Republic of Iraq

Ministry of Higher Education And Scientific Research

Al-Muthanna University

College of Engineering

Chemical Engineering Department

Industrial Management I

For Third Year

2021-2020

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Chapter 1

Production and Operation Management

1.1 Introduction

Production/operations management is the process, which combines and transforms various resources used in the production/operations subsystem of the organization into value added product/services in a controlled manner as per the policies of the organization. Therefore, it is that part of an organization, which is concerned with the transformation of a range of inputs into the required (products/services) having the requisite quality level. The set of interrelated management activities, which are involved in manufacturing certain products, is called as **production management**. If the same concept is extended to **services management**, then the corresponding set of management activities is called as **operations management**.

1.2 Important of Production Management

The importance of production management in a business is that it will spearhead the process that will ultimately bring in profit to the business. There are several responsibilities and tasks that a production management team is responsible for and it is a very stressful job because a product manager needs to make sure they are constantly making profit from the manufactured services that they are selling. The importance of production management to the business firm:

1. Accomplishment of firm's objectives:

Production management helps the business firm to achieve all its objectives. It produces products, which satisfy the customers' needs and wants. Therefore, the firm will increase its sales.

2. Reputation, Goodwill and Image:

Production management helps the firm to satisfy its customers. This increases the firm's reputation, goodwill and image. A good image helps the firm to expand and grow.

3. Helps to introduce new products:

Production management helps to introduce new products in the market. It conducts Research and development (R&D). This helps the firm to develop newer and better quality products.

4. Supports other functional areas:

Production management supports other functional areas in an organisation, such as marketing, finance, and personnel. The marketing department will find it easier to sell good-quality products, and the finance department will get more funds due to increase in sales.

5. Helps to face competition:

Production management helps the firm to face competition in the market. This is because production management produces products of right quantity, right quality, and right price and at the right time.

6. Optimum utilization of resources:

Production management facilitates optimum utilisation of resources such as manpower, machines, etc. So, the firm can meet its capacity utilisation objective. This will bring higher returns to the organisation.

7. Minimizes cost of production:

Production management helps to minimize the cost of production. It tries to maximise the output and minimise the inputs. This helps the firm to achieve its cost reduction and efficiency objective.

1.3 Production System

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. 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.

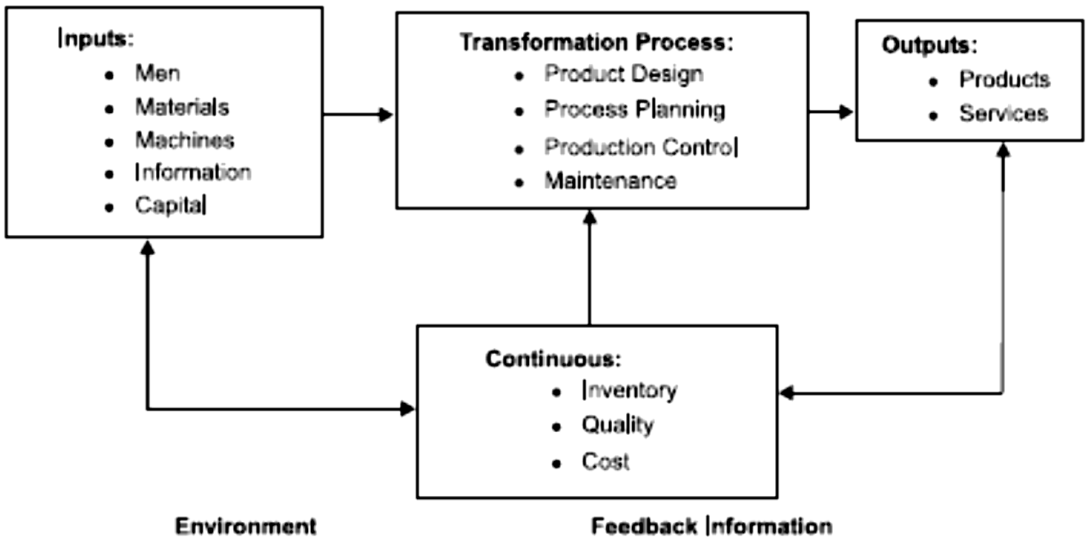

Fig. 1.1 Schematic production system

1.3.1 Classification of Production System

Production systems can be classified as Job Shop, Batch, Mass and Continuous Production systems.

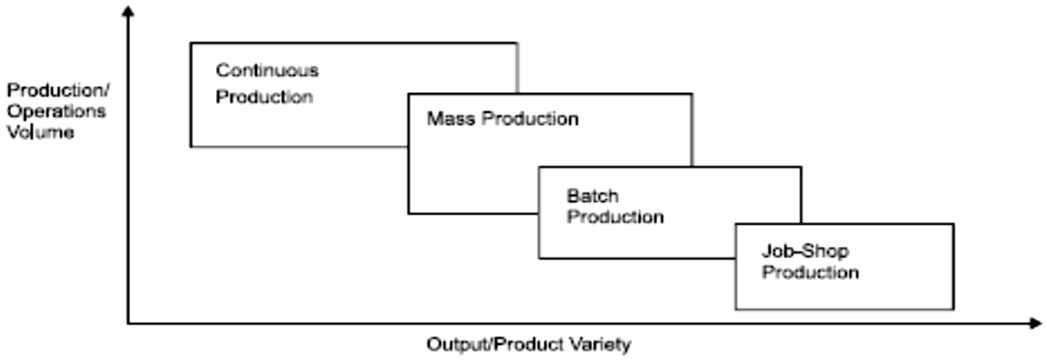

Fig. 1.2 Classification of production systems

I. Job Shop Production

Job shop production are characterized by manufacturing of one or few quantity of products designed and produced as per the specification of customers within prefixed time and cost. The distinguishing feature of this is low volume and high variety of products. A job shop comprises of general purpose machines arranged into different departments. Each job demands unique technological requirements, demands processing on machines in a certain sequence.

Characteristics The Job-shop production system is followed when there is:

1. High variety of products and low volume. **2.** Use of general purpose machines and facilities.

3. Highly skilled operators who can take up each job as a challenge because of uniqueness.

Advantages

Following are the advantages of job shop production:

1. Because of general purpose machines and facilities variety of products can be produced.

2. Operators will become more skilled and competent, as each job gives them learning opportunities.

3. Full potential of operators can be utilized.

Limitations

Following are the limitations of job shop production:

1. Higher cost due to frequent set up changes. **2.** Higher level of inventory at all levels and hence higher inventory cost. **3.** Production planning is complicated. **4.** Larger space requirements.

II. Batch Production

Batch production is defined by American Production and Inventory Control Society (**APICS**) "as a form of manufacturing in which the job passes through the functional departments in lots or batches and each lot may have a different routing." It is characterized by the manufacture of limited number of products produced at regular intervals and stocked awaiting sales.

Characteristics Batch production system is used under the following circumstances:

1. When there is shorter production runs.

2. When plant and machinery are flexible.

3. When manufacturing lead time and cost are lower as compared to job order production.

Advantages Following are the advantages of batch production:

1. Better utilization of plant and machinery. **2.** Promotes functional specialization.

3. Cost per unit is lower as compared to job order production. **4.** Lower investment in plant and machinery.

Limitations Following are the limitations of batch production:

1. Material handling is complex because of irregular and longer flows. **2.** Production planning and control is complex.

III. Mass Production

Manufacture of discrete parts or assemblies using a continuous process are called mass production. This production system is justified by very large volume of production. The machines are arranged in a line or product layout. Product and process standardization exists and all outputs follow the same path.

Characteristics Mass production is used under the following circumstances:

1. Standardization of product and process sequence. **2.** Large volume of products.

3. Shorter cycle time of production. **4.** Lower in process inventory.

Advantages Following are the advantages of mass production:

1. Higher rate of production with reduced cycle time. **2.** Less skilled operators are required.

3. Low process inventory. **4.** Manufacturing cost per unit is low.

Limitations Following are the limitations of mass production:

1. Breakdown of one machine will stop an entire production line. **2.** High investment in production facilities. **3.** The cycle time is determined by the slowest operation.

IV. Continuous Production

Production facilities are arranged as per the sequence of production operations from the first operations to the finished product. The items are made to flow through the sequence of operations through material handling devices such as conveyors, transfer devices, etc.

Characteristics Continuous production is used under the following circumstances:

1. Dedicated plant and equipment with zero flexibility. **2.** Material handling is fully automated.

3. Process follows a predetermined sequence of operations. **4.** Planning and scheduling is a routine action.

Advantages Following are the advantages of continuous production:

1. Standardization of product and process sequence. **2.** Higher capacity utilization due to line balancing.

3. Person with limited skills can be used on the production line.

Limitations Following are the limitations of continuous production: **1.** Flexibility to accommodate and process number of products does not exist. **2.** Very high investment for setting flow lines. **3.** Product differentiation is limited.

1.4 Objectives of Production Management

The objective of the production management is 'to produce goods services of right quality and quantity at the right time and right manufacturing cost'.

1. Right quality

The quality of product is established based upon the customers' needs. The right quality is not necessarily best quality. It is determined by the cost of the product and the technical characteristics as suited to the specific requirements.

2. Right quantity

The manufacturing organization should produce the products in right number. If they are produced in excess of demand the capital will block up in the form of inventory and if the quantity is produced in short of demand, leads to shortage of products.

3. Right time

Timeliness of delivery is one of the important parameter to judge the effectiveness of production department. So, the production department has to make the optimal utilization of input resources to achieve its objective.

4. Right manufacturing cost

Manufacturing costs are established before the product is actually manufactured. Hence, all attempts should be made to produce the products at pre-established cost, so as to reduce the variation between actual and the standard (pre-established) cost.

1.5 Major functions covered in the production management system are as follows:

A- Planning: - Planning is the main function of management. All other functions follow the planning function.

B- Organization: - Organizing is an important function of management by which it combines the human power with other resources to give desired output

C- Leading

1- Staffing; for a new enterprise, staffing function is followed by planning and organizing functions. Staffing function comprises, the activities essential to manage and keep manned the positions created by the organization structure

2- Directing is a function which includes all those activities which are designed to encourage subordinates to work effectively both in short and long run.

D- Controlling

Controlling is a continuous process of measuring actual results in relation to those planned. Controlling can also be defined as that managerial activity whereby the manager compares actual performance against the planned one, find out the deviation, and take corrective actions.

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1.6 Operations Management

➤ What is the operation management?

Operations management can be defined as "a systematic approach to address all the issues pertaining to the transformation process that converts some inputs into output that are useful, and could fetch revenue to the organization.

Operations management is inter-connected with many other business functions such as marketing, new product development, accounting and finance, human resources management (HRM), supply-chain management, as well as, technical functions of the business. For example, the quality of supply chain management for the Company directly effects operations management in a way that inbound logistics of raw materials of low quality is going to compromise the quality of the output.

Activities involved in operations management for the Company include designing processes and products, controlling and purchasing the inventory, planning and control of operations and planning raw materials and production capacity.

➤ Why is operations management important in all types of organization?

Operations in the organization, the operations function is central to the organization because it produces the goods and services that are its reason for existing, but it is not the only function. It is, however, one of the three core functions of any organization. These are:

- The marketing (including sales) function – which is responsible for communicating the organization's products and services to its markets in order to generate customer requests for service;
- The product/service development function – which is responsible for creating new and modified products and services in order to generate future customer requests for service;
- The operations function – which is responsible for fulfilling customer requests for service through the production and delivery of products and services.

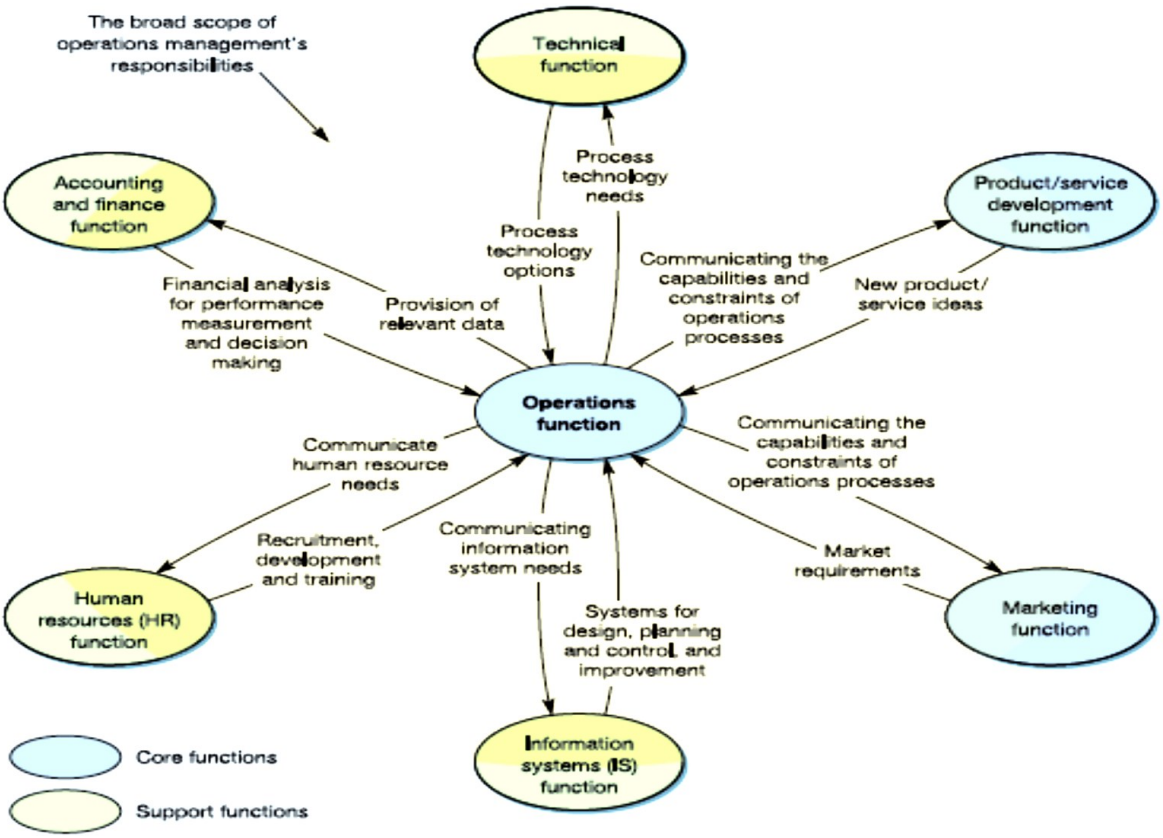

Figure 1.3 The relationship between the operations function and support functions of the Organization.

➤ What is the input–transformation–output process?

All operations produce products and services by changing inputs into outputs using an 'input-transformation-output' process. Figure 1.4 shows this general transformation process model.

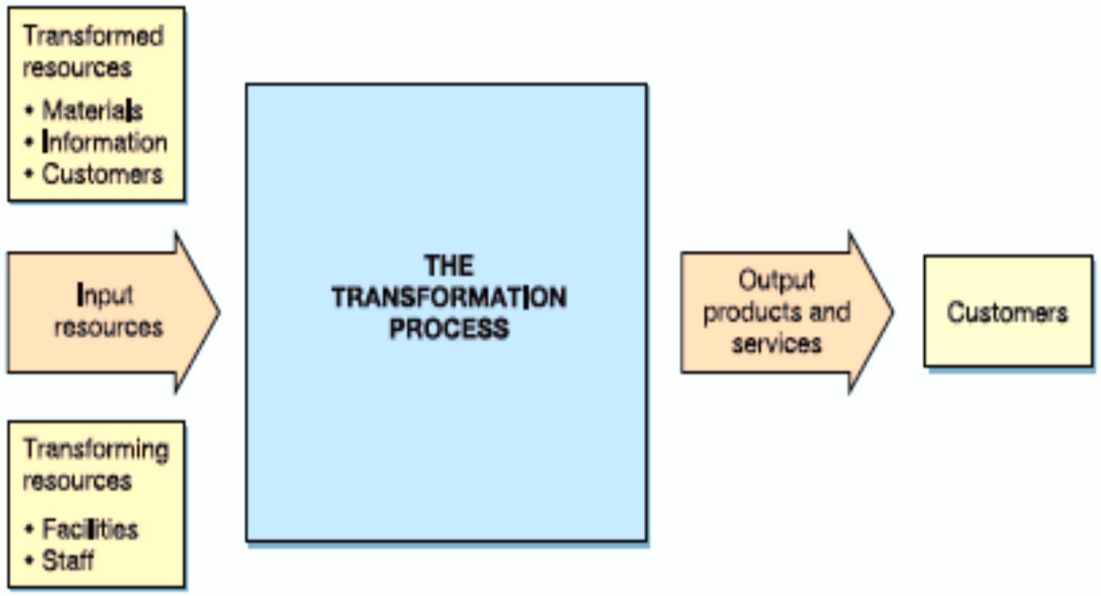

Figure 1.4 All operations are input–transformation–output processes

1.6.1 Inputs to the process

One set of inputs to any operation's processes are transformed resources. These resources are treated, transformed or converted in the process. They are usually a mixture of the following:

● Materials – operations that process materials could do so to transform their physical properties. Most manufacturing operations are like this.

● Information – operations that process information could do so to transform their informational properties (that is the purpose or form of the information); accountants do this.

● Customers – operations that process customers might change their physical properties in a similar way to materials processors: for example, hairdressers or cosmetic surgeons.

➤ What are the activities of operations management**?**

● Responsibilities include understanding relevant performance objectives, setting an operations strategy, the design of the operation (products, services and processes), planning and controlling the operation, and the improvement of the operation over time.

● Operations managers also have a set of broad societal responsibilities. These are generally called 'corporate social responsibility' or CSR objectives.

1.7 Concept of Operations

An operation is *defined in terms of the mission it serves for the organization, technology it employs and the human and managerial processes it involves*. Operations in an organization can be categorized into **manufacturing operations** and **service operations**. Manufacturing operations is a conversion process that includes manufacturing yields a tangible output: a product, whereas, a conversion process that includes service yields an intangible output: a deed, a performance, an effort.

1.7.1 Distinction between Manufacturing Operations and Service Operations

Following characteristics can be considered for distinguishing manufacturing operations with service operations:

1. Tangible/Intangible nature of output **2.** Consumption of output

3. Nature of work (job) **4.** Degree of customer contact

5. Customer participation in conversion **6.** Measurement of performance.

Manufacturing is characterized by tangible outputs (products), outputs that customers consume overtime, jobs that use less labor and more equipment, little customer contact, no customer participation in the conversion process (in production), and sophisticated methods for measuring production activities and resource consumption as product are made.

Service is characterized by intangible outputs, outputs that customers consumes immediately, jobs that use more labor and less equipment, direct consumer contact, frequent customer participation in the conversion process, and elementary methods for measuring conversion activities and resource consumption. Some services are equipment based namely rail-road services, telephone services and some are people based namely tax consultant services, hair styling.

1.8 Operations Management

Managing operations can be enclosed in a frame of general management function. Operation managers are concerned with planning, organizing, and controlling the activities which affect human behavior through models.

PLANNING

The operations manager defines the objectives for the operations subsystem of the organization, and the policies, and procedures for achieving the objectives. This stage includes clarifying the role and focus of operations in the organization's overall strategy.

ORGANIZING

Operation managers establish a structure of roles and the flow of information within the operations subsystem. They determine the activities required to achieve the goals and assign authority and responsibility for carrying them out.

CONTROLLING

To ensure that the plans for the operations subsystems are accomplished, the operations manager must exercise control by measuring actual outputs and comparing them to planned operations management.

BEHAVIOUR

Operation managers are concerned with how their efforts to plan, organize, and control affect human behaviour. They also want to know how the behaviour of subordinates can affect management's planning, organizing, and controlling actions. Their interest lies in decision-making behaviour.

MODELS

As operation managers plan, organize, and control the conversion process, they encounter many problems and must make many decisions. They can simplify their difficulties using models like aggregate planning models for examining how best to use existing capacity in short-term, break even analysis to identify break even volumes, linear programming and computer simulation for capacity utilization, decision tree analysis for long-term capacity problem of facility expansion, simple median model for determining best locations of facilities etc.

1.9 Managing Global Operations

The term '**globalization**' describes businesses' deployment of facilities and operations around the world. Globalization can be defined as a process in which geographic distance becomes a factor of diminishing importance in the establishment and maintenance of cross border economic, political and socio-cultural relations. There are four developments, which have spurred the trend toward globalization.

1. Improved transportation and communication technologies;

2. Opened financial systems;

3. Increased demand for imports; and

4. Reduced import quotas and other trade barriers.

When a firm sets up facilities abroad it involves some added complexities in its operation. Global markets impose new standards on quality and time. Managers should not think about domestic markets first and then global markets later, rather it could be think globally and act locally. Some other important challenges of managing multinational operations include other languages and customs, different management style, unfamiliar laws and regulations, and different costs.

Managing global operations would focus on the following key issues:

- To acquire and properly utilize the following concepts and those related to global operations, supply chain, logistics, etc.
- To associate global historical events to key drivers in global operations from different perspectives.
- To develop criteria for conceptualization and evaluation of different global operations.
- To associate success and failure cases of global operations to political, social, economic and technological environments.

1.10 Types of Industrial

Industry is that part of the business activity which concerns itself with the production, processing or fabrication of products. The products may be consumer goods, capital goods or intermediate goods (like aluminum, copper, steel, plastic etc.) broadly the industries can be divided into four types:

1. Extractive Industries. The commodities raised by such industries are produced with comparatively little assistance from man.

2. Genetic Industries. These industries are engaged in reproducing and multiplying certain species of plants and animals with the object of earning profit from their sale. For example, nurseries, cattle bearing farms, poultry farms etc.

3. Construction Industries. These involve construction of buildings, roads, canals, dams, bridges etc.

4. Manufacturing Industries. Generally the term industry is used to refer to manufacturing industries (which is not correct). Manufacturing industries are engaged in the conversion or transformation of raw materials or semi-finished products into finished products.

1.11 Process Engineering Economics

Economics is ever present in our lives because we earn money from our jobs and we spend money allocated by our personal budgets for housing, clothing, transportation, entertainment, etc. Chemical engineers in the performance of their jobs will employ economics in the preparation of capital cost estimates, operating expense estimates, and to perform sensitivity and uncertainty analyses considering many alternatives. The capital budgeting function may be divided into several categories depending upon the time frame involved:

- **Strategic planning** involves setting the goals, objectives, and broad business plans for a 5- to 10-year time period in the future.
- **Tactical planning** involves the detailing of the strategic planning for say 2–5 years in the future.
- **Capital budgeting** involves a request, analysis, and approval of expenditures for the coming year.

Business plans minimally consist of the following information along with a projected timetable:

Perceived goals and objectives of the company

A- Market data	**B- Capital requirements**	**C- Operating expenses**
Projected share of the market	Fixed capital investment	Manufacturing expenses
Market prices	Working capital	General overhead expenses
Market growth	other capital requirements	Sales expenses
Markets the company serves		

D- Profitability	**E- Projected risk**
Profit after taxes	Effect of changes in revenue
Cash Flow	Effect of changes in direct and indirect expenses
Payout period	Effect of cost of capital

1.12 Sources of Funds

The funding available for corporate ventures may be obtained from internal or external sources.

A- Internal Sources

The capital from internal sources is from retained earnings or from an allowance known as reserves. Internal financing is "owned" capital, and it is argued that it could be loaned or invested in other ventures to receive a given return. In determining the cost of owned capital, interest to be paid on this capital is equal to the present return on all the company's capital

B- External Sources

There are three sources of external financing: debt, preferred stock, and common stock. These sources vary widely with respect to the cost and the risk the company assumes with each of these financing sources. The cheapest form of capital is the least risky. A general rule is the riskier the project, the safer should be the type of financing the capital used. A new venture with modest capital requirements could be funded by common stock. In contrast, a well-established business area may be financed by debt.

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Chapter 2

PLANT LOCATION AND LAYOUT

2.1 Introduction

Plant location **is an important strategic level decision making for an organization**. **One of the key features of a manufacturing system is the efficiency with which the products (services) are transferred to the customers.** This fact will include the determination of where to place the plant or facility. The selection of location is **a key-decision as large investment** is made in building plant and machinery. It is not advisable or not possible to change the location very often.

Before a location for a plant is selected, long range forecasts should be made anticipating future needs of the company. The 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. The purpose of the location study is to **find an optimum location one that will result in the greatest advantage to the organization**.

2.2 Factors Influencing Plant Location/Facility Location

Facility location is the process of determining a geographic site for a firm's operations. Managers of both service and manufacturing organizations must weigh many factors when assessing the desirability of a particular site, including proximity to customers and suppliers, labour costs, and transportation costs.

The leading factors affecting plant location are as follows: 1. Selection of Region 2. Township Selection 3. Question of Urban and Rural Area 4. Location of a Factory in a Big City 5. Location of an Industry in Small Town 6. The Sub-Urban Location for a Factory 7. Site Selection 8. Current Trends in Pant Location 9. Appropriate Site Selection 10. The Design of Factory Plant Building.

Also, it is appropriate to divide the factors, which influence the plant location or facility location on the basis of the nature of the organization as:

1. General locational factors, which include controllable and uncontrollable factors for all type of organizations.

2. Specific locational factors specifically required for manufacturing and service organizations.

❖ **Location factors can be further divided into two categories:**

- Dominant factors are those derived from competitive priorities (cost, quality, time, and flexibility) and have a particularly strong impact on sales or costs.
- Secondary factors also are important, but management may downplay or even ignore some of them if other factors are more important.

2.3.1 General Factors of Locational

Following are the general factors required for location of plant in case of all types of organizations

❖ **CONTROLLABLE FACTORS**

1. Proximity to markets
2. Supply of materials
3. Transportation facilities
4. Infrastructure availability
5. Labour and wages

❖ **UNCONTROLLABLE FACTORS**

6. Government policy
7. Climate conditions
8. Supporting industries and services
9. Community and labour attitudes
10. Community Infrastructure

2.4 Plant Layout

Plant layout refers to the physical arrangement of production facilities. It is the configuration of departments, work center and equipment in the conversion process. It is a floor plan of the physical facilities, which are used in production.

2.4.1 Objectives of Plant Layout

The objectives of plant layout are:

1. Streamline the flow of materials through the plant.
2. Facilitate the manufacturing process.
3. Maintain high turnover of in-process inventory.
4. Minimize 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 arrangements.
8. Provide for employee convenience, safety and comfort.
9. Maintain flexibility of arrangement and operation.
10. Facilitate the organizational structure.

2.4.2 Principles of Plant Layout

1. **Principle of integration:** A good layout is one that integrates men, materials, machines and supporting services and others in order to get the optimum utilization of resources and maximum effectiveness.
2. **Principle of minimum distance:** This principle is concerned with the minimum travel (or movement) of man and materials. The facilities should be arranged such that, the total distance travelled by the men and materials should be minimum and as far as possible straight line movement should be preferred.
3. **Principle of cubic space utilization:** The good layout is one that utilizes both horizontal and vertical space. It is not only enough if only the floor space is utilized optimally but the third dimension, i.e., the height is also to be utilized effectively.
4. **Principle of flow:** A good layout is one that makes the materials to move in forward direction towards the completion stage, i.e., there should not be any backtracking.
5. **Principle of maximum flexibility:** The good layout is one that can be 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 workers safety and satisfaction and safeguards the plant and machinery against fire, theft, etc.
7. **Principle of minimum handling:** A good layout is one that reduces the material handling to the minimum.

2.5 Classification of Layout

Layouts can be classified into the following five categories:

1. Process 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 groups. A typical process layout is shown in Fig. 4.1. Process layout is normally used when the production volume is not sufficient to justify a product layout. Typically, job shops employ process layouts due to the variety of products manufactured and their low production volumes.

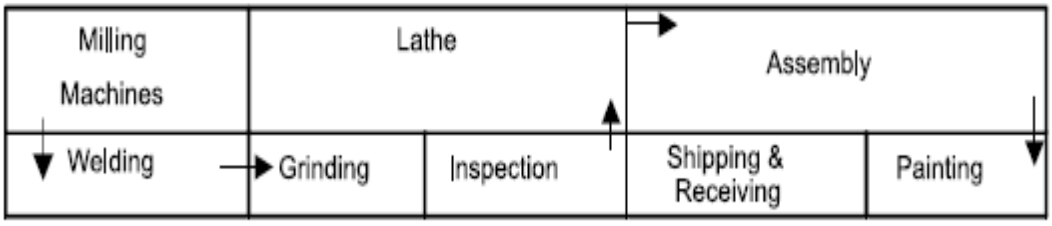

Figure 2.1: Process Layout

2. Product layout

In this type of layout, machines and auxiliary services are located according to the processing sequence of the product. If the volume of production of one or more products is large, the facilities can be arranged to achieve efficient flow of materials and lower cost per unit. The product layout is selected when the volume of production of a product is high such that a separate production line to manufacture it can be justified. A typical product layout is shown in Fig. 4.2.

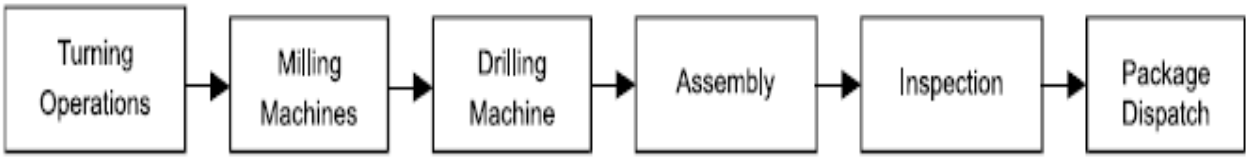

Figure 2.2: Product Layout

3. Combination layout

A combination layout is possible where an item is being made in different types and sizes. 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. Figure 4.3 shows a combination type of layout for manufacturing different sized gears.

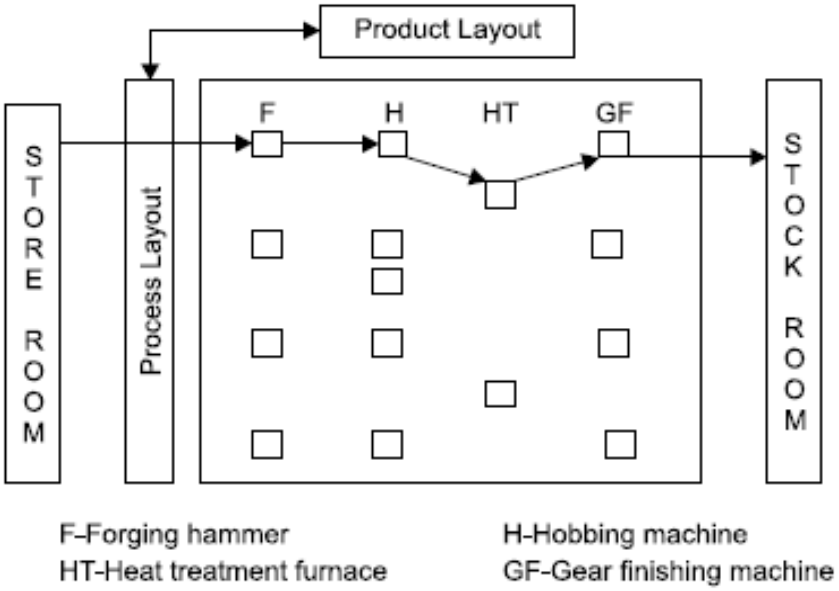

Figure 2.3: Combination Type

4. Fixed position layout

This is also called the **project type** of 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.

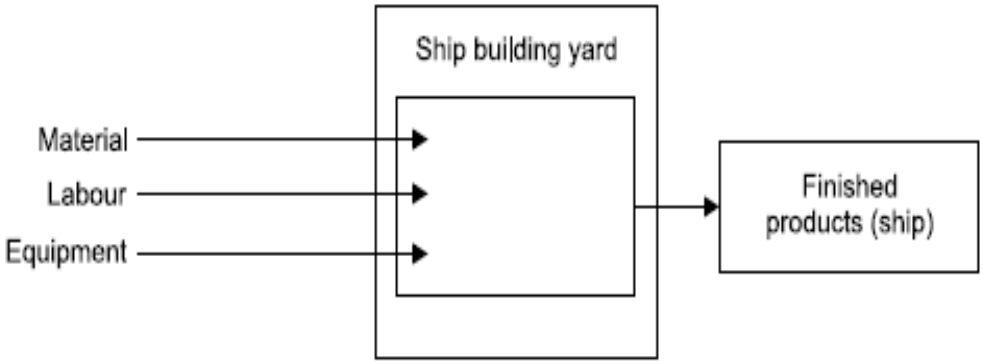

Figure 2.4: Project Type of Layout

5. Group layout (or Cellular Layout)

There is a trend now to bring an element of flexibility into manufacturing system as regards to variation in batch sizes and sequence of operations. A grouping of equipment for performing a sequence of operations on family of similar components or products has become all the important. Thus **group layout** is a combination of the product layout and process layout.

It combines the advantages of both layout systems. If there are *m*-machines and *n*-components, in a group layout (**Group-Technology Layout**), the *m*-machines and *n*-components will be divided into distinct number of machine-component cells (group) such that all the components assigned to a cell are almost processed within that cell itself. Here, the objective is to minimize the inter cell movements. In-group technology layout, the objective is to minimize the sum of the cost of transportation and the cost of equipment's. So, this is called as **multi-objective layout**.

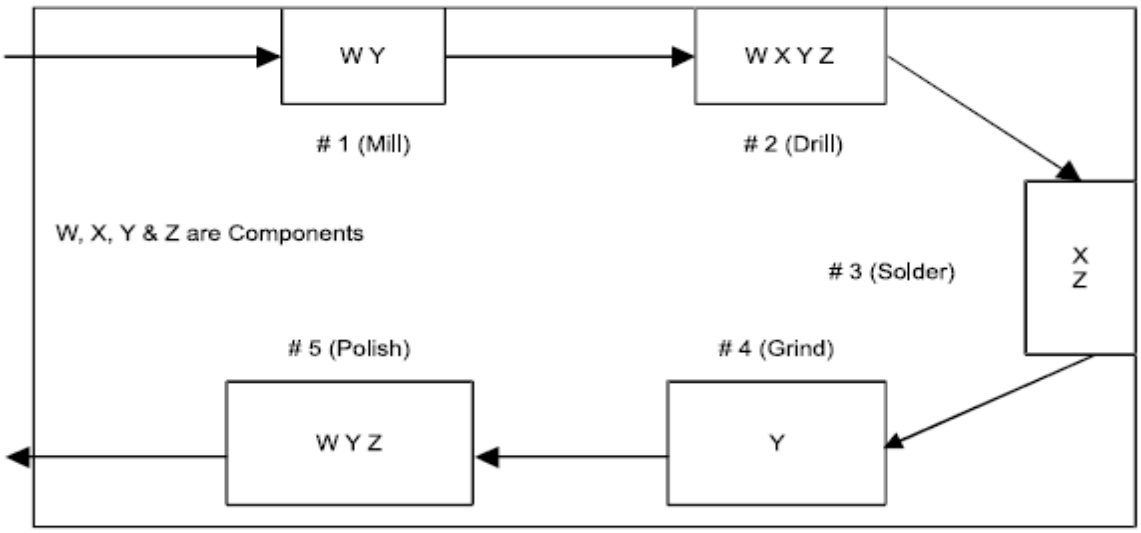

Figure 2.5: Cellular Layou

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Chapter 3

Materials Handling and Management

3.1 Introduction

Materials handling can be also defined as **'the function dealing with the preparation, placing and position of materials to facilitate their movement or storage'**. It does not add any value to the product but adds to the cost of the product and hence it will cost the customer more. Therefore, the handling should be kept at minimum. Poor material handling may result in delays leading to idling of equipment.

3.2 Objective of Materials Handling

1. Minimize cost of material handling.
2. Increase the productive capacity of the production facilities.
3. Safety in material handling through improvement in working condition.
4. Maximum utilization of material handling equipment.
5. Prevention of damages to materials.

3.3 Principle of Material Handling

Following are the principles of material handling:

1. Planning principle: All handling activities should be planned.
2. Systems principle: Plan a system integrating as many handling activities as possible and co-ordinating the full scope of operations (receiving, storage, production, inspection, packing, warehousing, supply and transportation).
3. Space utilization principle: Make optimum use of cubic space.
4. Unit load principle: Increase quantity, size, weight of load handled.
5. Gravity principle: Utilize gravity to move a material wherever practicable.
6. Material flow principle: Plan an operation sequence and equipment arrangement to optimize material flow.
7. Simplification principle: Reduce combine or eliminate unnecessary movement and/or equipment.
8. Safety principle: Provide for safe handling methods and equipment.
9. Standardization principle: Standardize method, types, size of material handling equipment.
10. Flexibility principle: Use methods and equipment that can perform a variety of task and applications.

3.4 Relationship between Plant Layout and Material Handling

There is a close relationship between plant layout and material handling.

1. Material movement does not add any value to the product. This is possible only through the systematic plant layout. Thus, a good layout minimizes handling.

2. The productive time of workers will go without production if they are required to travel long distance to get the material tools, etc.

3. Space is an important criterion. Plant layout integrates all the movements of men, material through a well-designed layout with material handling system.

4. Good plant layout helps in building efficient material handling system.

3.5 Materials Management

Materials management is a function, which aims for integrated approach towards the management of materials in an industrial undertaking. Its main objective is cost reduction and efficient handling of materials at all stages and in all sections of the undertaking. Its function includes several important aspects connected with material**, such as, purchasing, storage, inventory control, material handling, standardization etc.**

3.6 Scope or Functions of Materials Management

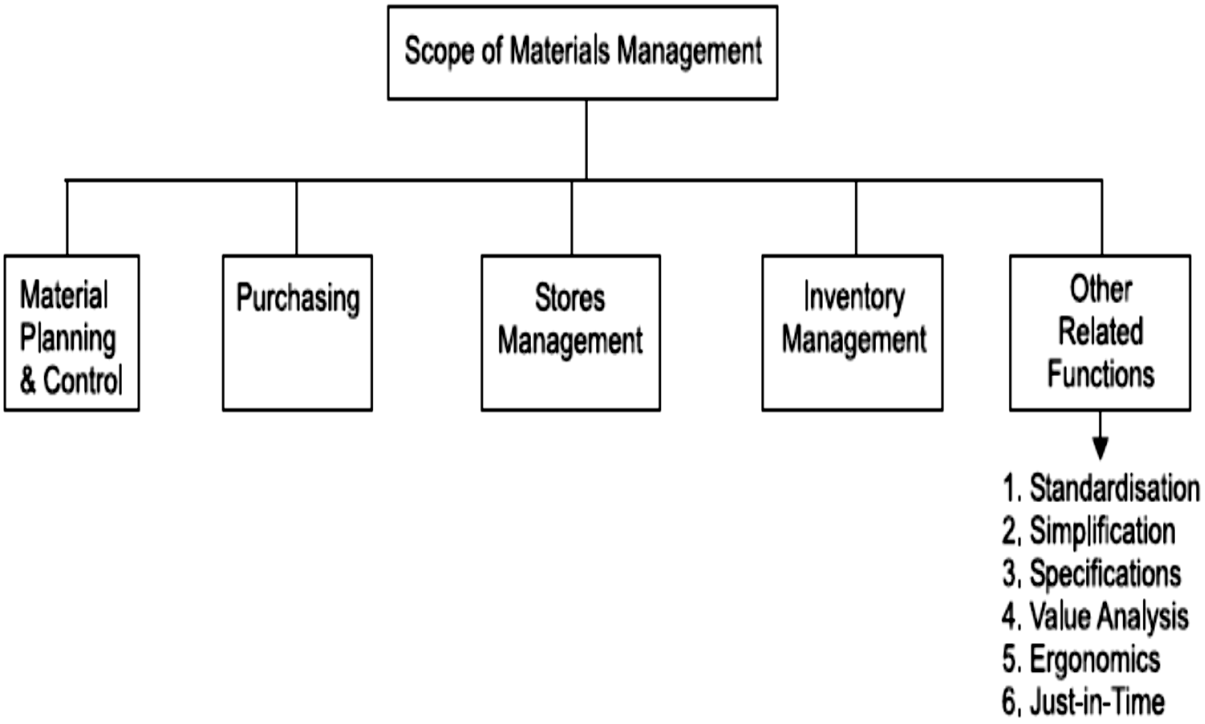
Materials management is defined as "a function responsible for the coordination of planning, sourcing, purchasing, moving, storing and controlling materials in an optimum manner so as to provide a pre-decided service to the customer at a minimum cost". The functions of materials management can be categorized in the following ways (as shown in Figure):

1. Materials planning and control: Based on the sales forecast and production plans, the materials planning and control is done. This involves estimating the individual requirements of parts, preparing materials budget, forecasting the levels of inventories, scheduling the orders and monitoring the performance in relation to production and sales.

2. Purchasing: This includes selection of sources of supply finalization in terms of purchase, placement of purchase orders, follow-up, maintenance of smooth relations with suppliers, approval of payments to suppliers, evaluating and rating suppliers.

3. Stores management or management: This involves physical control of materials, preservation of stores, and efficient handling, maintenance of stores records, proper location and stocking.

4. Inventory control or management: Inventory generally refers to the materials in stock. Either inventories represent those items, which are stocked for sale or they are in the process of manufacturing or they are in the form of materials, which are yet to be utilized.



3.7 Purchasing

Purchasing is an important function of materials management. In any industry purchase means buying of equipment, materials, tools, parts etc. required for industry. The importance of the purchase function varies with nature and size of industry. The objectives of the purchasing department can be outlined as under with their parameters:

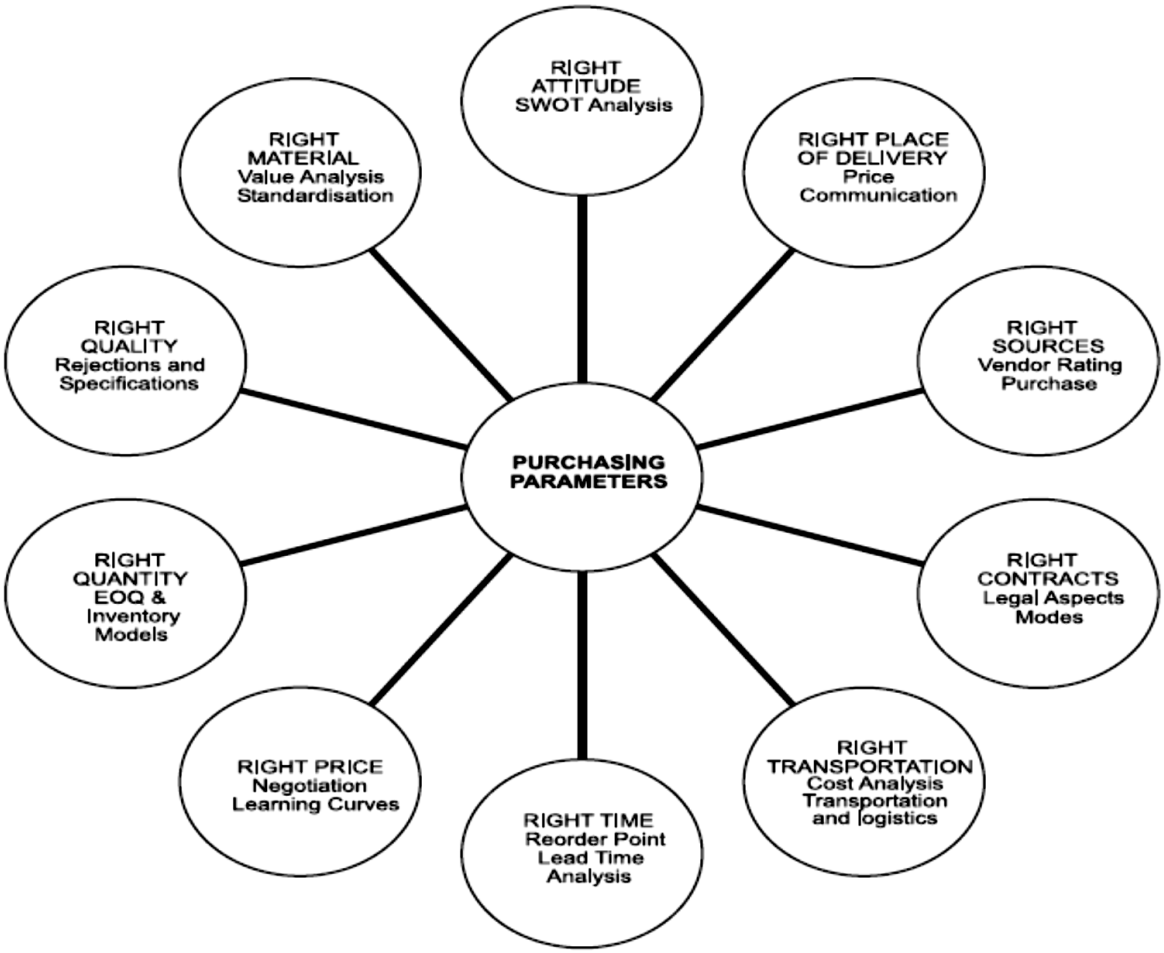
1. To avail the materials, suppliers and equipment at the minimum possible costs: These are the inputs in the manufacturing operations. The minimization of the input cost increases the productivity and resultantly the profitability of the operations.

2. To ensure the continuous flow of production through continuous supply of raw materials, components, tools etc. with repair and maintenance service.

3. To increase the asset turnover: The investment in the inventories should be kept minimum in relation to the volume of sales.

4. To develop an alternative source of supply: Exploration of alternative sources of supply of materials increases the bargaining ability of the buyer, minimization of cost of materials and increases the ability to meet the emergencies.

5. To establish and maintain the good relations with the suppliers: Maintenance of good relations with the supplier helps in evolving a favorable image in the business circles.



3.8 Standardization

Standardization means producing maximum variety of products from the minimum variety of materials, parts, tools and processes. It is the process of establishing standards or units of measure by which extent, quality, quantity, value, performance etc., may be compared and measured.

❖ **Advantages of Standardization**

1- Benefits to Design Department

- Fewer specifications, drawings and part list have to prepared and issued.
- Less qualified personnel can handle routine design work.

2- Benefits to Manufacturing Department

- Lower unit cost.
- Better quality products.
- Better services of production control, stock control, purchasing, etc.

3- Benefits to Production Control Department

- Well-proven design and methods improve planning and control.
- Fewer delays arise from waiting for materials, tools, etc.

3.9 Simplification

The concept of simplification is closely related to standardization. Simplification is the process of reducing the variety of products manufactured.

❖ **Advantages of Simplification**

- Simplification involves fewer, parts, varieties and changes in products.
- Simplification reduces variety; volume of remaining products may be increased.
- Simplification provides quick delivery and better after-sales services.

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Chapter 3

Materials Handling and Management

3.10 Ergonomics (Human Engineering)

The word 'Ergonomics' has its origin in two Greek words *Ergon* meaning laws. So it is the study of the man in relation to his work. The human factors or human engineering is concerned with man-machine system. Thus another definition, which highlights the man-machine system, is "The design of human tasks, man-machine system, and effective accomplishment of the job." Human engineering focuses on human beings and their interaction with products, equipment facilities and environments used in the work.

- **Objectives of Human Engineering**

1. To enhance the efficiency and effectiveness with which the activities (work) is carried out so as to increase the convenience of use, reduced errors and increase in productivity.
2. To enhance certain desirable human values including safety reduced stress and fatigue and improved quality of life.

3.11 Stores Management

Stores play a vital role in the operations of company. It is in direct touch with the user departments in its day-to-day activities. The most important purpose served by the stores is to provide uninterrupted service to the manufacturing divisions. Further, stores are often equated directly with money, as money is locked up in the stores.

3.11.1 Functions of Stores

The functions of stores can be classified as follows:

1. To receive raw materials, components, tools, equipment's and other items and account for them.
2. To provide adequate and proper storage and preservation to the various items.
3. To meet the demands of the consuming departments by proper issues and account for the consumption.
4. To minimize obsolescence, surplus and scrap through proper codification, preservation and handling.
5. To highlight stock accumulation, discrepancies and abnormal consumption and effect control measures.

3.11.2 Codification

It is one of the functions of stores management. Codification is a process of representing each item by a number, the digit of which indicates the group, the sub-group, the type and the dimension of the item. Many organizations in the public and private sectors, railways have their own system of codification, varying from eight to thirteen digits. The first two digits represents the major groups, such as raw materials, spare parts, sub-contracted items, hardware items, packing material, tools, oil, stationery etc. The next two digits indicate the sub-groups, such as, ferrous, non-ferrous etc. Dimensional characteristics of length, width, head diameter etc. constitute further three digits and the last digit is reserved for minor variations. Whatever may be the basis, each code should uniquely represent one item. It should be simple and capable of being understood by all. Codification should be compact, concise, consistent and flexible enough to accommodate new items. The groupings should be logical, holding similar parts near to one another. Each digit must be significant enough to represent some characteristic of the item.

3.11.3 Objectives of Codification

The objectives of a rationalized material coding system are:

1. Bringing all items together.
2. To enable putting up of any future item in its proper place.
3. To classify an item according to its characteristics.
4. To give an unique code number to each item to avoid duplication and ambiguity.
5. To reveal excessive variety and promote standardization and variety reduction.
6. To establish a common language for the identification of an item.

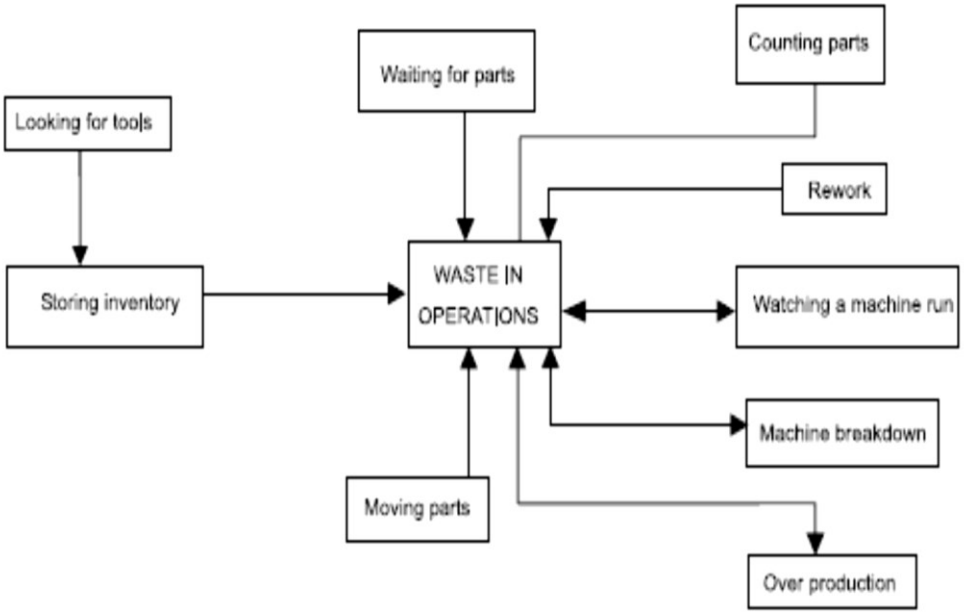
3.12 JUST-IN-TIME (JIT) MANUFACTURING

Just-In-Time (JIT) Manufacturing is a philosophy rather than a technique. By eliminating all waste and seeking continuous improvement, it aims at creating manufacturing system that is response to the market needs. The phase just in time is used to because this system operates with low WIP (Work-In- Process) inventory and often with very low finished goods inventory. Products are assembled just before they are sold, subassemblies are made just before they are assembled and components are made and fabricated just before subassemblies are made. This leads to lower WIP and reduced lead times. To achieve this organizations, have to be excellent in other areas e.g. quality. According to Voss, JIT is viewed as a "Production methodology which aims to improve overall productivity through elimination of waste and which leads to improved quality". JIT provides an efficient production in an organization and delivery of only the necessary parts in the right quantity, at the right time and place while using the minimum facilities".

3.12.1 Seven Wastes

Companies identifies seven wastes as being the targets of continuous improvement in production process. By attending to these wastes, the improvement is achieved.

1. Waste of over production eliminate by reducing set-up times, synchronizing quantities and timing between processes, layout problems. Make only what is needed now.
2. Waste of waiting eliminate bottlenecks and balance uneven loads by flexible work force and equipment.
3. Waste of transportation establish layouts and locations to make handling and transport unnecessary if possible. Minimise transportation and handling if not possible to eliminate.
4. Waste of processing itself question regarding the reasons for existence of the product and then why each process is necessary.
5. Waste of stocks reducing all other wastes reduces stocks.



3.13 Depreciation

"Depreciation is a decrease in value of a property over a period of time. Events that can cause a property to depreciate include wear and tear, age, deterioration, and normal obsolescence," according to the Internal revenue Service.

Types of depreciation

For further understanding, depreciation can be classified as under:

(a) Depreciation due to wear and tear. Everybody knows that when any machinery performs work, wear and tear of certain components takes place, although sufficient precautions are taken, i.e. proper lubricating and cooling is done, which minimize wear and tear but it cannot be totally prevented. Hence, the cost of replacement because of this cause is the value of depreciation due to wear and tear.

(b) Depreciation due to "physical decay". There are certain items in a factory, such as insulation of materials, furniture, electric cables, buildings, chemicals, vessels etc., which get decay, because of climatic and atmospheric effect, with the result the value of these articles goes on reducing with the lapse of time.

(c) "Accidental" depreciation. Although, the machine might have installed even few days back and sufficient care is taken to prevent accident, even then, accident may occur due to some wrong operation, or some loose component or some other cause that may result in heavy damages.

(d) Depreciation due to "deferred maintenance and neglect". Every manufacturer supplies certain instructions for the smooth and efficient running of equipment. For example, in the case of a vehicle, a manufacturer gave the following instructions:

(i) Lubricating oil of particular grade should be used in engine.
(ii) Oil should be drained and new oil should be refilled after first 1000 km running,
(iii) All the bolts and nuts should be re-tightened after 5000 km running.

(e) Inadequacy. This is the form of functional depreciation. Inadequacy means reduction in efficiency of an asset. This may result even if any equipment is servicing under proper precautions and sufficient maintenance is provided, there is fall in efficiency with the lapse of time.

(f) Depreciation by obsolescence. Now days because of rapid scientific advancement, there are frequent changes. If a new machine comes in the market which is more efficient because of new invention or better design than the existing one, manufacturing same type of products by the new one are much cheaper and better than the existing one, then the existing machinery has to be replaced to withstand market competition.

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Chapter 4

Quality Control

4.1 Introduction

In any business organization, profit is the ultimate goal. To achieve this, there are several approaches. Profit may be maximized by cutting costs for the same selling price per unit. If it is a monopolistic business, without giving much of importance to the cost reduction programs, the price may be fixed suitably to earn sufficient profit. But, to survive in a competitive business environment, goods and services produced by a firm should have the minimum required quality. Extra quality means extra cost. So, the level of quality should be decided in relation to other factors such that the product is well absorbed in the market. In all these cases, to have repeated sales and thereby increased sales revenue, basic quality is considered to be one of the supportive factors. **Quality is a measure of how closely a good or service conforms to specified standard. Quality standards may be any one or a combination of attributes and variables of the product being manufactured. The attributes will include performance, reliability, appearance, commitment to delivery time, etc.**

4.2 Quality

Quality begins with the design of a product in accordance with the customer specification further it involved the established measurement standards, the use of proper material, selection of suitable manufacturing process etc., quality is a relative term and it is generally used with reference to the end use of the product. The Quality of a product or service is the fitness of that product or service for meeting or exceeding its intended use as required by the customer.

4.2.1 Fundamental Factors Affecting Quality

1. **Market:** Because of technology advancement, we could see many new products to satisfy customer wants. At the same time, the customer wants are also changing dynamically.
2. **Money:** The increased global competition necessitates huge outlays for new equipments and process.
3. **Management:** Because of the increased complex structure of business organization, the quality related responsibilities lie with persons at different levels in the organization.
4. **Men:** The rapid growth in technical knowledge leads to development of human resource with different specialization.
5. **Materials:** Selection of proper materials to meet the desired tolerance limit is also an important consideration.
6. **Machines and mechanization:** In order to have quality products which will lead to higher productivity of any organization, we need to use advanced machines and mechanize various operations.
7. **Modern information methods:** The modern information methods help in storing and retrieving needed data for manufacturing, marketing and servicing.
8. **Mounting product requirements:** Product diversification to meet customers taste leads to intricacy in design, manufacturing and quality standards.

4.3 Control

The process through which the standards are established and met with standards is called control. This process consists of observing our activity performance, comparing the performance with some standard and then taking action if the observed performance is significantly too different from the standards. The control process involves a universal sequence of steps as follows:

1. Choose the control object
2. Choose a unit of measure
3. Set the standard value
4. Choose a sensing device which can measure
5. Measure actual performance
6. Interpret the difference between actual and standard

4.3.1 Need for Quality Controlling

In the absence of quality, the following will result:

1. No yardstick for comparing the quality of goods/services.
2. Difficulty in maintaining consistency in quality.
3. Dissatisfied customers due to increased maintenance and operating costs of products/services.
4. Increased rework cost while manufacturing products/providing services.
5. Reduced life time of the products/services.
6. Reduced flexibility with respect to usage of standard spare parts.

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4.4 Inspection

Inspection is an important tool to achieve quality concept. It is necessary to assure confidence to manufacturer and aims satisfaction to customer. Inspection is an indispensable tool of modern manufacturing process. It helps to control quality, reduces manufacturing costs, eliminate scrap losses and assignable causes of defective work. The inspection and test unit is responsible for appraising the quality of incoming raw materials and components as well as the quality of the manufactured product or service.

It checks the components at various stages with reference to certain predetermined factors and detecting and sorting out the faulty or defective items. It also specified the types of inspection devices to use and the procedures to follow to measure the quality characteristics.

Inspection only measures the degree of conformance to a standard in the case of variables. In the case of attributes inspection merely separates the nonconforming from the conforming. Inspection is the most common method of attaining standardization, uniformity and quality of workmanship. It is the function of quality control. If the said item does not fall within the zone of acceptability it will be rejected and corrective measure will be applied to see that the items in future conform to specified standards.

4.4.1 Objectives of Inspection

1. To detect and remove the faulty raw materials before it undergoes production.
2. To detect the faulty products in production whenever it is detected.
3. To bring facts to the notice of managers before they become serous.
4. To prevent the substandard reaching the customer and reducing complaints.
5. To promote reputation for quality and reliability of product.

4.4.2 Purpose of Inspection

1. To distinguish good lots from bad lots.
2. To distinguish good pieces from bad pieces.
3. To determine if the process is changing.
4. To determine if the process is approaching the specification limits.
5. To rate quality of product.
6. To measure the precision of the measuring instrument.
7. To secure products-design information.
8. To measure process capability.

4.4.3 Types of Inspection

1. FLOOR INSPECTION

In this system, the inspection is performed at the place of production. It suggests the checking of materials in process at the machine or in the production time by patrolling inspectors. Inspectors have to be highly skilled. This method of inspection minimizes the material handling, does not disrupt the line layout of machinery and quickly locate the defect and readily offers field and correction.

2. CENTRALISED INSPECTION

Inspection is carried in a central place with all testing equipment; sensitive equipment is housed in air-conditioned area. Samples are brought to the inspection floor for checking. Centralized inspection may locate in one or more places in the manufacturing industry.

3. FUNCTIONAL INSPECTION

This system only checks for the main function, the product is expected to perform. Thus an electrical motor can be checked for the specified speed and load characteristics.

4. FIRST PIECE OR FIRST-OFF INSPECTIONS

First piece of the shift or lot is inspected. This is particularly used where automatic machines are employed. Any discrepancy from the operator as machine tool can be checked to see that the product is within in control limits.

5. PILOT PIECE INSPECTION

This is done immediately after new design or product is developed. Manufacturer of product is done either on regular shop floor if production is not disturbed. If production is affected to a large extent, the product is manufactured in a pilot plant. This is suitable for mass production and products involving large number of components such as automobiles aero planes etc.

4.5 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. It depends on materials, tools, machines, type of labour, working conditions etc. QC is a broad term, it involves inspection at particular stage but mere inspection does not mean QC. As opposed to inspection, in quality control activity emphasis is placed on the quality future production. Quality control aims at prevention of defects at the source, relies on effective feedback system and corrective action procedure. Quality control uses inspection as a valuable tool.

4.5.1 Types of Quality Control

1. **Off-line quality control:** Its procedure deal with measures to select and choose controllable product and process parameters in such a way that the deviation between the product or process output and the standard will be minimized. ***Example:*** Taguchi method, principles of experimental design etc.
2. **Statistical process control:** SPC involves comparing the output of a process or a service with a standard and taking remedial actions in case of a discrepancy between the two. It also involves determining whether a process can produce a product that meets desired specification or requirements.
3. **Acceptance sampling plans:** A plan that determines the number of items to sample and the acceptance criteria of the lot, based on meeting certain stipulated conditions (such as the risk of rejecting a good lot or accepting a bad lot) is known as an acceptance sampling plan.

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4.5.2 Steps in Quality Control

Following are the steps in quality control process:

1. Formulate quality policy.
2. Set the standards or specifications on the basis of customer's preference, cost and profit.
3. Select inspection plan and set up procedure for checking.
4. Detect deviations from set standards of specifications.
5. Take corrective actions or necessary changes to achieve standards.
6. Coordination of quality problems.
7. Developing quality consciousness both within and outside the organization.
8. Developing procedures for good vendor-vendee relations.

4.5.3 Benefits of Quality Control

- ✓ Improving the quality of products and services.
- ✓ Increasing the productivity of manufacturing processes, commercial business, and corporations.
- ✓ Reducing manufacturing and corporate costs.
- ✓ Determining and improving the marketability of products and services.
- ✓ Reducing consumer prices of products and services.
- ✓ Improving and/or assuring on time deliveries and availability.
- ✓ Assisting in the management of an enterprise.

o Factors affecting quality

There are some other factors which affect the product quality:

a. Market research i.e., demands of purchasers. **b**. Money i.e., capability to invest.

b. Management i.e., management policies for quality level.

o Responsibilities of quality assurance department

a. Plan, develop and establish Quality policies.

b. To assure that products of prescribed specification reaches to the customers.

c. Conduct studies and investigations related to the quality problems.

d. Develop Quality assurance system and regularly evaluate its

- **Quality Control System**

Quality assurance system should be developed incorporating the following aspects:

I. Formulate the quality control and manufacturing procedures.
II. Percentage checking is decided.
III. Rejection analysis and immediate feedback system for corrective action.
IV. Prepare a manual for quality assurance.

4.6 Quality and cost

Studies have indicated that any reduction in quality results in a reduced level of satisfaction and decrease in customer goodwill toward the producer. This will lead to reduction in return on investment in the long run. Following are the general principles of quality and cost relationship:

1. Costs of poor quality are far larger than that had been recognized.
2. Appraisal costs are reduced by focusing on preventing errors at the source.
3. System is established for reducing the cost rather than reducing the quality.

4.6.1 Quality Cost (or costs associated with quality)

Quality cost means cost of poor quality goods or services. Following are the main quality associated costs:

1. Failure costs: (A) Internal failure costs:

a. Scrap and rework cost. b. Losses due to avoidable processing. c. Expenditure in failure analysis. d. Costs involved in testing, inspecting and sorting for down gradation.

(B) External failure costs:

a. Warranty charges b. Redressal of complaints c. Loss of future sales

2. Appraisal/Detection costs

i. Incoming test and inspection including materials, in-process and final quality sampling.
ii. Quality audits. iii. Equipment calibration.

3. Prevention costs

a. Quality planning b. New product review c. Process control d. Training and education

4.7 Quality Control Organization

Over the years, the status of the quality control organization changed from a function merely responsible for detecting inferior or standard material to function that establishes what are termed preventive programmers. These programmers are designed to detect quality problems in the design stage or at any point in the manufacturing process and to follow up on corrective action. Quality control is a staff activity since it serves the line or production department by assisting them in managing quality.

The quality control organization depending upon the type of product, method of quality is sufficient enough to carry out following activities:

1. Inspection of raw material, product or processes.

2. Salvage inspection to determine rejected part and assembly disposition.

3. Records- and- reports maintenance.

4. Statistical quality control.

5. Gauges for inspection.

6. Quality control system maintenance and development.

I. Total quality management

In a total quality management concept, the word quality has a wider meaning, it means quality of output of every department and by every employee, cleanliness, orderliness, punctuality, customer service, standardization of works and continuous efforts for their improvement are also part of T.Q.M. in this, needs of the customer are constantly monitored to improve the products and processes to meet their requirement.

II. Total quality control

Total quality control (TQC) may be defined as," an effective system for integrating the quality development, quality maintenance and quality improvement efforts of the various groups in an organization so as to enable production and service at the most economical levels which allow for full customer satisfaction".

Chapter 5

Foundations of Engineering Economy

5.1 What is Engineering Economy?

Engineering economy (is a collection of techniques that simplify comparisons of alternatives on an economic basis). On the contrary, engineering economy begins only after the alternatives have been identified. If the best alternative is actually one that the engineer has not even recognized as an alternative, then not all of the engineering economic analysis tools have will not result.

Engineering economic (analysis is able to answer professional and personal financial questions). If you wish to evaluate the economics of purchasing a new home or leasing versus buying a new automobile for yourself, the techniques of engineering economy covered in this text are just as applicable as they are for determining if your employer should purchase a replacement piece of equipment.

While (economics will be the sole criterion for selecting the best alternatives in the work, real-world decisions usually include many other factors in the decision-making process). For example, in determining whether to build a nuclear-powered, gas-fired, or coal-fired power plant, factors such as safety, air pollution, public acceptance, water demand, waste disposal, global warming, and many others would be considered in identifying the best alternative.

5.2 Performing an Engineering Economy

In order to apply economic analysis techniques, it is necessary to understand the basic terminology and fundamental concepts that form the foundation for engineering economy studies.

Some of these terms and concepts are described below.

5.2.1 Alternatives

An ***alternative*** is a stand-alone solution for a given situation. The alternatives in engineering considerations usually involve such items as purchase cost (first cost), anticipated useful life, yearly costs of maintaining assets (annual maintenance and operating costs), anticipated resale value (salvage value), and the interest rate. After the facts and all the relevant estimates have been collected, an engineering economy analysis can be conducted to determine which is best from an economic point of view.

5.2.2 Cash Flows

The estimated inflows revenues and savings and outflows costs of money are called cash flows. These estimates are truly the heart of an engineering economic analysis. This means that economic decisions about proposed alternatives are made under risk, that is, without certainty. Techniques that utilize sensitivity

analysis, risk analysis, and multiple attribute analysis assist in understanding the consequences of variation in cash flow estimates).

5.2.3 Alternative Selection

Every situation has at least two alternatives. In addition to the one or more formulated alternatives, there is always the alternative of inaction. This is the as-is or status quo condition.

5.2.4 Evaluation Criteria

In economic analysis, financial units (dollars or other currency) are generally used as the tangible basis for evaluation. Thus, when there are several ways of accomplishing a stated objective, the alternative with the lowest overall cost or highest overall net income is selected.

5.2.5 Intangible Factors

In many cases, alternatives have noneconomic or intangible factors that are difficult to quantify. When the alternatives under consideration are hard to distinguish economically, intangible factors may tilt the decision in the direction of one of the alternatives. A few examples of noneconomic factors are safety, customer acceptance, reliability, convenience, and good will.

5.2.6 Time Value of Money

It is often said that money makes money. The statement is indeed true, for if we elect to invest money today, we inherently expect to have more money in the future.

5.3 Interest and Equivalence

INTEREST RATE, RATE OF RETURN, MARR AND Equivalent

Interest is the manifestation of the time value of money, and it essentially represents "rent" paid for use of the money. Computationally, interest is the difference between an ending amount of money and the beginning amount. If the difference is zero or negative, there is no interest. There are always two perspectives to an amount of interest-interest paid and interest earned. Interest is paid when a person or organization borrows money (obtains a loan) and repays a larger amount. Interest is earned when a person or organization saves, invests, or lends money and obtains a return of a larger amount. Interest paid or earned is determined by using the relation:

$$\text{Interest} = \text{end amount} - \text{original amount} \qquad \text{--- 5.1}$$

When interest over a specific time unit is expressed as a percentage of the original amount (principal), the result is called the interest rate or rate of return (**ROR**).

$$\text{Interest rate or rate of return} = \frac{\text{interest accrued per time unit}}{\text{original amount}} \times 100\% \qquad \text{-----5.2}$$

The time unit of the interest rate is called the interest period. By far the most common interest period used to state an interest rate is 1 year. Shorter time periods can be used, such as, 1% per month. Thus, the interest period of the interest rate should always be included. If only the rate is stated, for example, 8.5%, a 1-year interest period is assumed. The term return on investment **(ROI)** is used equivalently with **ROR** in different industries and settings, especially where large capital funds are committed to engineering-oriented

programs. The term interest rate paid is more appropriate from the borrower's perspective, while rate of return earned is better from the investor's perspective.

Example 5.1: An employee at LaserKinetics.com borrows $10,000 on May 1 and must repay a total of $10,700 exactly 1 year later. Determine the interest amount and the interest rate paid.

Solution

The perspective here is that of the borrower since $10,700 repays a loan. Apply Equation [3.1] to determine the interest paid. **Interest paid=$10,700-10,000=$700**

Equation [5.2] determines the interest rate paid for 1 year.

Percent interest rate = $700/ $10,000 X 100 % = 7% per year.

Engineering alternatives are evaluated upon the prognosis that a reasonable rate of return (**ROR**) can be realized. A reasonable rate must be established so that the accept/reject decision can be made. This reasonable rate, called the minimum attractive rate of return (**MARR**), is the lowest interest rate that will induce companies or individuals to invest their money. The **MARR** must be higher than the cost of money used to finance the alternative, as well as higher than the rate that would be expected from a bank or safe (minimal risk) investment.

Equivalent terms are used often in the transfer between scales and units. For example, 1000 meters is equal to (or equivalent to) 1 kilometer, 12 inches equals 1 foot, and 1 quart equals 2 pints or 0.946 liter. In engineering economy, when considered together, the time value of money and the interest rate help develop the concept of economic equivalence, which means that different sums of money at different times would be equal in economic value. For example, if the interest rate is 6% per year, $100 today (present time) is equivalent to $106 one year from today.

Amount in one year = 100 + 100(0.06) _ 100(1 +0.06) = $106

5.4 Code of Ethics for Engineers

Engineering is an important and learned profession. As members of this profession, engineers are expected to exhibit the highest standards of honesty and integrity. Engineering has a direct and vital impact on the quality of life for all people. Engineers must perform under a standard of professional behavior that requires adherence to the highest principles of ethical conduct.

❖ Rules of Practice

1. Engineers shall hold paramount the safety, health, and welfare of the public.

a. If engineers' judgment is overruled under circumstances that endanger life or property, they shall notify their employer or client and such other authority as may be appropriate.

b. Engineers shall approve only those engineering documents that are in conformity with applicable standards.

2. Engineers shall perform services only in the areas of their competence.

a. Engineers shall undertake assignments only when qualified by education or experience in the specific technical fields involved.

b. Engineers may accept assignments and assume responsibility for coordination of an entire project and sign and seal the engineering documents for the entire project, provided that each technical segment is signed and sealed only by the qualified engineers who prepared the segment.

3. Engineers shall issue public statements only in an objective and truthful manner.

a. Engineers shall be objective and truthful in professional reports, statements, or testimony.

b. Engineers may express publicly technical opinions that are founded upon knowledge of the facts and competence in the subject matter.

4. Engineers shall act for each employer or client as faithful agents or trustees.

a. Engineers shall disclose all known or potential conflicts of interest that could influence or appear to influence their judgment or the quality of their services.

b. Engineers shall not accept compensation, financial or otherwise, from more than one party for services on the same project, or for services pertaining to the same project, unless the circumstances are fully disclosed and agreed to by all interested parties.

5. Engineers shall avoid deceptive acts.

a. Engineers shall not falsify their qualifications or permit misrepresentation of their or their associates' qualifications.

b. Engineers shall not offer, give, solicit, or receive, directly or indirectly, any contribution to influence the award of a contract by public authority.

International Organization for Standardization (ISO)

ISO (International Organization for Standardization) is an independent, non-governmental, international organization that develops standards to ensure the quality, safety, and efficiency of products, services, and systems. ... **ISO** standards are in place to ensure consistency.

(FYI visit ---https://www.iso.org/home.html)

ISO STANDARDS ARE INTERNATIONALLY AGREED BY EXPERTS

Think of them as a formula that describes the best way of doing something. It could be about making a product, managing a process, delivering a service or supplying materials – standards cover a huge range of activities.

For instance,

1-Quality management standards to help work more efficiently and reduce product failures.
2-Environmental management standards to help reduce environmental impacts, reduce waste and be more sustainable.
3-Health and safety standards to help reduce accidents in the workplace.
4-Energy management standards to help cut energy consumption.
5-Food safety standards to help prevent food from being contaminated.
6-IT security standards to help keep sensitive information secure.
Discover some of the best-known and most widely-used standards, as well as those that address recently emerged challenges affecting us all.

POPULAR STANDARDS

❖ ISO 9000 SERIES

ISO stands for International Organization for Standardization. It is an international body, which consists of representatives from more than 90 countries. The national standard bodies of these countries are the members of this organization. These are non-governmental organizations, which exist to provide common standards on international trade of goods and services. ISO 9000 standards expect firms to have a quality manual that meets ISO guidelines, documents, quality procedures and job instructions, and verification of compliance by third-party auditors. ISO 9000 series has five international standards on quality managements. They are:

1. ISO 9000 — Quality management and Quality assurance standards
2. ISO 9001 — Quality systems: Quality in design
3. ISO 9002 — Quality systems: Production and Installation
4. ISO 9003 — Quality systems: Final inspection and test
5. ISO 9004 — Quality management and systems.

❖ Objectives of ISO 9000 Series

The objectives of ISO 9000 series is listed in Table.

Standard	*Objectives/Tasks*
ISO 9000	This provides guidelines on selection and use of quality management and quality assurance standards.
ISO 9001	It has 20 elements covering design, development, production, installation and servicing.
ISO 9002	It has 18 elements covering production and installation. It is same as ISO 9001 without the first two tasks, *viz*., design and development. This is applicable for the units excluding R & D functions.
ISO 9003	It has 12 elements covering final inspection and testing for laboratories and warehouses etc.
ISO 9004	This provides guidelines to interpret the quality management and quality assurance. This also has suggestions which are not mandatory.

❖ Benefits of ISO 9000 Series

ISO 9000 series provides several tangible and intangible benefits which are listed below:

1. This gives competitive advantage in the global market.
2. Consistency in quality, since ISO helps in detecting non-conformity early which makes it possible to take corrective action.
3. Documentation of quality procedures adds clarity to quality system.
4. ISO 9000 ensures adequate and regular quality training for all members of the organization.
5. ISO helps the customers to have cost effective purchase procedure.
6. The customers while making purchases from companies with ISO certificate need not spend much on inspection and testing. This will reduce the quality cost and lead-time.
7. This will help in increasing productivity.
8. This will aid to improved morale and involvement of workers.
9. The level of job satisfaction would be more.

❖ Steps in ISO 9000 Registration

1. Selection of appropriate standard from ISO 9001, ISO 9002 and ISO 9003 using the guidelines given in ISO 9000.
2. Preparation of quality manual to cover all the elements in the selected model.
3. Preparation of procedures and shop floor instructions which are used at the time of implementing the system. Also document these items.
4. Self-auditing to check compliance of the selected model.
5. Selection of a registrar and making application to obtain certificate for the selected model.

A registrar is an independent body with knowledge and experience to evaluate any one of the three models of the company's quality system (ISO 9002). Registrars are approved and certified by acridities.

The registrar, on successful verification and assessment will register the company. Before selecting a registrar, one should know the following:

1. Accreditors of the registrar.
2. Background and credibility of the registrar.
3. Cost of registration through the proposed registrar.
4. Expected harmony between the company and the potential registrar while working towards implementing ISO model in the company.

❖ APPLICATION ISO 9000: ISO 14000 SERIES

OVERVIEW

The ISO 14000 series of environmental management standards are intended to assist organizations manage the environmental effect of their business practices. The ISO 14000 series is similar to the ISO 9000 series published in 1987. The purpose of the ISO 9000 series is to encourage organizations to institute quality assurance management programs. Although ISO 9000 deals with the overall management of an organization and ISO 14000 deals with the management of the environmental effects of an organization, both standards are concerned with processes, and there
is talk of combining the two series into one.

Both series of standards were published by ISO, the International Organization for Standardization. The purpose of ISO is to facilitate international trade and cooperation in commercial, intellectual, scientific and economic endeavors by developing international standards. ISO originally focused on industrial and mechanical engineering standards. Now, it has ventured into setting standards for an organization's processes, policies, and practices. The environmental standards of ISO 14000 deal with how a company manages the environment inside its facilities and the immediate outside environment. However, the standards also call for analysis of the entire life cycle of a product, from raw material to eventual disposal. These standards do not mandate a particular level of pollution or performance, but focus on awareness of the processes and procedures that can affect the environment. It should be noted that adherence to the ISO 14000 standards does not in any way release a company from any national or local regulations regarding specific performance issues regarding the environment.

Some of the standards in the ISO 14000 series are:

- **ISO 14001—Specification of Environmental Management Systems**
- **ISO 14004—Guideline Standard**
- **ISO 14010 through ISO 14015—Environmental Auditing and Related Activities**
- **ISO 14020 through ISO 14024—Environmental Labelling**
- **ISO 14031 through ISO 14032—Environmental Performance Evaluation**
- **ISO 14040 through ISO 14043—Life Cycle Assessment**
- **ISO 14050—Terms and Definitions**

Although the ISO 14000 standards are similar to the ISO 9000 standards, the nature of the environmental standards creates a need for people who are technical environment professionals in addition to those required to maintain the documentation necessary for certification.

❖ The Benefits of ISO 14000 Certification

The benefits of acquiring ISO certification go beyond the satisfaction of doing a good deed. Adhering to the standard may result in better conformance to environmental regulations, greater marketability, better use of resources, higher quality goods and services, increased levels of safety, improved image and increased profits.

- The environmental awareness and the documentation that are required by the ISO 14000 standards assist a company in conforming to environmental regulations. This means that a company, by diligently adhering to the standard, is less likely to violate environmental regulations and is always ready for inspection by a regulatory agency. In addition, the certification and documentation may aid a company in acquiring capital, in defending itself during environmental litigation and in receiving insurance or permits.
- A wider market for a company's goods and services may result from certification. Many corporations and governments will be looking for suppliers that are ISO 14000 certified in order to maintain their own certification and environment-friendly image.
- Producers of consumer goods may find that many consumers not only try to purchase goods from environment-friendly companies, but will spend a little more if they feel they are helping the environment. In order to reap this benefit, a company must make their environmental efforts known through advertising and labelling.
- The process analyses that go along with ISO 14000 certification may result in streamlining processes and more efficient use of resources and raw materials and subsequently reduce a company's costs.
- Reducing the amount of potentially dangerous substances in an end product may result in less use of dangerous chemicals in a plant. This leads to a safer internal environment for employees and the possibility of reduced insurance premiums. Improved employee morale may result when employees feel that the workplace is safer and they are contributing to the environmental effort.

Chapter 6

Introduction to Industrial Engineering

6.1 Introduction

The Merriam-Webster dictionary (M.W.D) defines engineering as the design and creation of large structures such as roads and bridges or new products or systems by using scientific methods. Engineering design is a process of translation of requirements, specifications, and needs into a language understood by the people responsible for making the new product, service, facility, or system. The design is in a language understood by construction workers, purchasing agents, suppliers, subcontractors, quality control experts, and so on.

6.2 Industrial Engineering (IE)

According to M.W.D, IE deals with the design, improvement, and installation of integrated systems (as of people, materials, and energy) in the industry. Modern IE is concerned with the design, management, and control of operational processes. For that purpose, IE combines classical knowledge in physics, mathematics, computing, and statistics with tools for incorporating the human factor, ergonomics, sociology, and psychology. For example, in the design of a new business branch, industrial engineers plan the work packages and their allocation to operators. Industrial engineers also design the work positions using their knowledge of ergonomics, facility layout planning, and efficient work planning.

6.3 Industrial Engineers

Industrial engineers design organizational processes and perform projects and ongoing activities that may involve facilities, products, and systems. An industrial engineer is also involved in determining how to best utilize the resources of the organization. Resources such as workers, raw materials, capital, information, buildings, equipment, energy, and technological knowledge are used by industrial engineers to perform their tasks. They do so by utilizing the rules of physics, mathematics, and statistics along with human factor related knowledge, such as ergonomics and psychology, and the rules of law, morality, and ethics. A relatively new area of industrial engineering is the design and implementation of information systems that supports processes. In the past, industrial engineers integrated material requirement planning (MRP) systems into industrial organizations. Later on, they played a vital role in the incorporation of enterprise resource planning (ERP) systems in many organizations.

6.4 What Do Industrial Engineers Do?

Industrial engineers are involved in designing organizational processes, performing projects and ongoing activities, and planning their operations. This includes a large variety of activities. A partial example includes, among others, the following: Design of production and service systems, design and implementation of processes, production management, design of supply chains, planning and managing supply-chains operations, project management, economics analysis, quality control, and design and operations of information systems.

6.5 Tools Used by the Industrial Engineer

To succeed in his or her job, the industrial engineer needs understanding, skills, tools, and techniques in a variety of fields. We will review the skills necessary and demonstrate how these skills are used in the case of a company in the automotive industry.

6.6 Models

Problem solving and decision making are important parts of the job of the industrial engineer. Textbooks and courses are often organized according to the types of problems. Industrial engineering textbooks have chapters dealing with problems related to inventory, production scheduling, service system design, procurement, and the like. A model is a simplified presentation of reality. An organizational chart, for example, is a model that conceptually describes the relationships among members in the organization.

When decision makers analyze a model, they are trying to find a good solution to the problem that the model represents. This solution is appropriate for solving the original problem if it is not too sensitive to the simplifying assumptions underlying the model. Therefore, a sensitivity analysis of the solution obtained must be performed to assess its suitability for solving the original problem. The relationship between the original problem, the model, and the solution is shown in Figure 1.1.

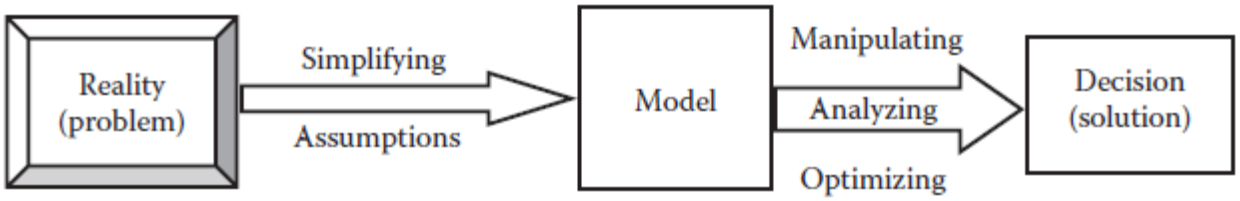

Figure 1: Models and Their Use.

6.7 Industrial Engineering and Process Design

Industrial engineers design and implement processes in organizations. Although there are a large variety of processes, it is common to use Hammer and Champy (1993) five "basic processes," which is generally found in most organizations:

1. The development process: The process starts with an idea for a new product or service and ends with the design of the new product or service and a working prototype.
2. Preparation of infrastructure: The process starts with a working prototype of a new product and ends with the successful completion and testing of the production facility for the product.
3. Sales: The process starts with market research and ends with an order from a customer.
4. Delivery: The process starts with an order from a customer and ends with a delivery and receipt of payment from the customer who received the requested products.
5. Service: The process starts with a customer's request for service and ends when the service is provided to his or her satisfaction.

Methods have been developed to support the planning of processes aimed at maximizing the value received by the customer by mapping the value chain. Industrial engineers plan the processes in the organization to achieve organizational goals and customer satisfaction. This role requires a thorough understanding of the organization and its environment, and, accordingly, the industrial engineer must cooperate and collaborate with other professionals in the organization, and people from other units such:

• Marketing: This unit is responsible for contact with customers and processing of customer orders.
• Purchasing: This unit handles relationships with the external sources involving supply of products and services.
• Engineering: This unit is responsible for product design and the design of production-service systems.
• Finance: This unit is responsible for the organization's budget and management of cash flow including relationships with banks, payments to suppliers, payments received from customers, etc.
• Production: This unit is responsible for the proper operation of the production system.