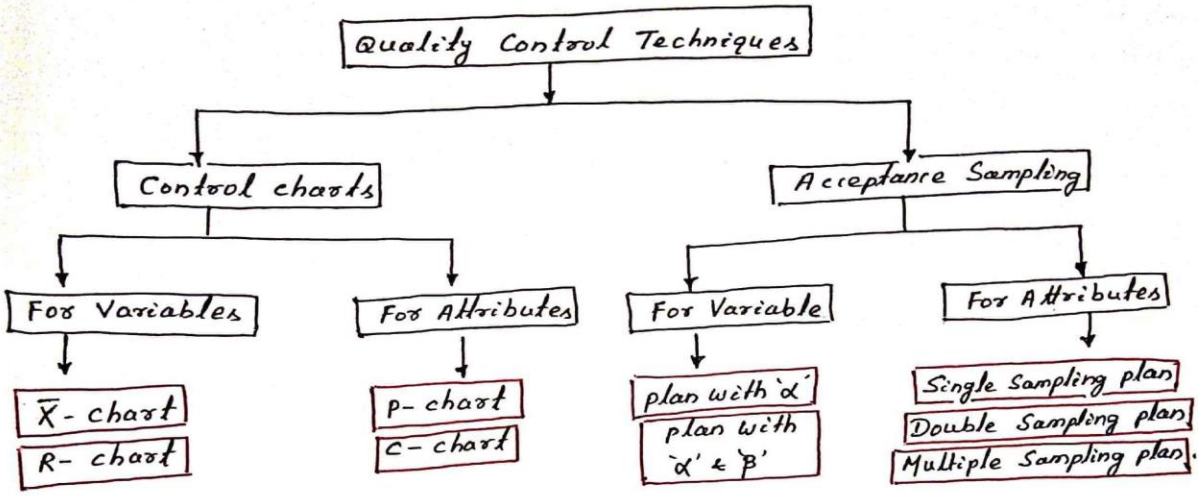
What are the types of Control Charts?

There are two main categories of Control Charts, those that display attribute data, and those that display variables data.

Attribute Data: This category of Control Chart displays data that result from counting the number of occurrences or items in a single category of similar items or occurrences. These "count" data may be expressed as pass/fail, yes/no, or presence/absence of a defect.

Variables Data: This category of Control Chart displays values resulting from the measurement of a continuous variable. Examples of variables data are elapsed time, temperature, and radiation dose.

Classification of Quality Control Techniques:-



Control charts

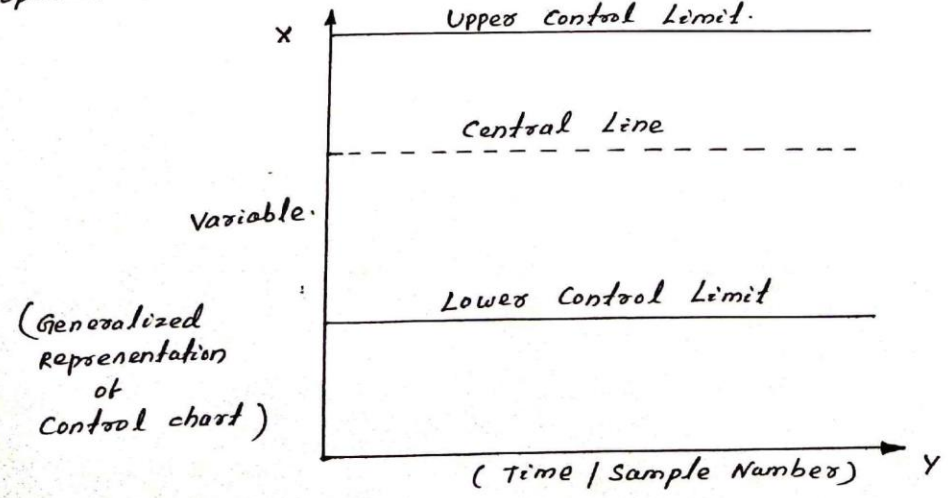
⇒ Control charts show the performance of a process from two points of view

⇒ First they show a snap-shot of the process at the moment the data are collected.

⇒ Second, they show the process trend as time progresses.

⇒ Process trend are important because they help in identifying the out-of-control status, if it actually exists.

⇒ Procem trend help to detect variations outside the normal operational limits and to identify the causes of variation.



⇒ In the figure, the X-axis shows observation number in sequence. The Y-axis shows the sample values of the observation.

⇒ There are three lines, namely upper control limit (UCL), lower control limit (LCL) and central line. The central line is w.r.t. the average of the observations.

⇒ The UCL & LCL jointly specify the range over which each sample observation can lie.

⇒ After plotting all the sample observations on the chart. If any sample observation is outside of these two limits, then it conclude that the process is out of control and definately requires corrective action.

Control Charts for Variable

⇒ These chart will use variable data of a process. These chart will reveal the variation between sample observation and it is of two types such as $\bar{X}$-chart & R-chart.

⇒ $\bar{X}$-chart given an idea of the central tendency of the observations. The $\bar{X}$-chart reveal the variations between sample observations.

⇒ R-chart given an idea about the spread (dispersion) of the observations. R-chart shown the variations within the samples.

$\bar{X}$-chart & R-chart

The formulas used to establish various control limits are as follows;

Control limits for $\bar{X}$-chart

$$\text{Upper Control limit, } UCL_{\bar{X}} = \bar{\bar{X}} + 3\sigma_{\bar{X}} = \bar{\bar{X}} + 3\sigma/\sqrt{n}$$

$$\text{Lower Control limit, } LCL_{\bar{X}} = \bar{\bar{X}} - 3\sigma_{\bar{X}} = \bar{\bar{X}} - 3\sigma/\sqrt{n}$$

where, $\bar{X}$ = Mean of a sample

$\bar{\bar{X}}$ = Mean of the sample means.

$\sigma_{\bar{X}} = \sigma/\sqrt{n}$ = Sample standard error.

Control limits for R-chart

$$\text{Upper Control limit. } UCL_R = R + 3\sigma_R$$

$$\text{Lower Control limit, } LCL_R = R - 3\sigma_R$$

where, R = Range of sample observations

σ_R = Standard deviation of R

Procedure to Construct $\bar{x}$-chart & R-chart

Step-1 ⇒ Identify the process to be controlled.

Step-2 ⇒ Select the variable of interest

Step-3 ⇒ Decide a suitable sample size (n) and no. of samples to be collected (K).

Step-4 ⇒ Collect the specified no. of samples over a given time interval.

Step-5 ⇒ Find the measurement of interest for each piece within the sample.

Step-6 ⇒ Obtain mean ($\bar{x}$) of each sample ($\bar{x} = \frac{\sum x_i}{n}$)

Also obtain Range (R) of each sample ($R = \max x_i - \min x_i$)

Then obtain $\bar{\bar{x}} = \frac{\sum \bar{x}}{K}$ & $\bar{R} = \frac{\sum R}{K}$

Step-7 ⇒ Establish control limits for $\bar{x}$-chart & R-charts.

Control limits for $\bar{x}$

$$UCL_{\bar{x}} = \bar{\bar{x}} + A\bar{R}$$

$$LCL_{\bar{x}} = \bar{\bar{x}} - A\bar{R}$$

Control limits for R

$$UCL_R = B\bar{R}$$

$$LCL_R = C\bar{R}$$

where, A = Mean Factor

B = Upper Range Factor

C = Lower Range Factor.

Table Factors of Control Charts

Sample Size n	Mean Factor A	Upper Range Factor B	Lower Range Factor C
2	1.88	3.27	0.00
3	1.02	2.57	0.00
4	0.73	2.28	0.00
5	0.58	2.11	0.00
6	0.48	2.00	0.00
7	0.42	1.92	0.08
8	0.37	1.86	0.14
9	0.34	1.82	0.18
10	0.31	1.78	0.22
11	0.29	1.74	0.26
12	0.27	1.72	0.28
13	0.25	1.69	0.31
14	0.24	1.67	0.33
15	0.22	1.65	0.35
16	0.21	1.64	0.36
17	0.20	1.62	0.38
18	0.19	1.61	0.39
19	0.19	1.60	0.40
20	0.18	1.59	0.41

Step-8 ⇒ Incorporate the control limit on $\bar{x}$ - chart & R- charts.

Step-9 ⇒ plot $\bar{x}$- and R- values in $\bar{x}$- and R- charts respectively.

Step-10 ⇒ Hunt for assignable causes when the process is out of control.

* when $\bar{x}$- chart is used along with R-chart, it tells when to leave the process alone and when to chase and hunt for the cause which leads to variation.

Control charts for Attributes

⇒ Quality measurements are expressed as attributes (good or bad etc.), in such situations, the percent defective chart (p- chart) or the number of defectives per sample area (c-chart) are considered to be more suitable control charts to control the quality.

⇒ Both charts convey a similar type of information, but p-chart is based on a normal distribution and the c-chart is based on the Poisson distribution.

P- chart (Percent Defective chart)

The main purposes of this chart are:

⇒ To discover the average proportion of non-conforming articles or parts submitted for inspection over a period of time.

⇒ To bring to the management attention, if there is any change in average quality level.

The formulas for control limits are as follows.

$$UCL_p = \bar{p} + 3\sqrt{\frac{\bar{p}(1-\bar{p})}{n}} = \bar{p} + 3\sigma_p$$

$$LCL_p = \bar{p} - 3\sqrt{\frac{\bar{p}(1-\bar{p})}{n}} = \bar{p} - 3\sigma_p$$

where, p = process percent defective of a sample
= (Number of defective items in a sample)/n

$\bar{p}$ = process mean percent defective.

n = Sample size

K = Number of samples

σ_p = standard deviation of per-cent defectives.

C- chart

This chart applies to the number of nonconformities in samples of constant size. 'c' is a variable representing the number of nonconformities (defects) in each sample. Usually, the sample size is considered to be one. The control limits of this chart are based on Poisson distribution. Some application of C-chart are listed below;

⇒ To control the no. of nonconforming rivets in an aircraft wing.
⇒ To control the no. of imperfection observed in a galvanized sheet.
⇒ To control the no. of surface imperfection on a large casting like gear blank which is used to rotate kiln in cement plants.
⇒ To control the number of defects in final assemblies (like, TV, radio, computer, I.C. Engines etc)

The formulas for control limits are given below:

$$UCL_c = \bar{c} + 3\sqrt{\bar{c}}$$

$$LCL_c = \bar{c} - 3\sqrt{\bar{c}}$$

where, $\bar{c}$ = the mean number of nonconformities. Also, this is the central line in the control chart.

(Example on X & R- Control Chart)

Example . The following data were obtained over a five-day period to indicate $\bar{X}$ and R control chart for a quality characteristic of a certain manufacturing product that had required a substantial amount of rework. All the figures apply to the product made on a single machine by a single operator. The sample size was 5. Two samples were taken per day. Comment on the process using $\bar{X}$- and R-charts.

Sample Number	Observations					$\bar{X}$	R
	1	2	3	4	5		
1	10	12	13	8	9	10.4	5
2	7	10	8	11	9	9.0	4
3	11	12	9	12	10	10.8	3
4	10	9	8	13	11	10.2	5
5	8	11	11	7	7	8.8	4
6	11	8	8	11	10	9.6	3
7	10	12	13	13	9	11.4	4
8	10	12	12	10	12	11.2	2
9	12	13	11	12	10	11.6	3
10	10	13	7	9	12	10.2	6

$$\Sigma \bar{X} = 103.2 \quad \Sigma R = 39$$

$$\bar{\bar{X}} = \Sigma \bar{X}/k = 103.2/10 = 10.32$$

$$\bar{R} = \Sigma R/k = 39/10 = 3.9$$

The values for A, B and C for the sample size of 5 are given below.

For $n = 5$, $A = 0.58$, $B = 2.11$ and $C = 0$.

Control limits for $\bar{X}$

$$UCL_{\bar{X}} = \bar{\bar{X}} + A\bar{R} = 10.32 + .58 \times 3.9$$
$$= 10.32 + 2.262 = 12.582$$
$$LCL_{\bar{X}} = \bar{\bar{X}} - A\bar{R} = 10.32 - 0.58 \times 3.9$$
$$= 10.32 - 2.262 = 8.058$$

Control limits for R

$$UCL_R = B\bar{R} = 2.11 \times 3.9 = 8.229$$
$$LCL_R = C\bar{R} = 0 \times 3.9 = 0$$

The above control limits for $\bar{X}$- and R-charts are shown in Figs. 18.5 and 18.6 respectively. The sample $\bar{X}$- and R-values are also plotted on the respective figures.

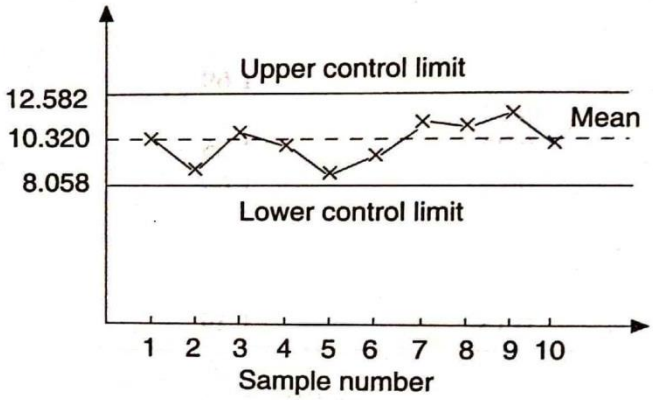


Fig. 18.5 $\bar{X}$-chart.

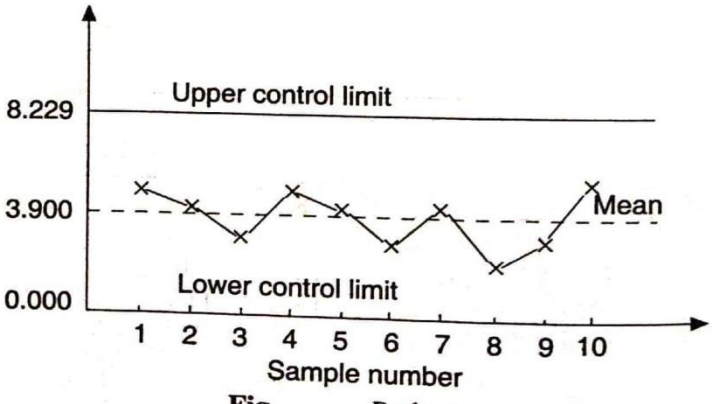


Fig. R-chart.

Comment. All the points in $\bar{X}$-chart are within the control. All the points on the R-chart are also within the control limits. But, there is a dominant up-trend towards right hand side of $\bar{X}$-chart. So, we will have to hunt for reasons for variations. This may be due to tool wear, operator fatigue, etc.

(Example on P- Control Chart)

Example . Alpha electronic company manufactures cathode ray tubes on mass production basis. At some intermediate point of production line, 15 samples of size 50 each have been taken. Tubes within each sample were classified into good or bad. The related data are given in the following table. Construct a *P*-chart with 3 sigma limit and comment on the process.

Sample Number	Number of Defective Tubes	Percentage of Defective Tubes
1	10	0.20
2	10	0.20
3	9	0.18
4	10	0.20
5	4	0.08
6	6	0.12
7	2	0.04
8	3	0.06
9	9	0.18
10	4	0.08
11	8	0.16
12	11	0.22
13	8	0.16
14	10	0.20
15	9	0.18

$$\bar{p} = 113/(15 \times 50) = 0.151$$

$$UCL_p = \bar{p} + 3\sqrt{\bar{p}(1-\bar{p})/n}$$

$$UCL_p = 0.151 + 3\sqrt{0.151(1-0.151)/50}$$

$$= 0.301$$

$$LCL_p = 0.151 - 3\sqrt{0.151(1-0.151)/50}$$

$$= .001 = 0 \text{ (Approx.)}$$

The limits are incorporated in the following Fig. along with the sample observations.

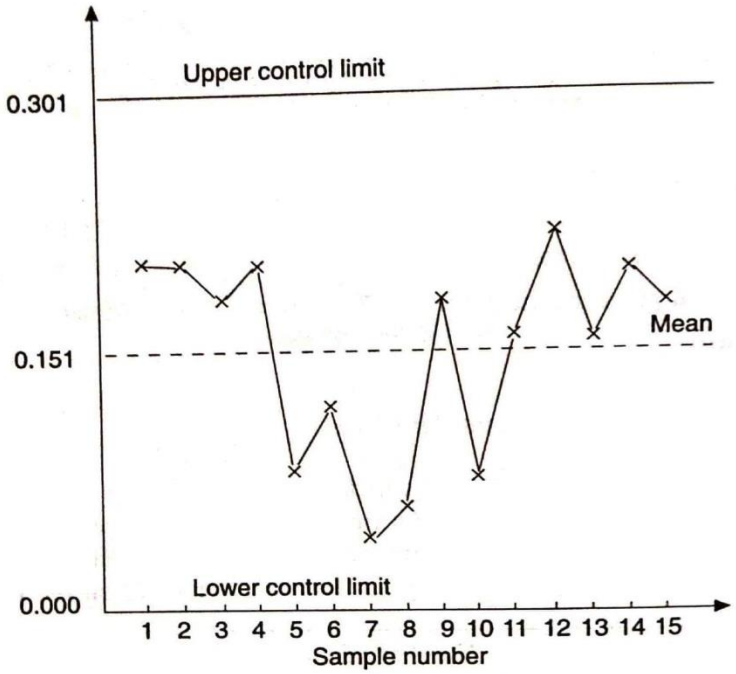


Fig. *P*-chart.

Solution. From this figure, it is clear that all the points are within the control limits. But, there is an upswing towards the right hand side of the figure. This means that there is predominant up-trend which may take the process out of control in future, if no corrective action is taken.

(Example on C- Control Chart)

Example The following table gives the number of missing rivets noted in a newly fabricated bus. Construct a *C*-chart

Bus Number	1	2	3	4	5	6	7	8	9	10
Number of missing rivets (c)	14	13	26	20	9	25	15	11	14	13

Solution.

$$\Sigma c = 160$$

$$\bar{c} = 16$$

$$UCL_c = \bar{c} + 3\sqrt{\bar{c}}$$

$$= 16 + 3 \times \sqrt{16} = 16 + 3 \times 4 = 28$$

$$LCL_c = \bar{c} - 3\sqrt{\bar{c}}$$

$$= 16 - 3\sqrt{16} = 16 - 3 \times 4 = 4$$

These are plotted as shown in Fig. The observations are scattered in the figure. This may be due to very frequent change of workers in the fabrication section or improper markings before performing riveting operation.

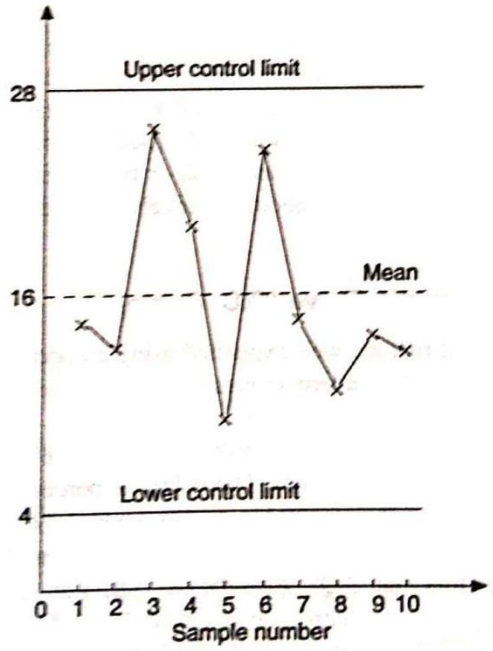


Fig. *C*-chart.

TQM (Total Quality Management):

In order to make business excellency in the present scenario, it calls for continuously changing process/method/procedure that makes the goods/services delighting to customers. TQM is that management philosophy which create such organization. Total Quality Control (TQC) is only limited to manufacturing department.

Definition

TQM is an integrated organizational approach in delighting customers (both external and internal) by meeting their expectation on a continuous basis through everyone involved with the organization working on continuous improvement basis in all products/processed along with proper problem solving methodology.

In other words, TQM means activities involving everyone (management persons & workers) in a totally integrated effort towards improving performance at every level. Improved performance means: Quality, cost, manpower development, quality of work life etc. It leads to increased customer and employee satisfaction.

In short, the definition implies – continuously meeting customers requirement at the lowest cost by utilizing the potential of all employees. Hence TQM can also be called as = Continuous Quality Improvement (CQI).

Why TQM? The reasons are:

1. Commitment to customers.
2. Improved productivity and quality.
3. Reduced cost.
4. Improved company's image.
5. Increased employees participation.

Principles of TQM

1. Agree with customers requirement.
2. Understand customers/suppliers.
3. Do the right things.
4. Do things right first time.
5. Various measures/action for success.
6. Continuous improvement is the goal.
7. Training is essential.
8. Better communication skills.

TQM should become a way of life. Once started, it is never ending. Continuous improvement is the goal. The top management should demonstrate their commitment to the subordinate consistently so that

remaining members of the organization can follow it. Total means really total. TQM is a process of habitual improvement, where control is embedded within and is driven by the culture of organization.

Where applicable?

TQM is applicable to all functions/organization

TQM is traditional approach.

	TQM Approach		Traditional Approach
1	No workers, no managers, only facilitators and team members	**1**	Blue collar employees – workers white collar employees – managers
2	Here everyone is given importance.	**2**	Here only top managers (decision makers) are given importance.
3	Employees can voluntarily participate to look after various problems and take the pride of solving the problems.	**3**	Workers participation is legislated and take part at the time of bargaining (for money & other facilities).
4	Employee mostly focuses of organizational needs especially meeting the customers' requirements.	**4**	Workers/managers focuses mostly on their needs.
5	Open-ness, trust and respect is observed.	**5**	Secretive, distrust and hatred culture.
6	Integrated co-operative (family like) working culture.	**6**	Conflict, win/loss style.

TQM philosophy was implemented in every organization after 1970. From this time the boss & servant culture has been changed to friendly (family like) working environment.

Introduction to ISO-9000

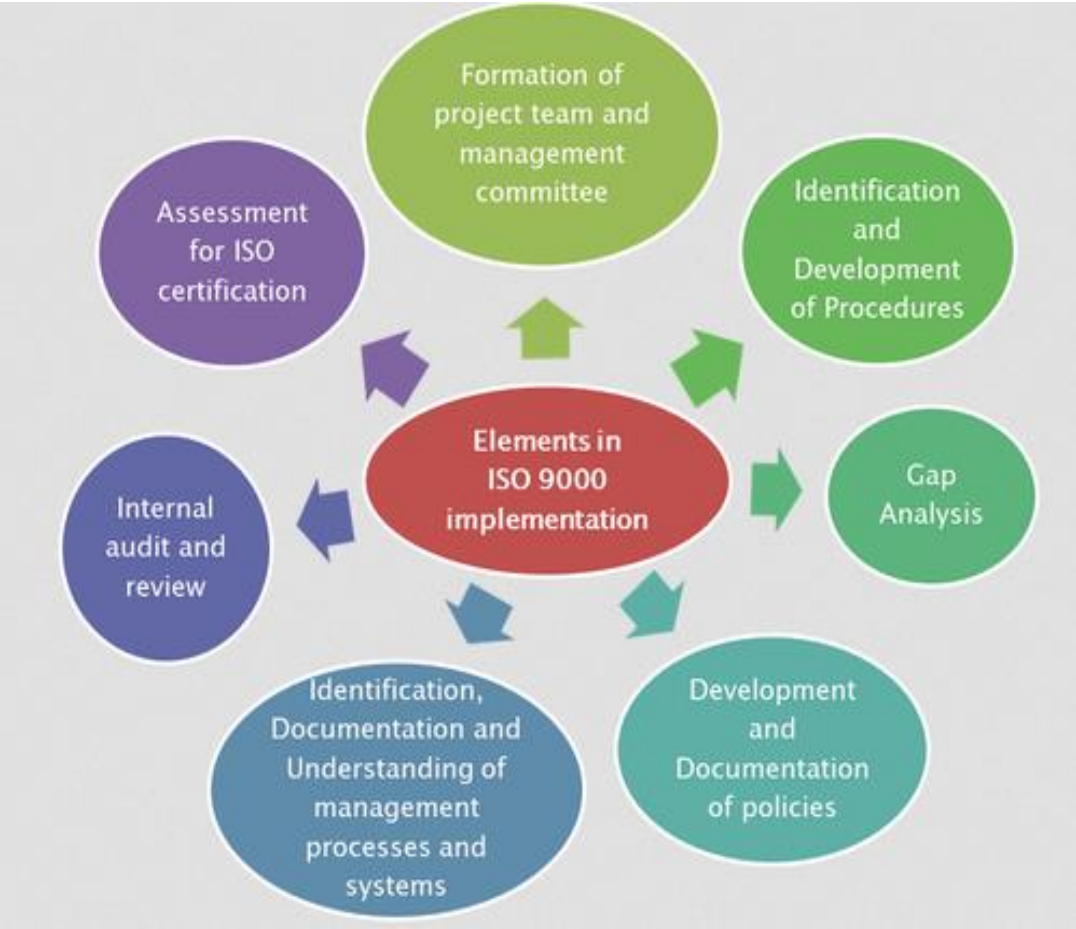
1) ISO stands for International Organization for Standardization. It is an international body consists of representatives from more than 90 countries. The national standard bodies of these countries are the members of this organization. This is a non-government organization. It provides common standards of goods and services on international trades.

2) ISO 9000 is defined as a set of international standards on quality management and quality assurance developed to help companies effectively document the quality system elements needed to maintain an efficient quality system. They are not specific to any one industry and can be applied to organizations of any size.

3) ISO 9000 can help a company satisfy its customers, meet regulatory requirements, and achieve continual improvement. It should be considered to be a first step or the base level of a quality system.

4) The ISO 9000 family of quality management systems (QMS) standards is designed to help organisations ensure that they meet the needs of customers and other stakeholders while meeting statutory and regulatory requirements related to a product or service.

5) ISO 9000 deals with the fundamentals of quality management systems, including the seven quality management principles upon which the family of standards is based. ISO 9001 deals with the requirements that organizations wishing to meet the standard must fulfill.



ISO 9000 series Quality Management Principles

The ISO 9000 series are based on seven quality management principles (QMP)

The seven quality management principles are:

QMP 1 – Customer focus
QMP 2 – Leadership
QMP 3 – Engagement of people
QMP 4 – Process approach
QMP 5 – Improvement
QMP 6 – Evidence-based decision making
QMP 7 – Relationship management

Principle 1 – Customer focus: Organizations depend on their customers and therefore should understand current and future customer needs, should meet customer requirements and strive to exceed customer expectations.
Principle 2 – Leadership: Leaders establish unity of purpose and direction of the organization. They should create and maintain the internal environment in which people can become fully involved in achieving the organization's objectives.
Principle 3 – Engagement of people: People at all levels are the essence of an organization and their full involvement enables their abilities to be used for the organization's benefit.
Principle 4 – Process approach: A desired result is achieved more efficiently when activities and related resources are managed as a process.
Principle 5 – Improvement: Improvement of the organization's overall performance should be a permanent objective of the organization.
Principle 6 – Evidence-based decision making: Effective decisions are based on the analysis of data and information.
Principle 7 – Relationship management: An organization and its external providers (suppliers, contractors, service providers) are interdependent and a mutually beneficial relationship enhances the ability of both to create value.

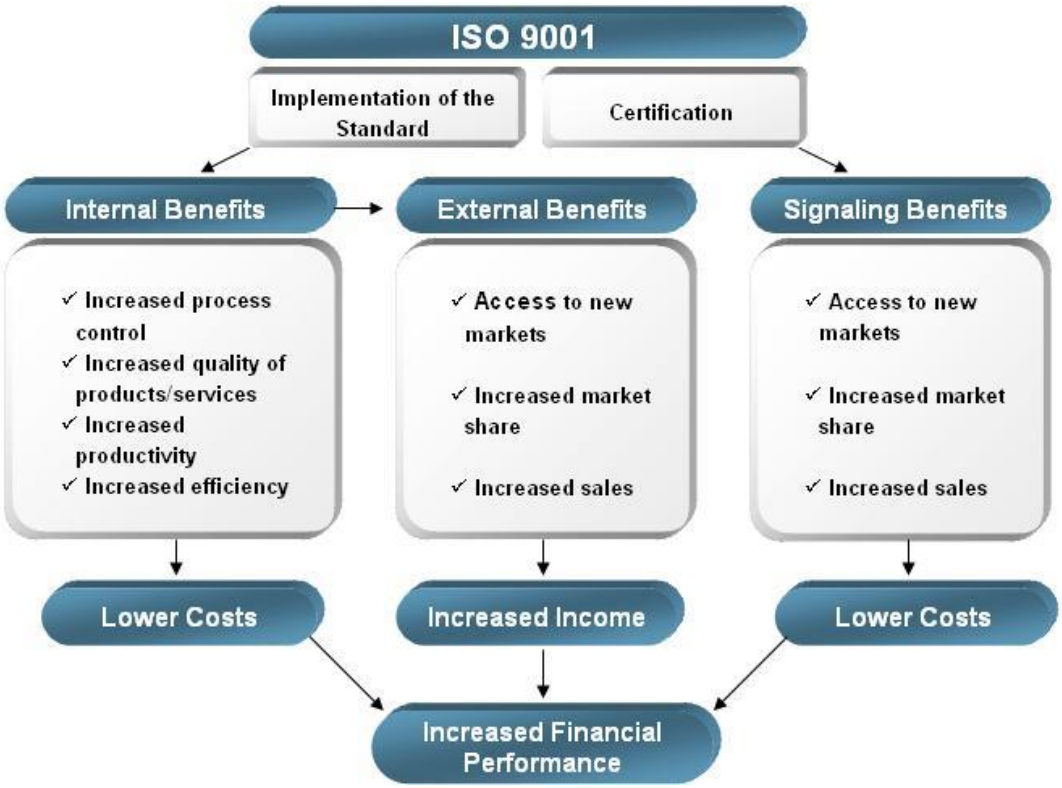
ISO 9000 series has 5 nos. of international standards on quality management with different objectives as stated in the following.

Sl. No.	ISO	Description

1	ISO 9000	Provides general guidelines for quality standard
2	ISO 9001	Provide guidelines for supplier i.e. a) Design & development b) Production c) Installation d) Servicing (It has 20 elements)
3	ISO 9002	Provide guidelines for manufacturer i.e. a) Production b) Installation It has 18 elements (i.e. excepts design & development as comp. to 9001)
4	ISO 9003	Provides guidelines for test houses i.e. a) Final inspection b) Testing for laboratories and warehouses. (It has 12 elements)
5	ISO 9004	Provide guidelines for i.e. a) Quality management b) Quality assurance

Benefits of 9000 series

1) It helps to compete with global market.
2) Consistency in quality as ISO guidelines detect defective early so that rectification is possible.
3) Documentation of quality procedure adds clarify to quality system.
4) It gives guidelines and ensures adequate and regular quality training for all members of the organization.
5) It helps the customers to have cost effective purchase procedure.
6) The customers need not spend much time for quality testing for the firm holding ISO certificate.
7) The job satisfaction is more.
8) It also help in increasing productivity by reducing wastage and improvement of quality (for which revenue is high).



Steps in ISO 9000 Registration

The following steps are followed in ISO 9000 registration

1) Selection of appropriate standard i.e., ISO 9001/9002/9003 using guidelines given in ISO 9000.
2) Preparation of quality manual to cover all the elements in the selected standard.
3) Preparation of procedure and shop floor instruction which are used at the time of implementing the system. Also document these items.
4) Self-auditing to check compliance for the selected standard/model.
5) Selection of a Registrar (an independent person with knowledge and experience to evaluate any one of the three quality system i.e., ISO9001/9002/9003) and application is to be submitted to obtain certificate for the selected quality standard/system/model.

The various elements involved in ISO 9001 & ISO 9002 are stated in the following.

Sl. No.	System requirement	ISO9001	ISO9002
1	Management responsibility	√	√
2	Quality system	√	√
3	Product identification & traceability	√	√
4	Inspection status	√	√
5	Inspection & testing	√	√
6	Inspection, measuring & test equipment	√	√
7	Controlling of non-conforming product	√	√
8	Handling, storage, packaging & delivery	√	√
9	Document control	√	√
10	Quality record	√	√
11	Training	√	√
12	Statistical technique	√	√
13	Internal auditing	√	√
14	Contract review	√	√
15	Purchasing	√	√
16	Process control	√	√
17	Purchaser supplied product	√	√
18	Corrective action	√	√
19	Design control	√	×
20	Servicing	√	√

Introduction to ISO-14000:

1) ISO 14000 is defined as a series of international environmental management standards, guides, and technical reports. It is other wisely called Environment management system.
2) The standards specify requirements for establishing an environmental management policy, determining environmental impacts of products or services, planning environmental objectives, implementing programs to meet objectives, and conducting corrective action and management review.
3) The first environmental management system standard, BS 7750, was published in 1992 by the BSI group. In 1996, the International Organization for Standardization (ISO) created the ISO 14000 family of standards. ISO 14001 underwent revision in 2004. The current revision of ISO 14001 was published in September 2015.
4) The ISO 14000 standards provide a guideline or framework for organizations that need to systematize and improve their environmental management efforts. The ISO 14000 standards are

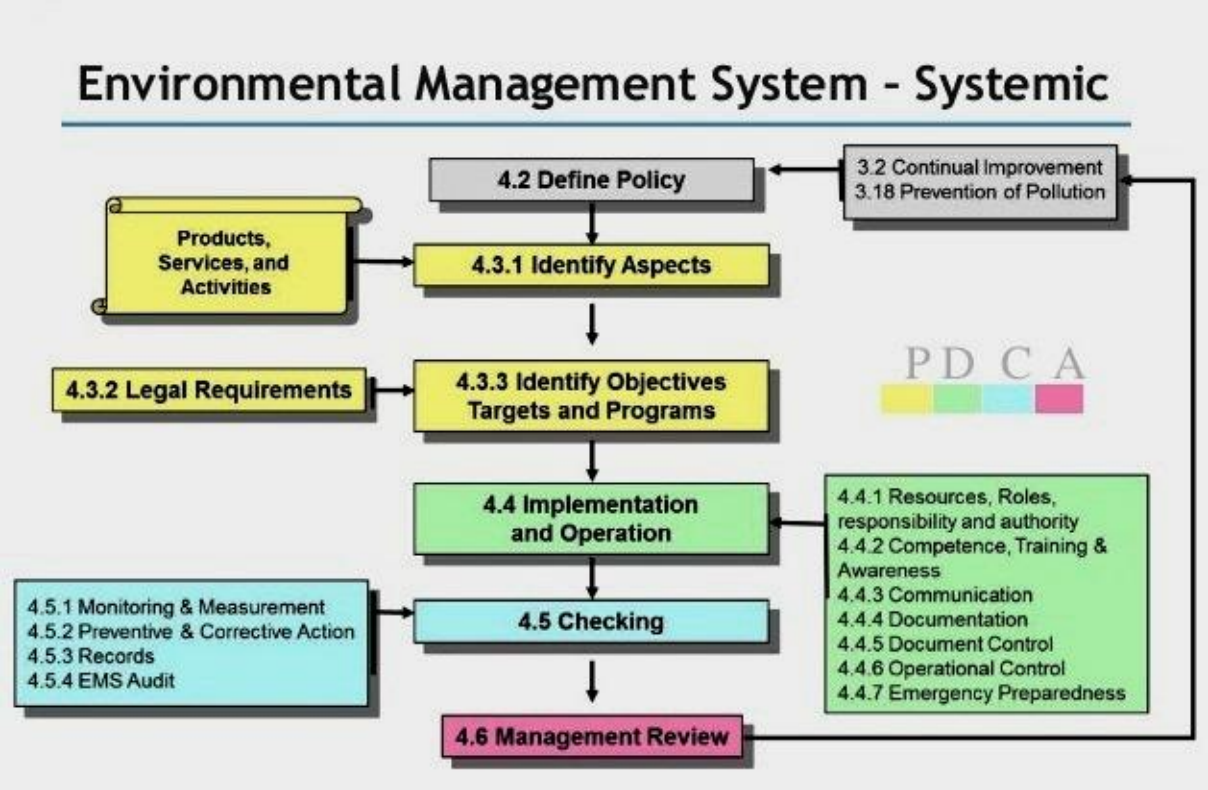
not designed to aid the enforcement of environmental laws and do not regulate the environmental activities of organizations.

5) The ISO 14000 family is designed to be implemented according to the same Plan-Do-Check-Act (PDCA) cycle underlying all ISO management systems standards. The following table classifies the standards making up the ISO 14000 family according to their optimal place in the PDCA cycle.



Features of an Environmental Management System (EMS):

1) Serves as a tool, or process, to improve environmental performance and information mainly "design, pollution control and waste minimization, training, reporting to top management, and the setting of goals"
2) Provides a systematic way of managing an organization's environmental affairs
3) EMS assists with planning, controlling and monitoring policies in an organization which addresses immediate and long-term impacts of its products, services and processes on the environment.
4) Gives order and consistency for organizations to address environmental concerns through the allocation of resources, assignment of responsibility and ongoing evaluation of practices, procedures and processes.
5) Sets framework for training to achieve objectives and desired performance.
6) Helps understand legislative requirements to better determine a product or service's impact, significance, priorities and objectives.
7) Focuses on continual improvement of the system and a way to implement policies and objectives to meet a desired result. Encourages contractors and suppliers to establish their own EMS.
8) Facilitates e-reporting to federal, state and provincial government environmental agencies through direct upload.



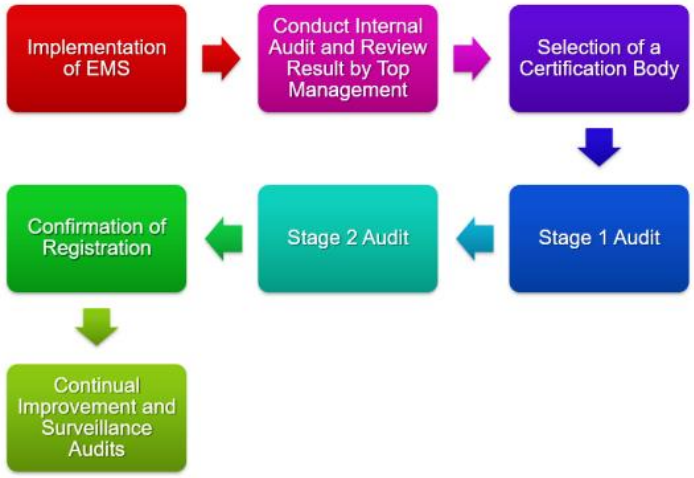
ISO 14000 family of standards provides management tools for organizations to manage their environmental aspects and assess their environmental performance. Together, these tools can provide significant tangible economic benefits, including the following :

1) Reduced raw material/resource use
2) Reduced energy consumption
3) Improved process efficiency
4) Reduced waste generation and disposal costs
5) Utilization of recoverable resources.

ISO 14000 FAMILY

ISO 14000 Standard	Title	General Description	Thrust Area
14001:1996	Environmental Management Systems—Specification with Guidance for Use	Main organizational environmental standard and the ISO standard to which an EMS is formally registered	Organizational
14004:1996	Environmental Management Systems—General Guidelines on Principles, Systems and Supporting Techniques	Complementary document to ISO 14001 which provides more information and assistance in understanding and implementing the EMS standard.	Organizational
14010:1996	Guidelines for Environmental Auditing—General Principles	Covers the concepts of environmental auditing which can be used separately to create an organizational environmental audit program or is used to implement a program in support of the ISO 14001 EMS audit requirements	Organizational

ISO 14001 Certification Process



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