Production and Operation Management

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Preface

This textbook introduces the students to production and operation management. It discusses different issues of the functions of production management in manufacturing organizations and extends the concept of operation management to the service sector.

The structure of the textbook consists of six chapters. The first chapter introduces the reader to production and operation management. The second chapter discusses the subject of productivity and how to measure it. The third chapter discusses the value chain analysis in relation to operation management. The fourth chapter discusses the subject of production planning and control. The fifth chapter discusses the issues related to facility location, layout, and production system. The last chapter focuses on quality as a crucial tool for achieving excellent in organizations.

CHAPTER ONE
Introduction to Production and Operation Management

OBJECTIVES:

This chapter focuses on the following:

1. Define production management .
2. Differentiate between goods and services.
3. Differentiate between production and operation management.
4. Understand the difference between strategic and tactical operations' decisions.
5. Discuss the transformation process model and give examples.
6. Differentiate between different types of control in the transformation process model.
7. List and discuss the objectives and importance of production management.
8. Discuss the functions of production management.

What is Production Management?

Production/operations management is the process of combining and transforming various resources used in the organization's

production/operations subsystem into value-added products/services in a controlled manner in accordance with the organization's policies. As a result, it is that part of an organization that is concerned with transforming a variety of inputs into the required (products/services) with the required quality level. Production and Operation Management (POM) is about the transformation of production and operational inputs into outputs, that when distributed, meet the needs of customers.

Production management refers to the collection of interconnected management activities involved in the manufacture of specific products. When the same concept is applied to service management, the corresponding set of management activities is referred to as operation management.

Production management means planning, organizing, directing, and controlling of production activities.

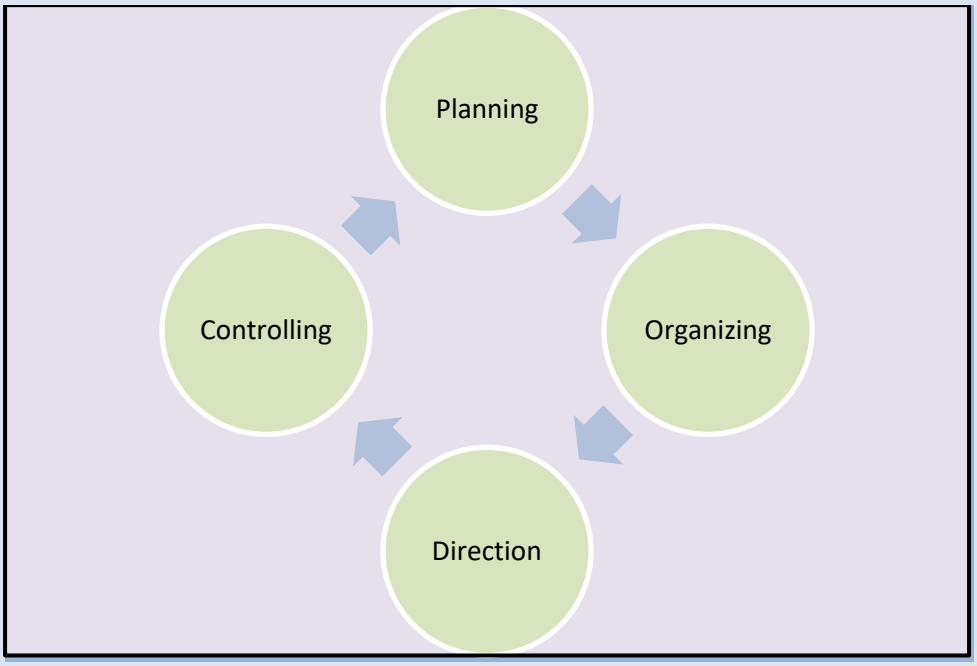


Figure 1 production management functions

Production management is concerned with the transformation of raw materials into finished goods. It brings together the 6Ms, or (men, money, machines, materials, methods, and markets), to satisfy people's needs. Production management is concerned with production process's decision-making so that the resulting goods or services are

produced according to specification, in the amount and by the schedule required, and at the lowest possible cost.

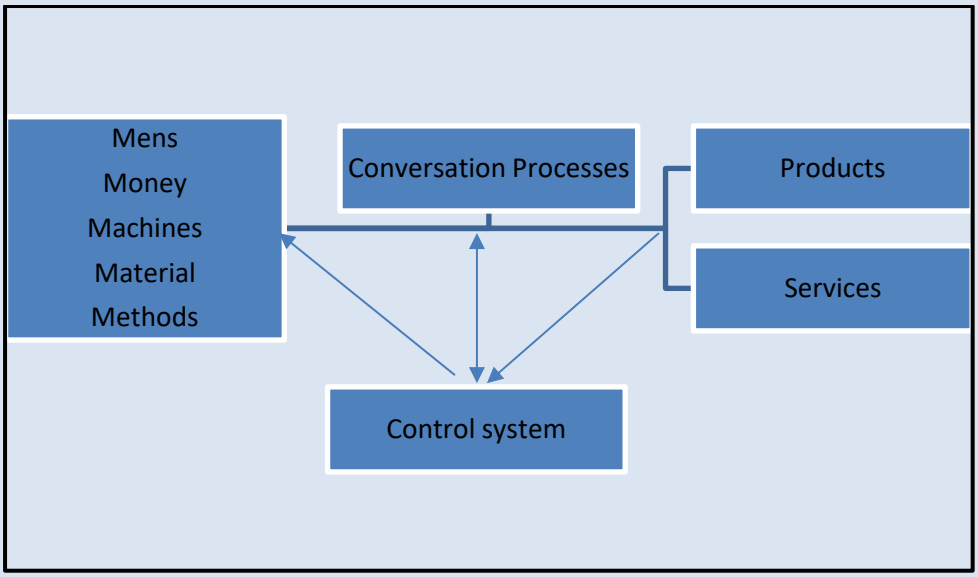
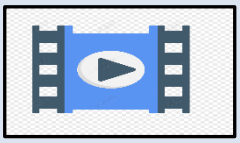


Figure2 Production management Conversation Process

Production management is a part of business management. It is also called "Production Function." Production management is slowly being replaced by operations management.

Figure 3 Functions in organization

Source: http://accountingcollege.co.uk/



Watch Video

The main functions of organizational departments

https://youtu.be/4drdIkjYG0U

Hence, production management is defined as management function which plans, organizes, coordinates, directs, and controls the material supply and processing activities of an enterprise, so that specified products are produced by specified methods to meet an approved sales program. These activities are being carried out in such a manner that resources, labor, plant and capital available are used to the best advantage of the organization, create utility and satisfy customers.

Objectives of Production Management

What are the objectives of production management?

The main objective of production management is to produce goods and services of the right quality, right quantity, at the right time and at minimum cost. It also tries to improve the efficiency. An efficient organization can face competition effectively. Production management ensures full or optimum utilization of available production capacity.

The following summarize the six primary objectives of production management, and why they relate to any given business field.

1. Production of goods and services within the lowest possible manufacturing cost and minimum possible resource consumption:

The first objective is to produce a great product or service without costing more than is estimated and allowed and using resources the most efficiently.

2. Ensuring the proper quality of goods and services:

Any group or department working in customer service/support, as well as research and development, customer experience or similar fields contributes to this. They collect information from users who will be a window on how good a product or service is, as well as researching how to improve the product or service to meet these standards if anything falls short.

3. Production within timelines:

Meeting schedules for production of goods and services according to the standards of quality, and at the budget allocated is the third objective. All people working within management in the company should dedicate themselves, through their leadership in their department, to ensure that these goals are met.

4. Ensuring minimal use of resources:

Reducing consumption of production resources will help to reduce the cost of production and achieve a competitive advantage.

5. Maximization of manpower utilization:

This is another aspect where everyone in management, team leadership or similar positions are integral components. This is all about utilization of manpower to its fullest means

ensuring that all skills available in all people involved are utilized to their fullest potential.

6. Ensuring efficiency by reducing redundancy of tasks:

This basically means eliminating unnecessary steps or reworking any given process or procedure to ensure that the minimal amount of work and time is being consumed. This must be maintained while also ensuring that the above criteria of maximum utilization of manpower, minimum resource consumption, proper standards of quality and maximum expediency are met. Leadership, again, is directly involved in this, no matter the role nor department.

Organization as a system:

The system approach consider organization as a system or as “an organized whole” made up of sub- systems integrated into a unity or orderly totality. Systems approach is based on the generalization that everything is inter-related and interdependent. A system is composed of interlinked together and dependent element which when in interaction, forms a unitary whole.

The business organization is classified into different subsystems based on the functions like marketing, production/operation, finance, and human resource etc.

These systems represent the main functions of organizations.

Concept of Operations

Business dictionary defines process as "Sequence of interdependent and linked procedures which, at every stage consume one or more resources to convert inputs into outputs".

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 producing a tangible output, a product, while a conversion process that includes service yields an intangible output, a deed, a performance, an effort.

The transformation process model

Operating system converts inputs to provide outputs which are required by a customer. It converts physical resources into outputs, the function of which is to satisfy customer wants i.e., to provide some utility for the customer.

In some of the organization the product is a physical good (car manufacturers) while in others it is a service. Banks, taxi services, hospitals and builders are examples of an operating system.

The input, processing, output, and control of a system are called the components of a system. Operations management transforms inputs (labor, capital, equipment, land, buildings, materials and information) into outputs (goods and services) that provide added value to customers.

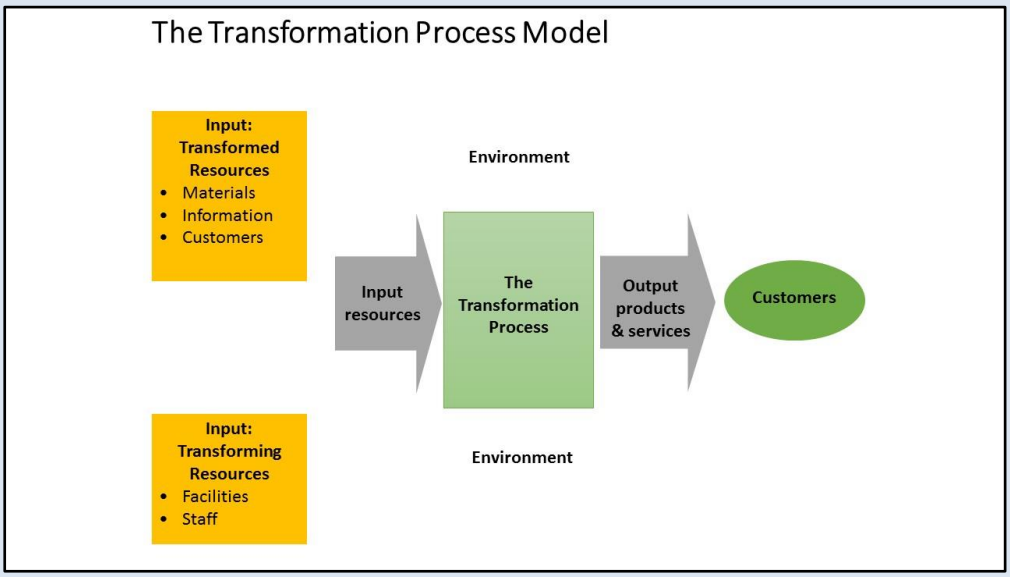
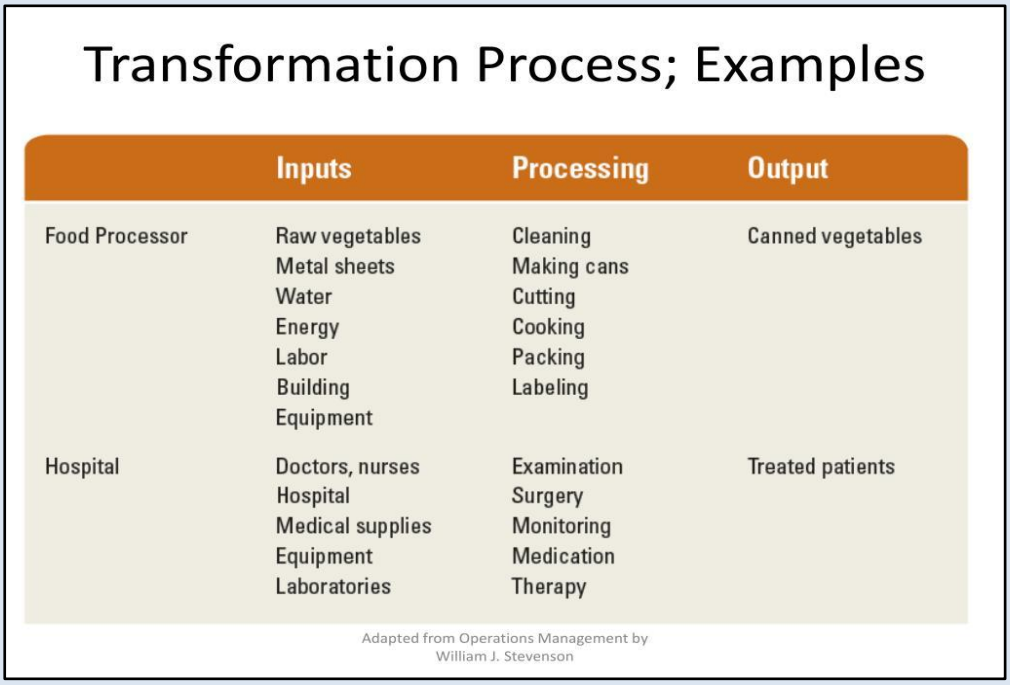


Figure 4 the transformation process

The previous figure summarizes the transformation process. The "Transformation System" is the critical element in the model that will determine how well the

organization produces goods and services that meet customer needs. It does not matter whether the organization is a for-profit company, a non-profit organization (religious organizations, hospitals, banks, and schools), or a government agency; all organizations must strive to maximize the quality of their transformation processes to meet customer needs.



Transformation Process; Examples

	Inputs	Processing	Output
Food Processor	Raw vegetables Metal sheets Water Energy Labor Building Equipment	Cleaning Making cans Cutting Cooking Packing Labeling	Canned vegetables
Hospital	Doctors, nurses Hospital Medical supplies Equipment Laboratories	Examination Surgery Monitoring Medication Therapy	Treated patients

Adapted from Operations Management by William J. Stevenson

Figure 5 Examples of transformation process

Hence, transforming inputs (labor, capital, equipment, land, buildings, and facilities) materials are used to transform material, information, and customers)

into outputs (goods and services) and provide added value to customers.

Types of Control in the transformation process model

Controls are most effective when they are applied at key places. Managers can implement controls before the process begins (feedforward), during the process (concurrent), or after it ceases (feedback).

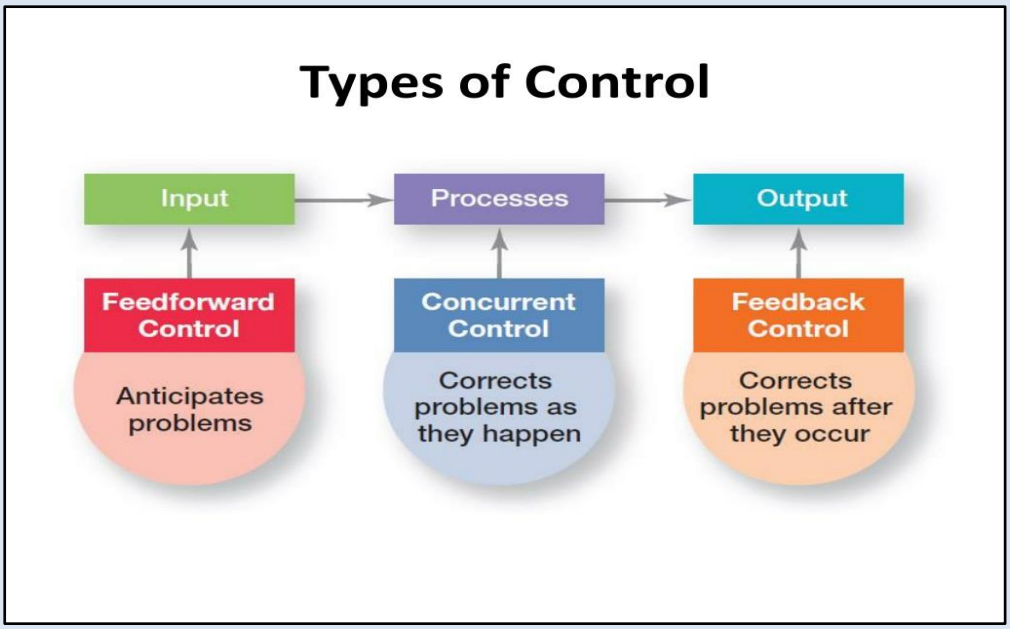


Figure 6 types of control

- **Feed-forward controls** focus on operations before they begin. Their goal is to prevent anticipated problems. An example of feed-forward control is scheduled maintenance on machinery. Regular maintenance feeds forward to prevent problems. Other examples include safety systems, training programs, and budgets.

- **Concurrent controls** apply to processes as they are happening. Concurrent controls enacted while work is being performed include any type of steering or guiding mechanism such as direct supervision, automated systems (such as computers programmed to inform the user when they have issued the wrong command), and organizational quality programs.

- **Feedback controls** focus on the results of operations. They guide future planning, inputs, and process designs. Examples of feedback controls include timely (weekly, monthly, quarterly, annual) reports so that almost instantaneous adjustments can be made.

Distinction between Goods and Services

Goods	Services
1-tangible, durable products. 2- Output can be inventoried. 3-consumption/use takes more time. 4-low costumer's involvement. 5-long response time. 6-available at regional, national and international market. 7-Reqire large facilities. 8-Capital intensive. 9-Quality easily measured. 10-Demand variable on weekly, monthly, seasonally.	1- Intangible, perishable products. 2- Output can't be inventoried. 3-Immidiate consumption. 4- High costumer's involvement. 5- Short response time. 6-local market. 7- Require small facilities. 8-Labour intensive. 9- Quality not easily measured. 10- Demand variable on hourly, daily, weekly basis.

- A 1st distinction, Manufacturing organization generally transfer tangible inputs or raw materials into some tangible output (ex: steel, refrigerator, toothpaste, soap etc.) Other inputs such as labor skills, management skills, capitals are used as well. Manufacturing organizations perform some chemical /physical processes (such as blending refining, welding, grinding. etc) to transfer their raw material into tangible products. Service providing organization transforms a set of input into set of output, they don't produce a tangible output. (ex: mail service, library service, restaurant etc.).or provide service (ex: health care, hair

care, watch and automobile repair etc.). The service of service providing organization is intangible.

- A 2nd distinction is based on inventories . Durable goods can be kept for longer time these goods can be stored for longer time and can be transported in anticipation in future demand. Thus with durable goods ,operation manager can co up with the peaks and valleys in demand by creating inventories and smoothing out output levels. Whereas service can't be pre produced. For example: getting fast food from a fast-food center, getting treatment from hospital etc.
- A 3rd distinction is based on consumption/use of output. The products (goods) generally take longer period for its use, for ex refrigerator, T.V. automobile etc. can be used at least for 10 years. On the other hand, the output produced from a service operation (i.e. service) is consumed within a small time. Ex. consumption of fast food, taking hair care, enjoying journey by a bus/train/aero plane enjoying entertainment program.
- A 4th distinction is based on customer contact. Most of the consumers/customers have little or no contact with the production system/organization. Whereas, in many service providing organizations consumers/customers

are directly involved. For example: students in an educational institution, patients in hospital.

- The 5th distinction is based on lead time/response time to customers demand. Manufacturers take generally some lead time (i.e. time period from placing the order to get the product) in terms of days/week. Whereas the services are offered within few minutes of customers arrival. For ex: ATM Service, getting postal stamps, getting grocery from a retail shop and getting examined by a doctor etc.
- The 6th distinction is on availability. Products can be available from regional, national or international markets due to availability of transportations and distribution facilities whereas, service can't shipped to distant locations. Thus service organization requiring direct customer contact must locate very near to the customers.
- The 7th distinction is based on liabilities/facilities. Manufacturing unit/organization producing products generally require larger facilities, more automation and greater capital investment than service providing organization.
- The 8th distinction is based on capital/labor priority. Generally manufacturing firm producing

goods/products require more capital than a service provider. Ex. An automobile firm requires more capital than a post office/Nursing home.

- The 9th and 10th distinction is based on quality and demand variation.

Distinction between Manufacturing Operations and Service Operations

As a result of the previous distinction between goods and services, the following characteristics can be considered for distinguishing manufacturing operations with service operations:

There are five main differences between manufacturing and service organizations: the tangibility of their output; production on demand or for inventory; customer-specific production; labor-intensive or automated operations; and the need for a physical production location. However, in practice, service and manufacturing organizations share many characteristics. Many manufacturers offer their own service operations, and both require skilled people to create a profitable business.

Compare between manufacturing operations with service operations

Tangibility of their output (goods):

The key difference between service firms and manufacturers is the tangibility of their output. The output of a service firm, such as consultancy, training, or maintenance, for example, is intangible. Manufacturers produce physical goods that customers can see and touch.

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.

Inventory

Service firms, unlike manufacturing firms, do not hold inventory; they create a service when a client requires it. Manufacturers produce goods for stock, with inventory levels aligned to forecasts of market demand. Some manufacturers maintain minimum stock levels, relying on the accuracy of demand forecasts and their production capacity to meet

demand on a just-in-time basis. Inventory also represents a cost for a manufacturing organization.

Customers

Service firms do not produce a service unless a customer requires it, although they design and develop the scope and content of services in advance of any orders. Service firms generally produce a service tailored to customers' needs, such as 12 hours of consultancy, plus 14 hours of design and 10 hours of installation. Manufacturers can produce goods without a customer order or forecast of customer demand. However, producing goods that do not meet market needs is a poor strategy.

Labor

A service firm recruits people with specific knowledge and skills in the service disciplines that it offers. Service delivery is labor intensive and cannot be easily automated, although knowledge management systems enable a degree of knowledge capture and sharing. Manufacturers can automate many of their production processes to reduce their labor requirements, although some manufacturing organizations are labor intensive, particularly in countries where labor costs are low.

Location

Service firms do not require a physical production site. The people creating and delivering the service can be located anywhere.

For example, global firms such as consulting companies use communication networks to access the most appropriate service skills and knowledge from offices around the world.

Manufacturers must have a physical location for their production and stock holding operations. Production does not necessarily take place on the manufacturer's own site; it can take place at any point in the supply chain.

Importance of Production Management

A) 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. So, the firm will increase its sales. This will help it to achieve its objectives.

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. These products are successful in the market because they give full satisfaction to the customers.
4. Supports other functional areas: Production management supports other functional areas in an organization, 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. It will also get more loans and share capital for expansion and modernization. The personnel department will be able to manage the human resources effectively due to the better performance of the production department.
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, right price and at the right time.

These products are delivered to the customers as per their requirements.

6. Optimum utilization of resources: Production management facilitates optimum utilization of resources such as manpower, machines, etc. So, the firm can meet its capacity utilization objective. This will bring higher returns to the organization.
7. Minimizes cost of production: Production management helps to minimize the cost of production. It tries to maximize the output and minimize the inputs. This helps the firm to achieve its cost reduction and efficiency objective.
8. Expansion of the firm: The Production management helps the firm to expand and grow. This is because it tries to improve quality and reduce costs. This helps the firm to earn higher profits. These profits help the firm to expand and grow.

B) The importance of production management to customers and society:

1. Higher standard of living: Production management conducts continuous research and development (R&D). So they produce new and better varieties of products. People use these products and enjoy a higher standard of living.

2. Generates employment: Production activities create many different job opportunities in the country, either directly or indirectly. Direct employment is generated in the production area, and indirect employment is generated in the supporting areas such as marketing, finance, customer support, etc.
3. Improves quality and reduces cost: Production management improves the quality of the products because of research and development. Because of large-scale production, there are economies of large scale. This brings down the cost of production. So, consumer prices also reduce.
4. Spread effect: Because of production, other sectors also expand. Companies making spare parts will expand. The service sector such as banking, transport, communication, insurance also expand. This spread effect offers more job opportunities and boosts economy.
5. Creates utility: Production creates Form Utility. Consumers can get form utility in the shape, size, and designs of the product. Production also creates time utility because goods are available whenever consumers need it.
6. Improve economy: Production management ensures optimum utilization of resources and effective production

of goods and services. This leads to speedy economic growth and well-being of the nation.

Strategic Versus Tactical Operations Decisions

Operations decisions include decisions that are strategic in nature, meaning that they have long-term consequences and often involve a great deal of expense and resource commitments.

a. Strategic decisions have major resource propositions for an organization. These decisions may be concerned with possessing new resources, organizing others or reallocating others.

b. Strategic decisions deal with harmonizing organizational resource capabilities with the threats and opportunities.

c. Strategic decisions deal with the range of organizational activities. It is all about what they want the organization to be like and to be about.

d. Strategic decisions involve a change of major kind since an organization operates in ever-changing environment.

e. Strategic decisions are complex in nature.

Strategic operations decisions include the following:

- Goods and services: This include looking for ways to implement consistency in costs, quality, and resources across all business divisions.
- Quality Management: Be clear on the customer's demands and then meet those expectations. Use market research to determine customer needs and batch quality assurance testing on products and services in production.
- Process and Capacity Design: Design strategies which support all production goals including technology and resources. A value stream map can help determine what processes are necessary and how to keep them running efficiently.
- Location: In developing a location strategy consider supply chain and how the location will receive supplies, the movement of goods and services internally and to customers, and the role of marketing and public relations in the location choice.
- Layout Design and Strategy: Consider the placement of desks, workstations, and how materials are delivered and used.
- Human Resources and Job Design: Implement continuous improvement programs with regular

reviews, provide continuous training for employees, and institute employee satisfaction programs to achieve success in this area.

- Supply Chain Management: Determine the best strategies to streamline, be cost effective, and to develop trusted partners.
- Inventory: Different markets mean different challenges when it comes to inventory but all need to strategize and plan their inventory control. Weather, supply shortages, and labor all influence how an organization maintains its inventory.
- The type of technologies that the organization will use,
- How much long-term capacity the organization will provide to meet customer demand.

Tactical operations decisions have medium term impact on the organization, often involve less commitment of resources, and can be changed more easily than strategic decisions.

The following are some tactical decisions:

- Scheduling: Consider both production and people. scheduling,
- Establishing quality assurance procedures,
- Contracting with vendors,

- Managing inventory.
- Maintenance: This includes maintaining people and machines, as well as process.

Strategic and tactical operations decisions determine how well the organization can accomplish its goals. They also provide opportunities for the organization to achieve unique competitive advantages that attract and keep customers.

Functions of Production Management

The components or functions of production management are as follows:

1. Facilities Location and Layout Planning:
2. Selection of Product and Design,
3. Selection of Production Process,
4. Selecting Right Production Capacity,
5. Production Planning,
6. Production Control,
7. Quality and Cost Control,
8. Inventory Control, and
9. Maintenance and Replacement of Machines

These functions of production management are briefly discussed below.

1. Facilities Location and Layout Planning:

The facilities location is a strategic decision and facilities once located will not be altered in near feature. So due considerations should be given to all the factors that affect the location.

2. Selection of Product and Design:

Production management first selects the right product for production. Then it selects the right design for the product. Care must be taken while selecting the product and design because the survival and success of the company depend on it. The product must be selected only after detailed evaluation of all the other alternative products. After selecting the right product, the right design must be selected. The design must be according to the customers' requirements. It must give the customers maximum value at the lowest cost.

3. Selection of Production Process

Production management must select the right production process. They must decide about the type of technology, machines, material handling system, etc.

4. Selecting Right Production Capacity

Production management must select the right production capacity to match the demand for the product. This is

because more or less capacity will create problems. The production manager must plan the capacity for both short and long term's production. He must use break-even analysis for capacity planning.

5. Production Planning

Production management includes production planning. Here, the production manager decides about the routing and scheduling.

Routing means deciding the path of work and the sequence of operations. The main objective of routing is to find out the best and most economical sequence of operations to be followed in the manufacturing process. Routing ensures a smooth flow of work.

Scheduling means to decide when to start and when to complete a particular production activity.

6. Production Control

Production management also includes production control. The manager must monitor and control the production. He must find out whether the actual production is done as per plans or not. He must compare actual production with the plans and finds out the deviations. He then takes necessary steps to correct these deviations.

7. Quality and Cost Control

Production management also includes quality and cost control. Quality and Cost Control are given a lot of importance in today's competitive world. Customers all over the world want good-quality products at cheapest prices. To satisfy this demand of consumers, the production manager must continuously improve the quality of his products. Along with this, he must also take essential steps to reduce the cost of his products.

8. Inventory Control

Production management also includes inventory control. The production manager must monitor the level of inventories. There must be neither over stocking nor under stocking of inventories. If there is an overstocking, then the working capital will be blocked, and the materials may be spoiled, wasted, or misused. If there is an under stocking, then production will not take place as per schedule, and deliveries will be affected.

9. Maintenance and Replacement of Machines

Production management ensures proper maintenance and replacement of machines and equipment. The production manager must have an efficient system for continuous inspection (routine checks), cleaning, oiling,

maintenance and replacement of machines, equipment, spare parts, etc. This prevents breakdown of machines and avoids production halts.

CHAPTER TWO

PRODUCTIVITY: CONCEPTS and MEASURES

OBJECTIVES

Productivity is a measure of the efficiency with which goods or services are produced. Productivity is frequently expressed as a ratio of an aggregate output to a single or aggregate input used in a production process, output per unit of input, typically over a specific time period. This chapter answer the following questions.

- What is productivity?
- How to measure productivity?

Defining Productivity:

Productivity is a measure of a machine's, factory's, or individual's efficiency in converting inputs into useful outputs. To calculate productivity, divide the average output per period by the costs incurred or resources consumed in that period, such as personnel.

Measuring the effectiveness of formulated operations and production strategies is critical for staying on track with the organization's goals. Simply put, productivity is the sum of total output per employee or per day.

The productivity of a company is determined by the industry and environmental conditions in which it operates. As a result, productivity is commonly defined as a ratio of output volume to input volume. In other words, it assesses how effectively an organization's production inputs, such as labor and capital, are used to produce a given level of output.

Measuring Productivity

Measuring your company's or department's productivity allows you to make operational changes, such as adding employees or equipment to meet deadlines. Understanding your workforce's productivity also allows you to assess overall efficiency and whether you can meet tight deadlines or take on new clients.

How Is Productivity Calculated?

There are several methods for measuring productivity and determining which is best for your company can take some time and thought.

Productivity is the amount of output a company can produce with a given amount of input. Productivity can be measured in a variety of ways, with newer methods relying on software tracking and monitoring.

Labor Productivity Calculation

Overall employee labor productivity is calculated by dividing the goods and services produced by the total number of hours worked by a company's employees over a given time. Assume a manager wishes to calculate the productivity of all employees at their company.

Example 1:

A manager calculates that XZ company produced 30,000 units last month while putting in 3,000 hours of labor.

Solution:

$$\text{labour productivity} = \frac{\text{output volume}}{\text{labor input use}}$$

The company's productivity is 10 (30,000 divided by 3,000), which means that employees produced 10 units per hour in the previous month.

Example 2: [1]

Suppose Sarah works as a quality assurance inspector for bottle caps in a large warehouse and inspects 800 bottle caps

in 8 hours. Her output is 8 hours, and her input is the time it took her to complete it. That is 8 hours in this case. We can calculate Sarah's productivity using this information:

Solution:

Productivity= **800 / 8 = 100 units/hour**

Using Total Sales to Measure Productivity

Another common method for determining a company's labor productivity

We can divide total sales by total hours worked.

Example 3: [2]

If surveying employees is not for you, another equation you might use to get a broad understanding of productivity is total sales during a given period divided by total hours worked in that period. Let's say, for example, you are a business of two employees who work 40-hours a week, each. That's 80-hours worked in a given week. During this specific week, we'll posit that the total amount of sales is $3,000.

Solution

Productivity = $3,000 / 80 = $37.50 / hour

Example4:

Company ABC, for example, had net sales of $15 million and employees who worked a total of 20,000 hours in the previous fiscal year. The output is the net sales of the company, and the input is the number of hours worked.

Solution

The company's productivity is =($15 million /20,000)= $750 This means that for every hour of labor, employees at company ABC generated $750 in sales.

Example 5:

If five workers each work 40 hours per week for a total of 200 hours and produce 4,000 units at the end of the week, the productivity is 4,000/200, or 200 units/hour. If everyone was paid $10 per hour, what is the labor productivity?

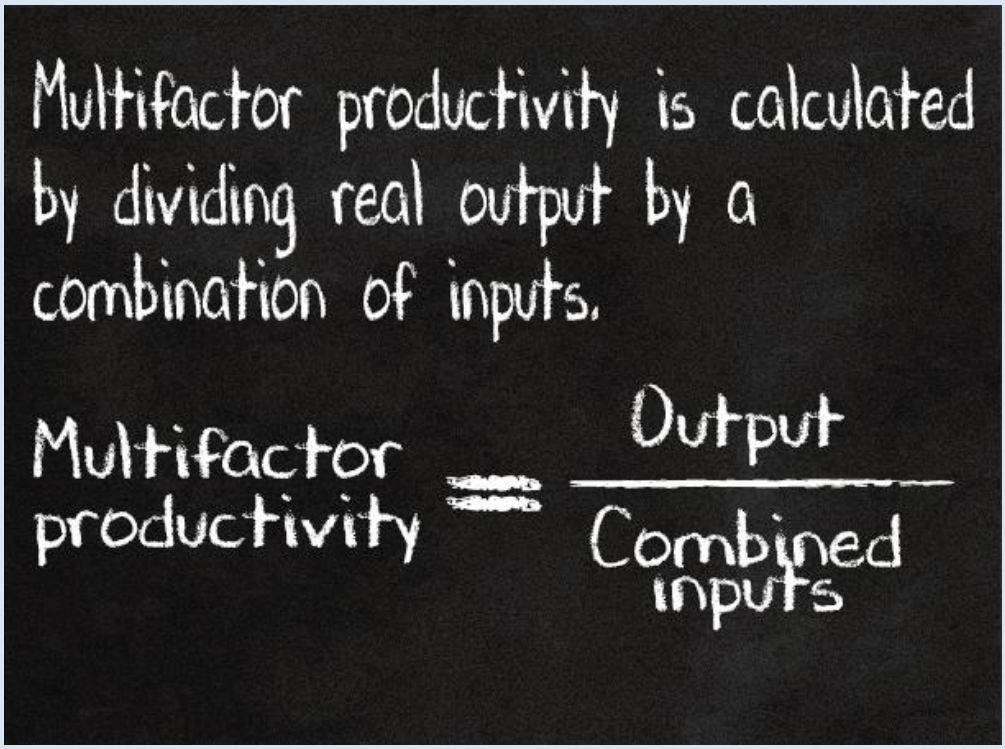
Solution

labor productivity could be calculated as 20 units/dollar.

Multifactor/Total Productivity

When multiple inputs are considered, the metric is known as multi-factor productivity, or MFP. (Hulten 2009,7, in[3]). We can measure productivity when using multiple inputs since Labor is not the only factor that influences productivity in the real

world. [4] Hence Multifactor productivity includes factors other than labor, such as capital and materials. These combined factors are added together and represented as a ratio under the output units. While the formula may differ depending on which units are used, the basic formula is as follows:



Total productivity considers the sum of all input factors that are used to produce output.

Total productivity can be measured by the formula:

$$Pt = \frac{Ot}{L + C + R + Q}$$

Where:

Pt = total productivity

Ot = total output

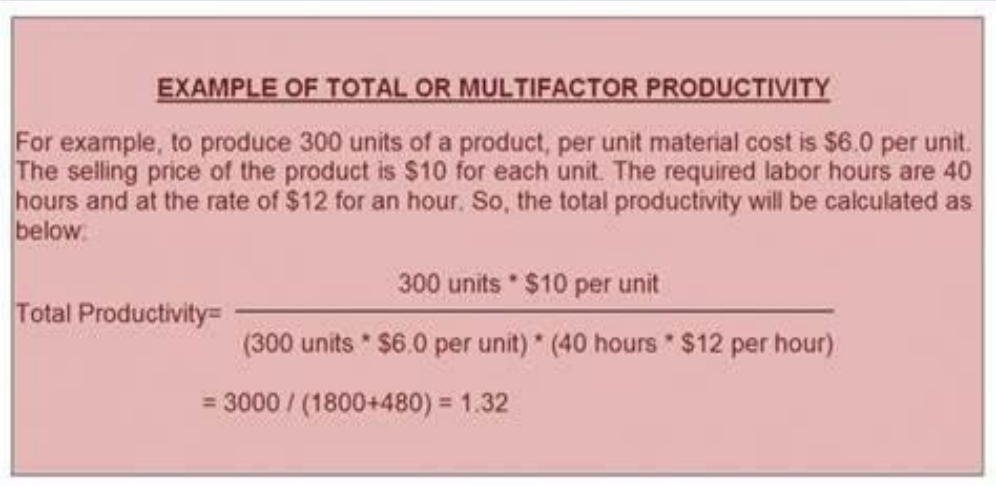
L = labor input factor

C = capital input factor

R = raw material and purchased parts input

Q = other various goods and services input factor

Example 6:



Exercise 1:

1. The weekly output of a fabrication process is shown below together with data for labor and material costs. Overhead is charged weekly at the rate of 1.5 times direct labor cost. Assume a 40-hour week and an hourly wage of $30.

(1) What is the **multifactor productivity** for each of the three weeks?

(2) Based on your computation of (1), what is the **growth rate (in percentage)** of **multifactor productivity** from week 1 to week 2 and week 2 to week 3?

Week	Output	No. of workers	Material costs
1	43,000	7	19,000
2	45,000	8	22,000
3	48,000	7	23,000

Exercise 2:

[redacted] 7040 units produced, sold for $1.10/unit
Cost of labor: $1,000
Cost of materials: $520
Overhead: $2000
What is the multifactor productivity in dollars per dollar?

Benefits of Productivity measurements:

Productivity measurement allows a company to identify areas that need to be improved or given special attention. Furthermore, productivity provides a ready-to-use report card to compare status to the company's production goal.

CHAPTER THREE

Value Chain and Operations Management

OBJECTIVES

This chapter discusses the following:

- How organizations create value.
- Identify the value chain components.
- Summarize the objectives and benefits of value analysis.
- Discuss the activities for Value Analysis.
- List the operations managers' responsibilities.

Value

All organizations strive to create value for their customers. This value creates valuable products and services to satisfy customer's needs. Value analysis, therefore, is a scientific method to increase this value and help organizations to create competitive advantage.

Value is a perception every customer will have their own perceptions on how they define value. However, overall, at the highest level, value is quality, performance, style and design relative to product cost. Increasing value necessarily does not mean decrease in all-inclusive cost of production but providing something extra for which a premium can be charged.

The objectives and benefits of value analysis can be summarized as below:

A. Value analysis aims to simplify products and process by increasing efficiency in managing projects, resolve problems, encourage innovation, and improve communication across organization.
B. Value analysis enables people to contribute to the value addition process by continuous focus on product design and services.
C. Value analysis provides a structure through cost saving initiatives, risk reduction and continuous improvement.

The value chain analysis[5]

The operations manager can make use of the value chain analysis to analyze the process that goes on within the company. It can be said

that all the operations that exist within the value chain can be considered as the processes.

The value chain is one of the most important tools to understand how all the processes are related to each other and how variations in any process will lead to a change in the overall profit margin.

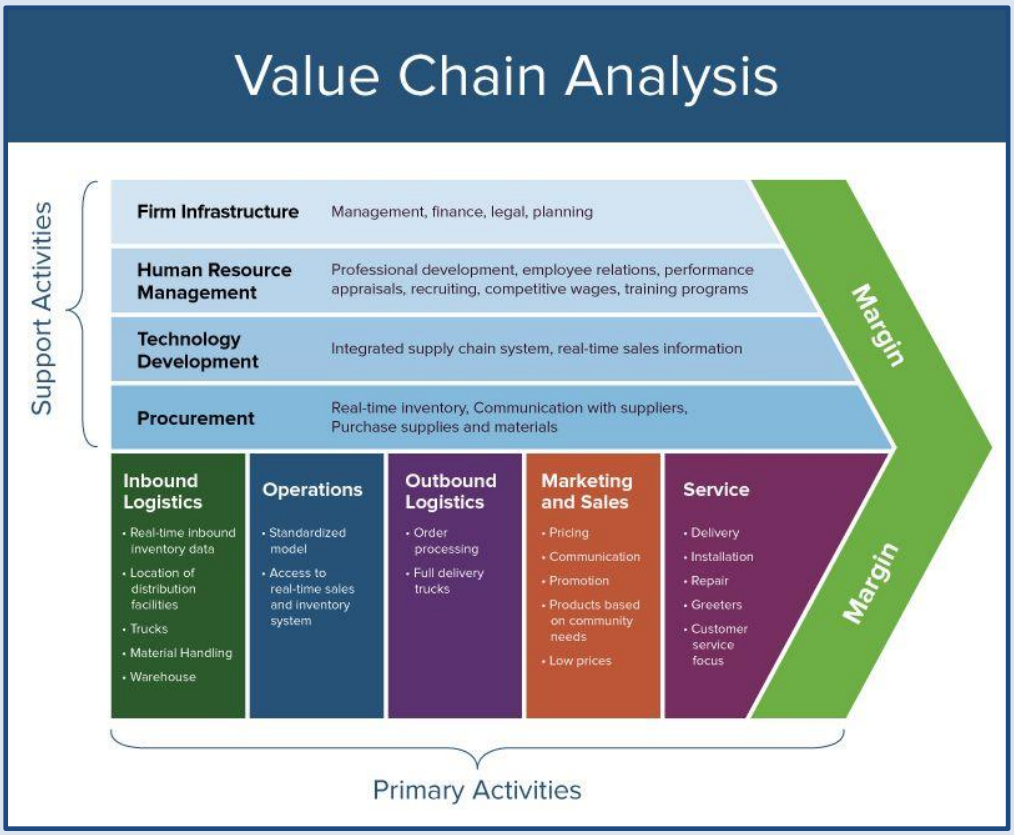


Figure 7 Porter value chain model

Source: [6]

As figure 5 shows, in the value chain we can see that there are primary activities and support activities.

A. Primary activities

These activities are related directly to the physical creation, sale, maintenance and support of a product or service. They consist of the following:

- Inbound logistics – These are all the processes related to receiving, storing, and distributing inputs internally. Your supplier relationships are a key factor in creating value here.
- Operations – These are the transformation activities that change inputs into outputs that are sold to customers. Here, your operational systems create value.
- Outbound logistics – These activities deliver your product or service to your customer. These are things like collection, storage, and distribution systems, and they may be internal or external to your organization.
- Marketing and sales – These are the processes you use to persuade clients to purchase from you instead of your competitors. The benefits you offer, and how well you communicate them, are sources of value here.
- Service – These are the activities related to maintaining the value of your product or service to your customers, once it's been purchased.

B. Support Activities

These activities help to support the primary functions listed above. The dotted lines in our diagram show that each support, or secondary, activity can play a role in each primary activity. Procurement, for example, assists operations with certain activities while also assisting marketing and sales with other activities.

- **Procurement (purchasing)** – This is what the organization does to get the resources it needs to operate. This includes finding vendors and negotiating best prices.
- **Human resource management** – This is how well a company recruits, hires, trains, motivates, rewards, and retains its workers. People are a significant source of value, so businesses can create a clear advantage with good HR practices.
- **Technological development** – These activities relate to managing and processing information, as well as protecting a company's knowledge base. Minimizing information technology costs, staying current with technological advances, and maintaining technical excellence are sources of value creation.

- **Infrastructure** – These are a company's support systems, and the functions that allow it to maintain daily operations. Accounting, legal, administrative, and general management are examples of necessary infrastructure that businesses can use to their advantage.

Processes that are critical to each of these activities can be found within each of these activities. People manage these processes, and the efficiency of these processes determines the overall outcome. As a result, all processes are managed by operations managers, and it is obvious that all operations managers manage processes.

As a result, activities can be evaluated in terms of how much they cost versus how much revenue (value) they generate. Activities that add more cost than revenue are not value-added and should be eliminated from the operation. The critical question for operations managers is therefore to understand how all of their activities fit into the organization's calculation. This analysis yielded a clearer picture of which activities do not add value and how value is created.

Non-commercial organizations Value analysis

So far, the concept of value has been expressed as a commercial concept. It can, however, be transferred to non-profit organizations that support the same type of analysis. In this context, value is

defined as some benefit provided to the operation's customers rather than revenue. All activities that contribute to this benefit's costs can be identified and compared to a subjective assessment of their contribution to the end benefit delivered. To be worthwhile, the costs must be outweighed by their perceived contribution to the benefit.

How can operations provide value?

Using the notion of value in this broad sense to include both commercial and non-commercial meanings, value can clearly be made up of many aspects. Operations can provide these different aspects of value in different ways:

1. Operations can change the state of some input. Manufacturing is a classic example of adding value in this way. Basic inputs like vehicle components, engines and car bodies can be changed to produce a car which is then valued highly enough to generate revenue. In the service sector the changes might be

of a more personal nature. Consider the changes made by a surgeon or a hairdresser for example.

2. Operations can create value by transporting inputs. Public transport is a good example of this, where the passengers are the inputs moved to a new location.
3. Storage may also add value in certain situations. The whole warehousing industry is structured on the premise that people will pay to have their goods dealt with in a protected environment.
4. Inspections may be perceived as adding value. We place a value upon the medical inspections carried out by our doctors for instance.

Competitiveness

We have all competed in various types of activities, perhaps in sports, or school. There may have been prizes or rewards for ranking high in these competitions. Business is no different. We define competitiveness as the ability and performance of a firm to sell and supply goods and services in a given market, in relation to the ability and performance of other firms[7]. In other words, how will one firm win over customers in order to become the product or service of choice.

Competitive Priorities[8]

The competitive priorities are the ways in which the Operations Management function focuses on the characteristics of cost, quality, flexibility and speed. The firm's customers will determine which of the competitive priorities are emphasized.

Cost – Firms whose customers prioritize price will be very interested in having processes that enable them to keep their costs low. These companies are typically paying close attention to identifying and eliminating waste within their operations. By reducing defects, they will reduce costs. These firms will closely monitor and seek to improve their productivity. Factors such as resource utilization and efficiency will be important.

Quality – Firms whose customers prioritize quality focus on creating both excellent product and process design. Marketing and Engineering collaborate to design products that meet customers' requirements. Manufacturing must ensure that the process is able to produce the products defect-free. It is only by having excellent design quality and excellent process quality that the organization can ensure that customers will have their expectations satisfied.

Flexibility – Firms whose customers prioritize variety must prioritize the ability to change rapidly. Firms who value flexibility usually do so by carefully choosing equipment that is general-purpose and able to perform multiple functions. They will often strive to keep a small amount of spare capacity in case it is needed. Multi-skilled employees who are able to work in various areas of the firm or operate multiple types of technology are valued. These firms want to ensure that they can get new products to market quickly and transition from making one product to another quickly. Keeping machine set-ups fast is a critical way to do this. They also strive to be able to abruptly modify the volume of their output in case the need or opportunity arises.

Delivery (reliability and speed) – Firms whose customers prioritize speed of product/service delivery must be very efficient and quick at providing their products and services. McDonald's and Amazon are examples of this.

Porter Competitive advantage strategies:

The relative position of a firm within its industry determines whether its profitability is higher or lower than the industry average. The fundamental foundation of long-term above-average profitability is sustained competitive advantage.

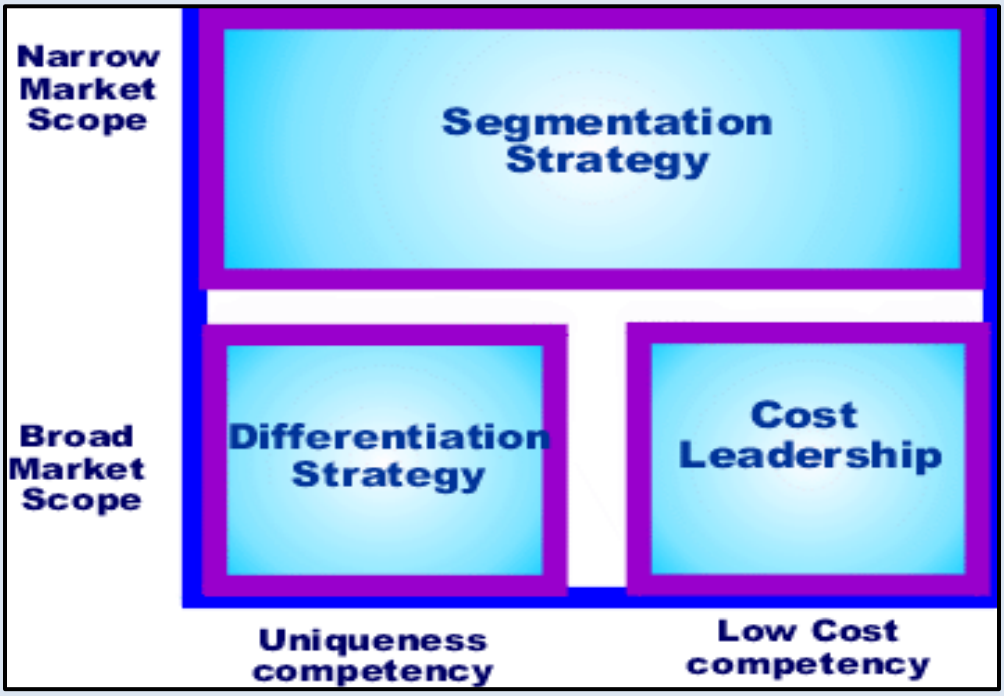


Figure 8 Porter Competitive advantage strategies

A firm's competitive advantage can be of two types: low cost or differentiation. When the two basic types of competitive advantage are combined with the scope of activities for which a firm seeks to achieve them, three generic strategies for achieving above-average performance in an industry emerge: cost leadership, differentiation, and

focus. There are two types of focus strategies: cost focus and differentiation focus.

- Cost leadership refers to a company's ability to achieve economies of scale through highly efficient operations that produce a large volume. Cost leaders include companies like Procter & Gamble, Walmart, McDonald's, and other large corporations that produce a large volume of goods that are distributed at a low cost (compared to the competition).
- Differentiation is less tangible and easily defined, but it is still an extremely effective strategy when executed properly. Differentiation refers to a company's ability to create a difficult-to-replicate good, thereby meeting niche needs. This strategy may include developing a strong brand image that allows the organization to charge a premium for its products or services.
- Market segmentation is a cross between the two strategies with a narrow scope (both cost leadership and differentiation have a relatively broad scope). Segmentation aims to find specific segments of the market that larger firms would not otherwise be able to access.

Operations managers' responsibilities:

Operations managers' responsibilities include the following:

- Human resource management – the people employed by an organization either work directly to create a good or service or provide support to those who do. People and the way they are managed are a key resource of all organizations.
- Asset management – an organization's buildings, facilities, equipment, and stock are directly involved in or support the operations function.
- Cost management – most of the costs of producing goods or services are directly related to the costs of acquiring resources, transforming them, or delivering them to customers. For many organizations in the private sector, driving down costs through efficient operations management gives them a critical competitive edge.
- Coordination with other departments: It is the responsibility of operation manager to coordinate with marketing department, purchasing department and financial department to be able to effectively achieve the organizational goals.

CHAPTER FOUR

Production Planning and Control

OBJECTIVES

- This part discusses the following:
- Importance of production planning and control
- Objectives and characteristics of production planning
- Methods of demand forecasting
- Capacity planning
- Production control

Importance of Production Planning and Control

For efficient, effective, and economical operation in a manufacturing unit of an organization, it is essential to integrate the production planning and control system. Production planning and control address a fundamental problem of low productivity, inventory management and resource utilization.

Production planning is required for scheduling, dispatch, inspection, quality management, inventory management, supply management and equipment management. Production control ensures that production

team can achieve required production target, optimum utilization of resources, quality management and cost savings.

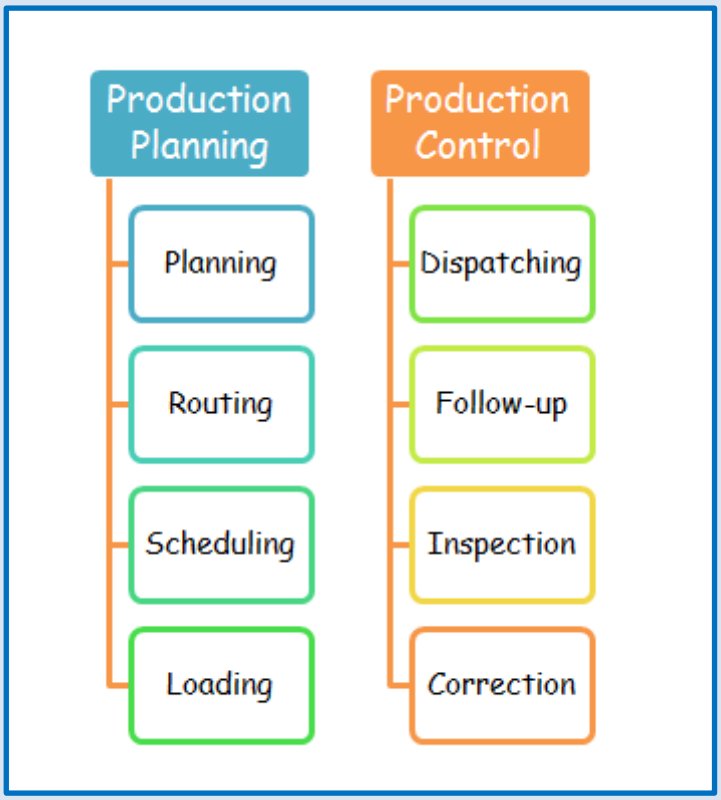


Figure 9 Production Planning and Control

Planning and control are essential ingredients for success of an operation unit.

Benefits of Production Planning and Control (PPC)

1. It ensures the continuous flow of production through the production facility.

2. It ensures that optimum utilization of production capacity is achieved, by proper scheduling of the machine items which reduces the idle time as well as overuse.
3. It ensures that inventory levels are maintained at optimum levels at all times.
4. It also ensures that production time is kept at optimum level. thus, increasing the turnover time through asset utilization.
5. It maintains the quality of final product.
6. High productivity of personnel and machinery as the inputs and the outputs (end-to-end) are taken care of.
7. Idle time is cut to the minimum and more emphasis is allowed on the process flow and its smooth functioning.
8. Performance can be monitored, and effective feedback can be given to employees or machines can be tended to
9. Proper utilization of machinery and the workforce is encouraged and followed.
10. Work among personnel is regulated to avoid under-loading or overloading of work.
11. Optimum levels of co-ordination are maintained on the production line through the implementation of Production Planning and Control (PPC)

12. Cost is effectively controlled and managed with sincere planning and control of wastage on the production line.
13. Quality achieved is of the highest level and is maintained throughout the workflow.

Limitations of Production planning and Control (PPC)

1. It can face rigidity from employees through their behavior.
2. It is difficult for small-scale firms and organizations as it is extremely time-consuming.
3. The initial setup cost is extremely high and will not be affordable to many organizations.
4. Highly dependent on external factors such as changes and updates in technologies, government rules and regulations

Production Planning

Objectives of Production planning:

Production planning is the organization of a company's or industry's production and manufacturing modules.

It utilizes the resource allocation of activities of employees, materials, and production capacity, to serve different customers. (Fargher and Richard, 1996). Manufacturing facilities are unable to schedule their production processes efficiently without production planning, limiting overall production output. Any error in planning process will lead to inaccurate schedule, which leads to late orders, internal chaos, dissatisfied customers, and lost business.

Objectives of production planning include the following:

- To ensure right quantity and quality of raw material, equipment, and other resources are available during times of production.
- To ensure capacity utilization is in tune with forecast demand at all the time.
- To ensures that overall production process is smooth providing following benefits:
    - Organization can deliver a product in a timely and regular manner.
    - Supplier are informed will in advance for the requirement of raw materials.
    - It reduces investment in inventory.

- It reduces overall production cost by driving in efficiency.

Production planning takes care of two basic strategies' **product** planning and **process** planning. Planning will involve performing tasks at the right time and under the right circumstance and environment.

Time of Planning

Production planning is done at three different time dependent levels:

- long-range planning dealing with facility planning, capital investment, location planning.
- Medium-range planning deals with demand forecast and capacity planning.
- Short term planning dealing with day-to-day operations.

Characteristics of Production Planning

We need to understand that during production planning, we are taking care of:

- Routing
- Scheduling
- Loading

Routing

This aspect of planning entails the precise path that the product or materials will take while on the assembly line. The entire operation is meticulously planned and designed, and their path and sequential order are determined and agreed upon. At this point, the use of machines and the appropriate resources is considered. The amount and quantity of machine work versus manpower is determined and planned, and the best and most cost-effective line of work that the operations require is identified. The tasks of this stage ensure quality management.

Scheduling

This stage determines the time required to complete a specific task, activity, or step based on the process, machines, and resources. These individual steps are then combined to determine the total time for a routed operation, providing the project manager with enough information to devise an efficient plan for creating and packaging products

on the line. The workflow and patterns are determined here based on time and priority.

Loading

This is where the scheduling and routing are carried out. The load is checked for resource help and support at each routing point and start-end of an activity or operation. Individual work personnel are assigned at this stage, and the process's efficiency is tested.

Demand Forecast:

Organization conduct analysis on its pre-existing database or conduct market survey as to understand and predict future demands. Operational planning is done based on demand forecasting.

Characteristics of Good Forecast

A good forecast should provide sufficient time with a fair degree of accuracy and reliability to prepare for future demand. A good forecast should be simple to understand and provide information relevant to production units

Methods of Demand Forecasting

Demand forecasting is the systematic and scientific estimation of a product's future demand. Simply put, demand forecasting is the estimation of future sales or demand for a product or products.

In terms of the purpose of forecasting, data required, data availability, and the time frame within which the demand is to be forecasted, there are several methods of demand forecasting used.

Because each method differs from the others, the forecaster must choose the method that best meets the requirements.

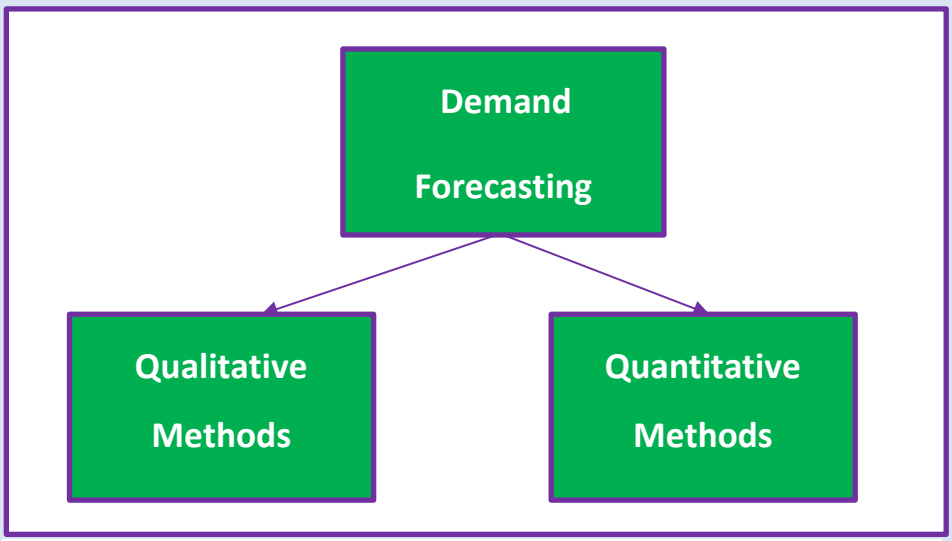


Figure 10 Methods of Demand Forecasting

There are generally two types of forecasting: quantitative and qualitative. First, qualitative forecasting makes predictions based on the opinions of others. For instance, you might work with a business consultant who can tell you how changing your prices will affect demand or whether there's a product-market fit for your offerings. Second, quantitative forecasting relies on data and numbers to predict future demand and sales.

The main difference between quantitative and qualitative forecasting is the data. With qualitative forecasting, the data is numerical, while qualitative forecasting relies on opinions rather than hard numbers. Neither forecasting method is considered better than the other. Instead, we recommend using a good balance of both when making important business decisions. Qualitative forecasting methods are based on data or fact, but both are up to interpretation based on who is reading the analytics report.

- **Qualitative Methods:**

Qualitative forecasting is based on personal opinions. It is founded on an examination of the human aspect of sales, market demand, and market trends. The ability to tap into the experience of industry experts as they make predictions about customer

behavior and future sales outcomes is a benefit of qualitative methods of demand forecasting. These methods are frequently used when forecasting demand for a short period of time. Among these methods are:

The qualitative methods are:

- Consumer and Market research
- Sales opinions
- Delphi method
- **Consumer and market research methods:**

These methods are of the most famous qualitative methods. These methods are techniques of demand forecasting that involve direct interview of the potential consumers. Under the consumer survey methods, the consumers are communicated and asked about their intentions and opinions for a product and their expected purchase plans.

  - **Complete Enumeration Method:** A forecaster contacts almost all the expected customers of the product and asks them about their expected future purchases. All the forecasted demand will be added to forecast the total demand of the potential consumers.

- **Sample Survey:** When the population of the consumer is big and it is costly to survey all the customers, it is preferable to choose a representative sample and forecast the demand. We can use interviews, mail surveys or other types.

- **Salespersons' opinions**

Interviewing salles representatives may be the best way to explore how customers think. Each sales representative is an expert on a unique type of customers and market.

- **Delphi method**

Perhaps the most well-known technique, the Delphi method involves consulting a panel of industry experts through a series of questionnaires regarding specific topics about the business or industry.

Quantitative Methods[9]:

The quantitative methods are often used when the forecasting of demand is to be done for a longer period. The quantitative methods use

past data to forecast for demand such as the time-series and cross-sectional data.

What are the advantages of using quantitative forecasting?

Quantitative forecasting methods use real, historical data to help business owners make important decisions, ensuring the data is always objective. The more data you have, the more reliable your results will be.

The advantages of using quantitative methods of forecasting include the following:

- **Accuracy**: Quantitative forecasting is accurate as long as the data used is reliable. Since it relies on existing numbers your business already has, you won't have to worry about inaccuracies as long as your system is up to date.
- **Consistency and reliability:** Because quantitative forecasting is accurate, it is consistent and reliable since the historical data is already established. This reliability makes identifying and predicting trends easier while driving better business decisions.
- **Objectivity:** You cannot argue with data. While qualitative forecasting relies on opinions business

owners can choose to ignore, you cannot overlook numerical data. Numbers are inherently more objective and less up to interpretation than opinions. Reviewing data objectively makes it easier to rely on it for decisions that can affect the performance and health of your business, making forecasting easier to understand.

- **Replicable:** Quantitative forecasting is replicable because it is based on historical data. Therefore, you can replicate various types of predictions, including sales and demand forecasts. In addition, since you're using data rather than opinions, you can repeat the forecast with new information, adjusting goals and insights depending on your needs.

What are the disadvantages of using quantitative forecasting?

- Unfortunately, quantitative forecasting isn't perfect. Historical data can help you make more accurate predictions, but many experts recommend a mix of both quantitative and qualitative data for forecasting because the former lacks detail.
- Quantitative forecasting models are simple and easy to understand, but they're based on numbers rather than

the opinions of your customers or industry experts. Many businesses also don't have enough data, and a small sample size can lead to inaccurate results.

- Additionally, quantitative forecasting can be challenging to interpret because it yields numerical results. Therefore, you'll need to understand the data available to you. Data doesn't have context, whereas qualitative information can help you fully understand why certain trends occur and the actions you need to take.

- Quantitative forecasting can also be expensive because you need to collect massive amounts of data to improve accuracy. Collecting this data can be a significant undertaking that many small businesses may not be able to afford. However, you can reduce expenses by using automated reporting software to simplify the process.

Types of quantitative forecasting methods:

Historical growth rate

The first one we are going to look at is known simply as the historical growth rate.

Essentially what you are doing here is using the data from a set period of time, this could be anything from weeks, to months or even years, depending on the type of forecast you are looking to draw up to predict the next period's growth rate.

Example, let's suppose you are trying to predict next month's sales.

You would multiply this month's sales by one, plus the monthly sales growth rate.

The formula would therefore look like this:

(x) month's sales x (1 + % rate of sales growth) = next month's sales

So if you had a 20% increase in sales over the past month, and you sold say, $25,000 worth of product, then your sales forecast for next month would be:

$25,000 x (1 + 20%) = **$30,000**

Run Rate

The run rate is an average calculated from past historical sales data and is represented by:

The run rate = total revenue / sum of past sales periods

So let’s imagine we are in April and your sales periods are broken into months, and as of this moment you have sold $32,000 worth of product.

That means your monthly revenue averages out at $8000.

Now in order to predict your overall revenue for the year you will need to calculate the expected amount sold over the remaining 8 months.

So if your average is $8000 a month:

8 x $8000 = $64,000

For a grand sum annual total of:

$64,000 + $32,000 = $96,000

As you can see the run rate method works best when trying to forecast revenue for the remainder of a set period of time.

- **Simple Moving Average**

One of the quantitative methods of sales forecasting we are going to look at is the Simple Moving Average. Similar to run rate, it requires you extrapolate sales data from a set period only this time that period is dynamic – it moves forward depending on the timeframe we are looking at.

Let me give you an example:

Say you want to predict sales for the next 6 months. You have sales data from the past 3 years from which to extrapolate your forecast which gives exactly 6x (6) month periods to work with.

6 Month Period	Revenue	Total Revenue	Shifting Average
1	$125,000.00		
2	$145,600.00		
3	$146,000.00	$416,600.00	$138,866.67
4	$154,555.00	$446,155.00	$148,718.33
5	$164,500.00	$465,055.00	$155,018.33
6			

- **Column 1:** The last 6x (6) month periods
- **Column 2:** Aggregated revenue from those 6 month periods
- **Column 3:** Total aggregated revenue from the set period of 18 months
- **Column 4:** Simple Moving Average: last 18 months total revenue / 3

As you can see from the graph the simple moving average for 6 month periods 1-3 is: **$138,866.67**

This was calculated by adding the revenue from the first three 6 month periods: $125,000 + $145,600 + 146,000 = $416,600 and then dividing by three (to give you the average) = **$138,866.67**

6 Month Period	Revenue	Total Revenue	Shifting Average
1	$125,000.00		
2	$145,600.00		
3	$146,000.00	= $416,600.00	$138,866.67
4	$154,555.00	$446,155.00	$148,718.33
5	$164,500.00	$465,055.00	$155,018.33
6			

Now this where we differentiate from run rate.

Because this is a simple moving average, everything moves forward by 1, 6 month period.

So we will repeat the same process for periods **2-4**:

And again, for periods **3-5**:

6 Month Period	Revenue	Total Revenue	Shifting Average
1	$125,000.00		
2	$145,600.00		
3	$146,000.00	$416,600.00	$138,866.67
4	$154,555.00	$446,155.00	$148,718.33
5	$164,500.00	=$465,055.00	$155,018.33
6			

So when trying to forecast the revenue for 6th period, you simply use the shifting average from period 5:

6 Month Period	Revenue	Total Revenue	Shifting Average
1	$125,000.00		
2	$145,600.00		
3	$146,000.00	$416,600.00	$138,866.67
4	$154,555.00	$446,155.00	$148,718.33
5	$164,500.00	$465,055.00	**$155,018.33**
6	**$155,018.33**		

Out of the other quantitative methods of sales forecasting we've looked at shifting average tends to be slightly more accurate as it takes a **dynamic average**. As you can see total revenue is steadily increasing over each 6 month period. If we solely used the run rate from periods 1-3 it wouldn't account for the steady increase in revenue from periods 3-5, leaving your forecast period 6 woefully short of it's likely revenue.

Trend Projection Methods

This method is concerned with the movement of variables across a long time. It is important to have a long time-series data to consider.

- **Graphical Linear Trend**

Another set of quantitative methods of sales forecasting we are going to look at are linear extensions. To put it simply, linear extensions work by plotting your historic sales data on

a chart, drawing a line through the middle of the points and extending this line in the future.

Let us plot some sales data into a standard line chart in Excel.

The (y) vertical axis are sales, represented by increments of $10K and the (x) horizontal axis refers to a period of time, in this case represented by month.

In order to forecast sales for the upcoming month you can use the TREND feature found in excel or alternatively you can click on the data line shown on the graph, and as you do so a pop up will appear to the right of the excel sheet. Click the “bar graph” icon and a drop-down list will appear with options to extend a tendency line past your input data (x).

You will end up with something similar to this:

Where this line **intersects your forecast date** will be your predicted forecast revenue. In this case the line intercepts (x) month 6 at (y) 172.

Therefore, our sales forecast for month 6 using the linear method is: **$172,000**

However, the linear extension does have its **drawbacks**. It assumes that the factors responsible for past trends in the variables to be projected will continue to play their role in the future in the same manner and to the same extent that they did in the past when determining the magnitude and direction of the variable. As most sales managers will attest to sales revenue rarely increases in a linear fashion i.e. what you made in April will be increased by (x) amount in May because we saw the same trend happen between March – April. That

is because it cannot account for seasonality. If you sell ice-cream for example, you will expect to see an increase in sales as the temperature increase and we head into the summer period.

- **Linear Trend Equation**

When the time-series data reveals a rising or a linear trend in sales, the following straight-line equation is fitted:

S = a + bT

Where S = annual sales(demand) T = time a and b are constants. The slope = a and The y-intercept = b

Exercise

Find the linear trend projection forecast for August

Month	Period	Demand
Jan	1	1000
Feb	2	1150
March	3	1200
April	4	1240
May	5	1300
Jun.	6	1310
July	7	1300
Aug.	8	??

Solution:

The slope = a = 52.5

The y-intercept = b = 1011.429

So, the linear trend equation is S = 52.5 (t) + 1011.429

To find the forecast for August, we plug in t=8 in the above equation as follows:

S8= 52.5(8) + 1011.429 = 1431.429

- **Regression analysis**

The Regression Equation is the algebraic expression of the regression lines. It is used to predict the values of the dependent variable from the given values of independent variables.

Regression Equation of Y on X: This is used to describe the variations in the value Y from the given changes in the values of X

$$Y_e = a + bX$$

- **Ye is the dependent variable**
- **X is the independent variable, and**
- **a & b are the two unknown constants that determine the position of the line.**

Capacity Planning

The production system design planning considers input requirements, conversion process and output. After considering the forecast and long-term planning organization should undertake capacity planning.

Capacity is defined as the ability to achieve, store or produce. For an organization, capacity would be the ability of a given system to produce output within the specific time period. In operations, management capacity is referred as an amount of the input resources available to produce relative output over a period of time.

In general, terms capacity is referred as maximum production capacity, which can be attained within a normal working schedule.

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

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.

Capacity Planning Classification

Capacity planning based on the timeline is classified into three main categories long range, medium range and short range.

Long Term Capacity: Long range capacity of an organization is dependent on various other capacities like design capacity, production capacity, sustainable capacity and effective capacity.

Design capacity is the maximum output possible as indicated by equipment manufacturer under ideal working condition.

Production capacity is the maximum output possible from equipment under normal working condition or day.

Sustainable capacity is the maximum production level achievable in realistic work condition and considering normal machine breakdown, maintenance, etc.

Effective capacity is the optimum production level under pre-defined job and work-schedules, normal machine breakdown, maintenance, etc.

Medium Term Capacity: The strategic capacity planning undertaken by organization for 2 to 3 years of a time frame is referred to as medium term capacity planning.

Short Term Capacity: The strategic planning undertaken by organization for a daily weekly or quarterly time frame is referred to as short term capacity planning.

Goal of Capacity Planning

The goal of capacity planning is to meet the current and future level of the requirement at a minimal wastage. The

three types of capacity planning based on goal are lead capacity planning, lag strategy planning and match strategy planning.

Factors Affecting Capacity Planning

Effective capacity planning is dependent upon factors like production facility (layout, design, and location), product line or matrix, production technology, human capital (job design, compensation), operational structure (scheduling, quality assurance) and external structure (policy, safety regulations)

Forecasting v/s Capacity Planning

There would be a scenario where capacity planning done on a basis of forecasting may not exactly match. For example, there could be a scenario where demand is more than production capacity; in this situation, a company needs to fulfill its requirement by buying from outside. If demand is equal to production capacity; company is in a position to use its production capacity to the fullest. If the demand is less than the production capacity, company can choose to reduce the production or share its output with other manufacturers.

Aggregate Planning

An organization can finalize its business plans on the recommendation of demand forecast. Once business plans are ready, an organization can do backward working from the final sales unit to raw materials required. Thus, annual and quarterly plans are broken down into labor, raw material, working capital, etc. requirements over a medium-range period (6 months to 18 months). This process of working out production requirements for a medium range is called aggregate planning.

Hence aggregate planning is the process of creating, analyzing, and maintaining a preliminary, approximate schedule of an organization's overall operations. The overall plan typically includes sales forecasts, production levels, inventory levels, and customer backlogs. This schedule is designed to meet the demand forecast at the lowest possible cost. When done correctly, aggregate planning should reduce the effects of short-term, day-to-day scheduling, in which small amounts of material are ordered one week, followed by a layoff of workers, followed by ordering larger amounts and rehiring workers the following week. This

longer-term perspective on resource use can help to reduce short-term impacts.

Factors Affecting Aggregate Planning

Aggregate planning is an operational activity critical to the organization as it looks to balance long-term strategic planning with short term production success. Following factors are critical before an aggregate planning process can start.

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

For aggregate planning to be a success, following inputs are required:

- An aggregate demand forecast for the relevant period

- Evaluation of all the available means to manage capacity planning like sub-contracting, outsourcing, etc.
- Existing operational status of workforce (number, skill set, etc.), inventory level and production efficiency

Note: Aggregate planning will ensure that organization can plan for workforce level, inventory level and production rate in line with its strategic goal and objective.

Aggregate planning as an Operational Tool

Aggregate planning helps achieve balance between operation goal, financial goal and the organization's overall strategic goal. It acts as a platform for capacity and demand planning.

What are the steps taken to create an aggregate plan?

- Determining demand and determining current capacity.
- Capacity is defined as the total number of units that can be produced a period (this requires that an average number of units be computed since the total may include a product mix utilizing distinctly different production times).

- The total number of units required is used to express demand. If the two are not balanced (equal), the firm must decide whether to increase or decrease capacity to meet demand or demand to meet capacity. There are variety of options are available to accomplish this.

- **What to do when Demand is less than Capacity?**

In situations where demand must be increased to match capacity, the following options are available:

- Pricing. Changing pricing to increase demand when demand is lower than peak. For example, matinée prices for movie theatres, off-season hotel rates, weekend phone service rates, and pricing for items with seasonal demand.
- Promotion. To shift demand, advertising, direct marketing, and other forms of promotion are used.
- Backordering is available. Demand is shifted to a period when capacity is not fully utilized by deferring delivery on current orders. This is simply a method of smoothing demand. Service industries can smooth demand by accepting reservations or making a reservation system.

- Creating new demand. A new but complementary demand for a product or service is created. When customers are forced to wait in a restaurant, they are frequently directed to a complimentary (but not complimentary) service, the bar. Other examples include the addition of video arcades within movie theatres and the expansion of convenience store services.

Options for increasing or decreasing capacity to match current demand include:

- Hiring/firing. Firms can maintain a balance between capacity and demand by hiring additional workers as needed or laying off workers who are no longer needed to meet demand.
- Overtime. Firms can create a temporary increase in capacity without the added expense of hiring additional workers by asking or requiring workers to work extra hours per day or an extra day per week.
- Part-time or casual employment. By utilizing temporary or casual workers (workers who are considered permanent but only work when needed, on an on-call basis, and typically without the benefits given to full-time workers).

- Inventory. Finished-goods inventory can be built up during times of low demand and then used to meet demand during times of high demand. In this manner, no new employees are required, no temporary or casual labor is required, and no overtime is incurred.
- Subcontracting. Frequently, companies will choose to have another manufacturer or service provider provide the product or service to the subcontracting firm's customers. Additional capacity is temporarily obtained by subcontracting work to a different source.
- Cross-training. Cross-trained employees may be able to perform tasks in several operations, creating some flexibility when scheduling capacity.
- Other methods. While varying workforce size and utilization, inventory buildup/backlogging, and subcontracting are well-known alternatives, there are other, more novel ways that find use in industry. Among these options are sharing employees with counter-cyclical companies and attempting to find interesting and meaningful projects for employees to do during slack times.

Importance of Aggregate Planning

Aggregate planning plays an important part in achieving long-term objectives of the organization. Aggregate planning helps in:

- Achieving financial goals by reducing overall variable cost and improving the bottom line
- Maximum utilization of the available production facility
- Provide customer delight by matching demand and reducing wait time for customers
- Reduce investment in inventory stocking
- Able to meet scheduling goals there by creating a happy and satisfied work force

Aggregate Planning Strategies

There are three types of aggregate planning strategies available for organization to choose from. They are as follows.

1. Level Strategy

As the name suggests, level strategy looks to maintain a steady production rate and workforce level. In this strategy, organization requires a robust forecast demand as to

increase or decrease production in anticipation of lower or higher customer demand.

A level strategy enables a company to maintain a consistent level of output while still meeting demand. This is preferable in terms of employee relations. The cost of excess inventory, subcontracting or overtime costs, and backorder costs, which are usually the cost of expediting orders and the loss of customer goodwill, are all negative outcomes of the level strategy.

- Advantage of level strategy is steady workforce.
- Disadvantage of level strategy is high inventory and increase back logs.

2. Chase Strategy

As the name suggests, chase strategy looks to dynamically match demand with production on a period-by-period basis. This could result in significant hiring, firing, or laying off employees; insecure and unhappy employees; increased inventory carrying costs; labor union issues; and erratic utilization of plant and equipment. It also implies a high level of adaptability on the part of the company.

- The primary benefit of a chase strategy is that it allows inventory to be held at the lowest possible level, which can result in significant savings for some businesses. Many companies that use the concept of just-in-time production use a chase strategy approach to aggregate planning.
- Disadvantages are lower productivity, quality and depressed work force.

3. Hybrid Strategy

As the name suggests, hybrid strategy looks to balance between level strategy and chase strategy. Most businesses find that combining the level and chase strategies is advantageous. A combination strategy, also known as a mixed strategy, can be found to better meet organizational goals and policies while also achieving lower costs than either of the pure strategies used separately.

Production Control

For efficient, effective, and economical operation in a manufacturing unit of an organization, it is essential to integrate the production planning and control system. Production planning and control address a fundamental problem of low productivity, inventory management and resource utilization.

Objectives and Advantages of Production Control

Production control looks to utilize different type of control techniques to achieve optimum performance out of the production system as to achieve overall production planning targets. Therefore, objectives of production control are as follows:

- Regulate inventory management
- Organize the production schedules
- Optimum utilization of resources and production process

The advantages of robust production control are as follows:

- Ensure a smooth flow of all production processes

- Ensure production cost savings thereby improving the bottom line
- Control wastage of resources
- It maintains standard of quality through the production life cycle.

Production control cannot be same across all the organization. Production control is dependent upon the following factors:

- Nature of production (job oriented, service oriented, etc.)
- Nature of operation
- Size of operation

Once the production plan is in place, keeping the processes under control and in a straight line becomes part of production control. This ensures that a certain level of monitoring is carried out over the production workflow and the resources that work in accordance with the workflow. Adjustments can be made during production control if there is a deviation. Steps and measures are anticipated and implemented to ensure that production always follows the path intended and established during the production planning phase.

Production control employs a variety of control techniques to enable the production unit to achieve the optimum level of performance that an organization desires. This ensures a qualitative perspective on things within a business and can help the business push their targets higher and higher each year. The following are the goals of production control:

- Managing production inventory;
- Completing and optimizing resource and time utilization; and
- Carefully organizing the production schedule.

Production control ensures that the processes designed and defined during production planning remain on track. After the stakes are checked, control measures take care of this fact and produce results on the outcome. The process that production control follows is as follows:

- Dispatching
- Follow-up
- Inspection
- Correction

Dispatching

This is where the real work begins, and the implementation of the plans are made into real-life production. During the dispatching phase, you have production orders issued to commence the operations and fuel the onward movement of the production line. Each operation is conducted as per the plan, schedule, and shortest possible route for the product to come alive.

Workstation management and use of resources are put to play and dispatched on duty. The time, effort, and the cost for completion of each task or activity is recorded and each of the routes of these tasks are then ready for the next stages involved in production control.

Follow-up

We won’t know the progress of a particular process that has been set up unless we follow up on the process. During such process and operation follow-ups, you need to look out for possible or visible bottlenecks that can hinder the smooth flow of your production line at any stage. The plans here are considered to be the blueprints against which the operations and its proceedings are checked for any sort of delay or possible deviations.

The routing plans are checked thoroughly, and the schedules and priorities are mapped against their respective blueprints, and any error or defects are reported immediately through the systems put in place. These different errors and deviations are then studied and analyzed only to provide suitable and remedial actions to avoid the reoccurrence, for smooth functioning.

Inspection

Timely audits and inspection bouts need to be conducted to ensure that everything under the production scanner was adhering to quality standards and maintaining overall quality of the product.

Correction

Once the previous steps are undertaken and they yield results, the plans of action and the actions on those reported anomalies or deviations take place and the processes are corrected to an extend of adjusting routes, rescheduling the work and time at which they are performed or the priority of the tasks, or even performances of individuals work personnel. Workloads are maintained, and any rectification is made on these correction rounds. Methods, tools, machinery,

and techniques are employed to make the process of production a completely unhindered one.

Characteristics of Production Control

Production control can help you earn the following benefits:

- Cost-effectiveness as part of the production process
- Narrow down the wastage that takes place on the production line
- Maintenance of high quality throughout the production life cycle
- Smooth functioning of the production process

It is dependent on the following factors for smooth functioning:

- Size of the operation to be conducted
- Nature of the operation to be conducted
- Type of production to be conducted

CHAPTER FIVE

Facility Location, Layout and Production Systems

OBJECTIVES

- To discuss the facility location and the factors affecting the decision to choose the right location.
- To explain and compare between the common types of production systems.

Facility Location

The optimal location of facilities (suppliers, manufacturers, and distributors) to reduce total supply chain costs. It is a decision-making process that involves determining the optimal, or at least good, location of facilities in a supply chain or distribution system, such as manufacturing plants, warehouses, distribution centers, and so on. The facility location is ideal for the manufacturing facility; it will have easy access to customers, workers, transportation, and so on.

Is facility location a strategic decision

1. Overall objective of an organization is to satisfy and delight customers with its product and services.

Therefore, for an organization it becomes important to have strategy formulated around its manufacturing unit.

2. A manufacturing unit is the place where all inputs such as raw material, equipment, skilled labors, etc. come together and manufacture products for customers. One of the most critical factors determining the success of the manufacturing unit is the location.
3. Facility location is the most strategic and critical. When you construct a new manufacturing facility, you make a significant investment of time, resources, and capital that cannot be reversed for a long time.
4. Selecting the wrong location can be disastrous.
5. Cost, available infrastructure, labor skill, government policies, and the environment are all critical factors for a company operating in a global environment. A good location provides easy access to customers, skilled labor, transportation, and so on. In today's global competitive environment, the right location ensures the organization's success.

Errors in Location Selection

The location of the facility is critical for the organization's business continuity and success. As a result, it is critical to avoid making mistakes when selecting a location.

Selection errors are classified into two types: behavioral and non-behavioral.

- Behavioral errors are decisions made by company executives in which personal factors are considered before the success of a location, such as the relocation of a personal establishment from its hometown to a new location facility.
- Non-behavioral errors include a lack of proper investigative practice and analysis, as well as ignoring critical factors and industry characteristics.

Factors Influencing Facility Location

- Presence of other similar manufacturing units around makes business area conducive for facility establishment.
- Availability of Skill Labor: Education, experience and skill of available labor are another important, which determines facility location.
- Credit finance, communication infrastructure, and insurance are available in the location.
- Facility locations are selected closer to the customer as to reduce transportation cost and decrease time in reaching the customer.

- Free-trade zones encourage the establishment of manufacturing facilities by offering incentives in the form of custom duties and levies. On the other hand, a free trade agreement is an agreement between countries that provides an incentive to establish a business a country.
- Continuous and quality availability and supply of the raw materials is another critical factor in determining the location of manufacturing facility.
- Environmental Policy: In today's globalized world, pollution control is critical; therefore, understanding environmental policy for facility location is another critical factor.
- Quality-of-life considerations
- Potential for future expansion

Facility Layout[10]

For an organization to have an effective and efficient manufacturing unit, it is important that special attention is given to facility layout.

Facility layout is an arrangement of different aspects of manufacturing in an appropriate manner as to achieve desired production results. Facility layout considers available

space, final product, safety of users and facility and convenience of operations.

An effective facility layout ensures that there is a smooth and steady flow of production material, equipment, and manpower at minimum cost.

Facility layout looks at physical allocation of space for economic activity in the plant. Therefore, main objective of the facility layout planning is to design effective workflow as to make equipment and workers more productive.

Facility Layout Objectives

A model facility layout should be able to provide an ideal relationship between raw material, equipment, manpower and final product at minimal cost under safe and comfortable environment. An efficient and effective facility layout can cover following objectives:

- Allow for adequate production capacity.
- Lower material-handling costs.
- Comply with site and building constraints.
- Make room for production machines.
- Allow for maximum utilization and productivity of labor, machines, and space.
- Allow for product and volume flexibility.

- Provide space for employee restrooms, cafeterias, and other personal-care needs.
- Ensure employee safety and health.
- Allow for ease of supervision.
- Allow for ease of maintenance.
- Achieve goals with the least amount of capital investment.
- Lower material-handling costs.
- Comply with site and building constraints.
- Make room for production machines.
- Allow for maximum utilization and productivity of labor, machines, and space.
- Allow for product and volume flexibility.
- Provide space for employee restrooms, cafeterias, and other personal-care needs.
- Ensure employee safety and health.
- Allow for ease of supervision.
- Allow for ease of maintenance.
- Achieve goals with the least amount of capital investment.

The objective of the facility layout study is to minimize total cost, this cost:

(1) Construction cost.

(2) Installation cost.

(3) Material handling cost.

(4) Ease of future expansion.

(5) Production cost.

(6) Machine downtime cost.

(7) In-process storage cost.

(8) Safety cost.

(9) Ease of supervision.

Design of Facility Layout

The principles that guide the design of a facility layout must consider the objective of the facility layout, the factors influencing the facility layout, and the constraints of the facility layout. These are the guiding principles:

- Flexibility: The layout of the facility should allow for future expansion or modification.
- Space Utilization: Optimal space utilizations saves time and promotes safety by reducing the amount of time spent moving materials and people.
- Capital: When finalizing various facility layout models, capital investment should be kept to a minimum.

Types of Layout for manufacturing facilities[11]

There are five basic types of layouts for manufacturing facilities; process, product, cellular manufacturing (CM) , fixed position and Hybrid Layouts.

- **The process layout**

The process layout organizes workflow around the production process. Workers who perform similar tasks are grouped together. Products are moved from one workstation to another (but not necessarily to every workstation).

- A process layout, for example, would be used by a manufacturer of custom machinery.
- It can handle varied processing requirements.
- It uses similar resources or processes that are located together

Example: Teddy Bear Company.

Let's say that you just placed an order for a personalized teddy bear—a "hiker bear" with khaki shorts, a white T-shirt with your name embroidered on it, faux-leather hiking boots, and a nylon backpack with sleeping bag.

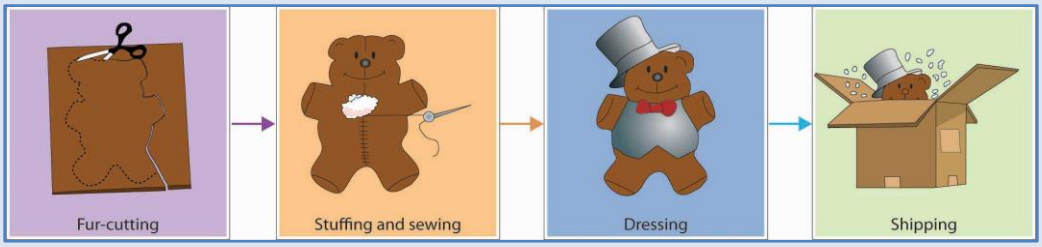


Figure 11 Teddy bear process layout

1. Your bear begins at the fur-cutting workstation, where its honey-brown "fur" coat is cut.
2. It then moves to the stuffing and sewing workstation to get its insides and have its sides stitched together.
3. Next, it moves to the dressing station, where it's outfitted with all the cool clothes and gear that you ordered.
4. Finally, it winds up in the shipping station and starts its journey to your house.

- **Product** (or **assembly-line**) **layout**

The product (or assembly-line) layout is used for products that require a continuous or repetitive manufacturing process. When large quantities of a product must be processed on a continuous basis, workstations or departments are organized in a line, with products moving along the line.

Figure12 Car manufacturing assembly line

A product layout is commonly used by automobile and appliance manufacturing, as well as food-processing plants.

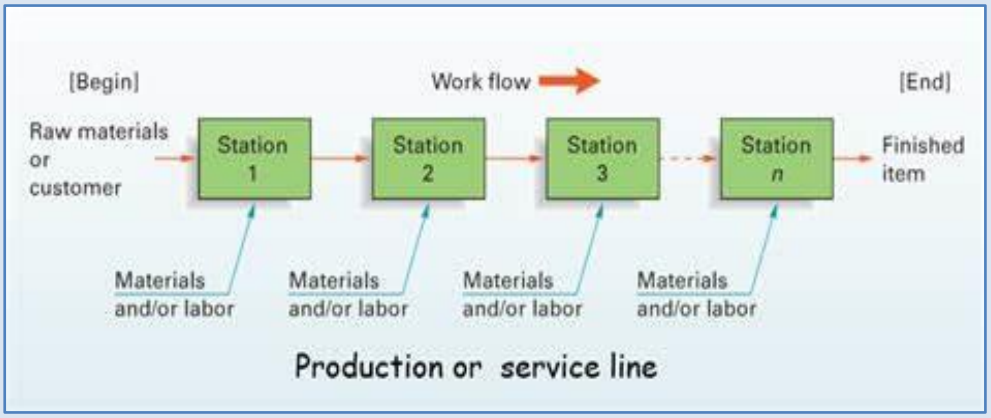


Figure 13 production or service line[12]

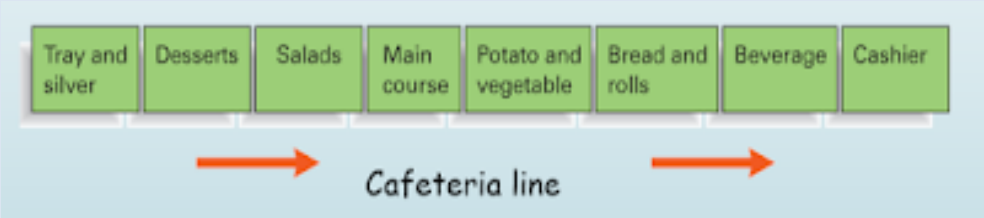


Figure 14 Self-serving cafeteria line[13]

Service companies can use product layout also for routine processing operations.

- **Cellular manufacturing layouts (CM)**

Cellular layouts incorporate elements of both product and fixed-position layouts. Work cells are small, self-contained production units that contain several machines and workers arranged in a compact, sequential order.

Each work cell completes all or nearly all the tasks required to complete a manufacturing order. A cell typically contains five to ten workers who have been trained to perform any of the steps in the manufacturing process. The goal is to create a team environment in which team members are involved in the production process from start to finish.

- **Fixed-Position Layouts**

A fixed-position layout allows the product to remain in the same location while workers and machinery move to it as needed. Products that cannot be moved, such as ships,

airplanes, and construction projects, are typically manufactured using a fixed-position layout.

Figure 15 ship building fixed position[14]

Due to limited space at the project site, parts of the product are frequently assembled at other locations, transported to the fixed site, and then assembled. Fixed-position layouts are also popular for on-site services such as housecleaning, pest control, open heart surgery and landscaping.

- **Hybrid Layouts**

Most manufacturing facilities use a combination of layout types. The departments are arranged according to the types of processes, but the products flow through on a product layout.

Finally it is important to understand the characteristics, advantages, and disadvantages of each basic type of layout.

Production Systems:

The four most common types of productions are listed below. The type of production that the company should use is determined by the type of product being manufactured, the demand for the product, and the availability of raw materials. Taking these factors into account, the four types of production are listed below.

Job or custom production:

Custom production, also known as job production, job shop production, or unit production, refers to small manufacturing systems that handle custom manufacturing processes. These job or machine shops typically move on to different projects (often with different customers) once each job or project is complete. Each shop contains its own unique mix of skills, processes, machines, and processing flexibility. Work is typically not constrained to any one machine. Think of custom production and flow manufacturing on opposite sides of the production spectrum.

Example:

Job production is ***made to order*** and to the buyer's specifications, such as buildings, paintings, designer clothes, meals, and haircuts. A custom furniture company offers about

fifty different products while stocking hundreds of inventory items, yet they ship about 10 finished pieces per month.

Another example of this would be tailored outfits made specifically for you or a cake made exactly to your specifications, consulting, making a motion picture, launching a new product or service.

It involves the creation of custom work, such as a one-of-a-kind product for a specific customer. Job production entails a single operator or group of operators working on a single job and completing it before moving on to the next similar or different job.

Manufacturing is a highly skilled process, and goods may be handcrafted and labor intensive. Production costs are typically high, particularly for labor, and as a result, premium prices can be charged.

- It is highly dependent on skill.
- It is more dependent on manual labor than mechanical labor.
- Customer service and customer management are critical.

Batch production[15,16,17]

It is one of the most common types of production used in consumer durables, and other industries with a wide range of products with varying demands.

- Batch production occurs in batches.
- Moderate volume of goods or services
- Moderate variety
- Not much flexible but Intermittent
- Easy to add or change products or services.
- The manufacturer already knows the number of units he requires, and they are manufactured in a single batch.

So, if a manufacturer has a shortage of Product X and 100 units of this product are consumed in one month, the manufacturer can place orders for 100 units of Product X batch production. The group stays together as it goes through each stage of production until all processes are finished. Between batches, changes can be made. Clothing, for example, may be manufactured in batches of varying sizes and colors. The process, therefore, includes a delay between

batches while equipment is changed or recalibrated; this is known as downtime.

Example: A bakery, for example, will produce batches of the following products one after the other every morning: 1. loaves of white bread 2. rolls made from brown bread 3. croissants[18]

Figure 16 Bakery batch production[19]

Advantages

- Allows for more flexible production.
- Making many small batches can be costly.

Disadvantages

- Partially finished goods inventories can be stored and completed later.

- If the production runs differ, there may be extra costs and delays in preparing the equipment.

Flow or Mass production

Mass production is another name for flow production. It allows a product to be created in stages on an assembly line. It is characterized by the continuous movement of items through the manufacturing process. This manufacturing process produces many the same goods on a continuous basis. A high level of automation is frequently possible on a flow production assembly line.

Figure 17 Motorbikes assembly plant

Some examples include: a car assembly plant, a bottling plant, and a bicycle production line.

Advantages

1. Because the cost per unit is low, economies of scale can be realized.
2. Higher volumes of more standardized goods or services
3. Assembly lines that are automated save time and money.
4. The skills of workers is generally low.
5. Quality systems can be integrated into the manufacturing process at each stage.

Disadvantages

1. Automated assembly lines have high initial setup costs.
2. Workers dislike their jobs because they are repetitive and boring.

Continuous Production:

Continuous production is a derivative of flow production. Put simply, this method is used to process materials without interruptions. Products flow continuously through a linear process on autopilot.

- Has the highest level of capacity utilization.
- High volume of no discrete.
- Highly standardized.

- Almost no variety in output.
- No need for equipment flexibility
- Skill requirements can range from low to high.
- Low unit costs due to a high volume of production.
- Component materials are heavily processed, and the finished product can't be identified with the source material
- Requires high initial investment, so competition is limited/scarce.

Example of continuous production

Continuous production is common for industries in which quality and performance hinge on uninterrupted processes,

Figure18 Contentious system

such as a water treatment plant, steel, iron, chemicals with little flexibility.

In a continuous water treatment plant, wastewater is continuously added, while treated water is continuously discharged to maintain a clean water supply for the area.

Product or Service & Flexibility Variety & Equipment Flexibility

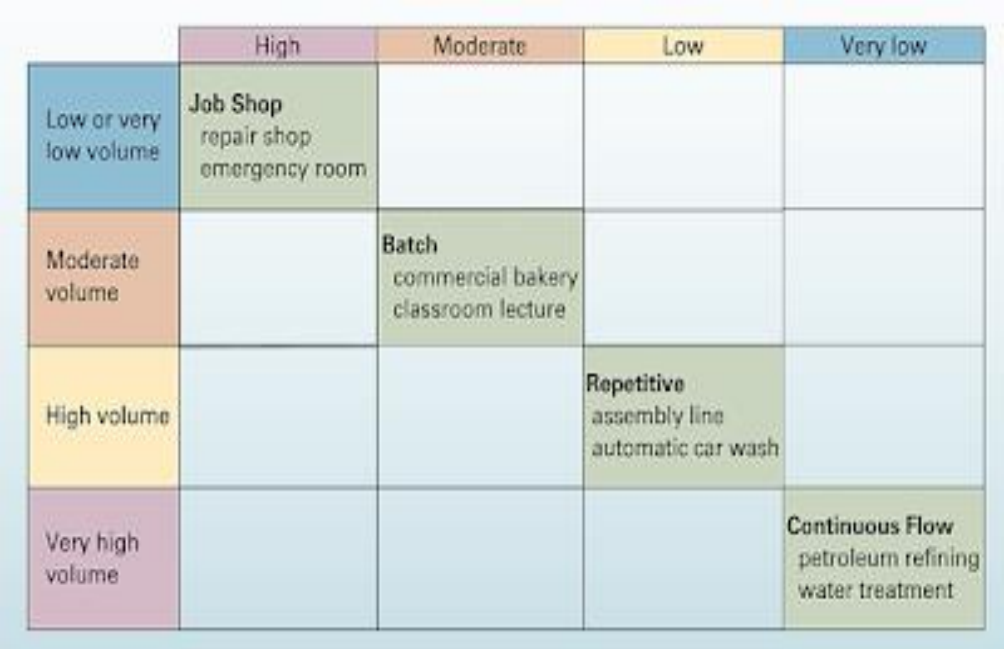


Figure19 Product or Service & Flexibility Variety & Equipment Flexibility

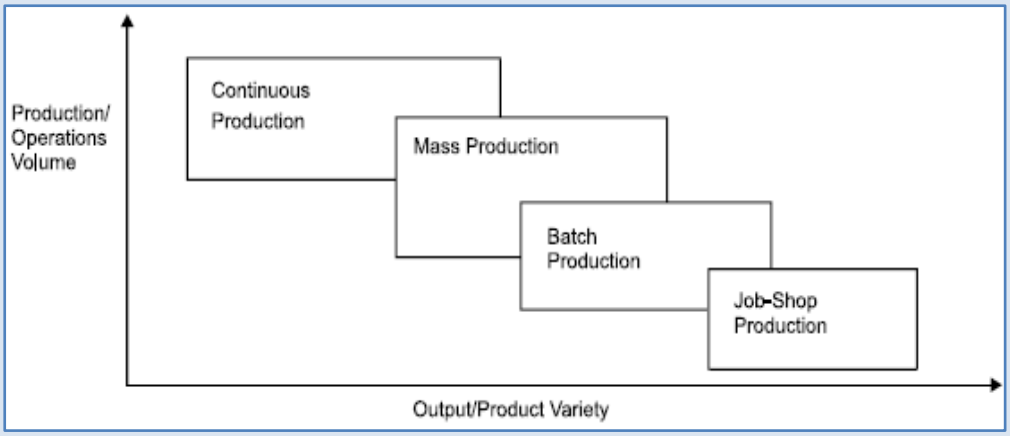


Figure20 Comparing Production Systems

CHAPTER SIX

Quality - A Tool for Achieving Excellence

OBJECTIVES

- To define quality
- To discuss the total quality approach
- To identify the quality control techniques.

For an organization to be successful it is of paramount importance to exceed customer expectations as to generate customer delight. One of the best ways of doing this is by providing quality products and services.

In technical language, quality means a product adhering to the specifications. For customer meeting or exceeding the expectation could be quality.

Therefore, quality has different meaning to different people, for example, in automobile industry quality means cars with no defects and works smoothly.

Quality involves meeting and exceeding customer expectations. So, to summarize quality is:

1. Satisfying customer defined standards.

2. Meet customer needs.
3. Meet or exceed customer expectations.
4. Satisfy future needs and requirements of customers.

Quality Definitions

According to industry and users' quality has many definitions some of them are as follows:

- Customer Oriented Industry: Meeting customer expectation
- Manufacturing Industry: Meeting technical specification and working with no defects.
- Product Oriented Industry: Product has additional value compared to similar products available in the market.
- Value Oriented Industry: Product is a perfect combination of features in the given price band.

Accordingly, Customers look at quality in different areas as follows:

- Airline Industry: On time, low cost, comfortable
- Railways: On time, low cost, secure and safe
- Postal Service: Accurate delivery and cost effective.

Total Quality Management (TQM)

The two main objectives of Total Quality Management are 100% customer satisfaction and zero defects. TQM is a

process beyond quality of product or services; it deals with the business philosophy of the organization. TQM propagates the concept of doing right things right and at first time itself. In TQM:

- Total means involvement of top management as well as workers
- Quality means meeting the expectations of the customers.
- Management means management of quality across the organization.

The focus of the total quality management is as follows:

- Involvement of all employees in the process
- Selection of suppliers
- Organization structure to support the process.
- Maximum customer satisfaction
- Appropriate reward for quality improvement and suggestions

Considering above focus points, scope of TQM can be defined as follows:

- Organization should encourage building of culture promoting TQM.
- Organizational resources, including infrastructure, should be dedicated in TQM.

- Top management decision and structure should support the TQM process.
- Proper training and environment should be created before implementation of TQM.

Total Quality Management gives a great importance to customers and suppliers. Here customers and supplier both can be internal as well external. The relationship of organization with customers as well supplier is critical in continuation of TQM. Therefore, it is important to understand customers and suppliers.

Principles of Total Quality Management

- The main principles of Total Quality Management are as follows:
- TQM proactively works towards prevention of quality problems.
- TQM strives to achieve a state with zero defects or minimal defects.
- TQM aims at producing right quality products at the first instance itself.
- TQM pushes the concept that quality is not the responsibility of production department but of organization as a whole.

- TQM encourages continuous improvement of business and production processes.
- TQM encourages award and recognition for worker's pro-actively working towards quality.
- TQM decisions are fully based by research and data.
- TQM should be always systematic and logical in the process.

Quality Control Techniques

Quality of product and services determines the success or failure of the organization. Consumers expect the company to maintain high-level of quality and consider it an important aspect of satisfaction. Quality management, therefore, becomes very important as far as any organization is concerned. Quality management can be accomplished through various quality control techniques. Quality assurance and quality control are objective oriented and can be achieved through statistical quality control.

Statistical quality control requires usage of acceptance sampling and process control techniques. Statistical quality control extensively uses charts to measure the acceptance level of the product samples. The objective is to ensure that products fall within pre-decided upper control and lower

control limits. Any sample falling outside the limits is inspected further for corrective action.

Quality Control

The quality of product or service is ensuring if proper designing process is followed. This design process needs to be backed by appropriate process design supported by a suitable technology which confirms to requirements of customers. Quality control ensures that defects and errors are prevented and finally removed from the process or product. Therefore, quality control should include planning, designing, implementation, gaps identification and improvisation. If organization can implement a stringent quality control than following benefits are possible:

- Reducing product defects leads to less variable cost associated with labor and material.
- Reduction in wastage, scrap, and pollution.
- Ability to produce quality products over longer period of time.
- With quality maintenance needs for inspection reduces leading to decrease in maintenance cost
- Large pool of satisfied customers.

- Increase in employee motivation and awareness of quality.
- Increase in productivity and overall efficiency.

Above mentioned points are relevant not only for the production stage but are equally important for input material, manufacturing process, delivery process, etc.

Statistical Quality Control

Quality control techniques require extensive usage of statistical methods. The advantages of the statistical analysis are as follows:

- Statistical Tools are automated and therefore, require less manual intervention, leading cost reduction.
- Statistical tools work on a model thus are very useful where testing requires destruction of products.

Statistical Quality tools can broadly be classified into following categories:

- Acceptance sampling is an important part of quality control wherein quality of products is assessed postproduction.
- Statistical process control helps in confirming whether the current process is falling within pre-determined parameters.

Acceptance Sampling

Acceptance sampling is done on sample's postproduction to check for quality parameters as decided by the organization covering both attributes as well as variables. If the sample does not meet the required parameters of quality than that given lot is rejected, and further analysis is done to identify the source and rectify the defects. Acceptance sampling is done on the basis of inspection, which includes physical verification of color, size, shape, etc.

The major objectives of inspection are:

- To detect and prevent defects in products and processes.
- To identify defected parts or product and prevent it from further consumption or usage.
- To highlight the product or process defect to appropriate authorities for necessary and corrective actions.

The scope of inspection covers input materials, finished material, plant, machinery etc.

To sustain the quality of product and services it is important to have in place robust quality control techniques.

Questions on Chapters

Chapter One: Production system

1. List the six primary objectives of production management and summarize why they relate to any given business field.
2. Outline the importance of Inventory Control in production management
3. Summarize the steps of Strategic Management Process for Production and Operation.
4. Discuss the importance of production management to the business firm.

Chose the right answer:

1. The role of a ---------- manager is to sustain, protect, and project the company's operations side.

A. Project Manager

B. Operations Manager

C. Finance Manager

D. Marketing Manager

2. All the following are examples of transformation process EXCEPT:

A. Cutting

B. Packing

C. Facilitating

D. Labeling

3. Materials, land, energy and human and capital resources are the examples of:

A. Inputs

B. Transformation

C. Outputs

D. Productivity

4. Which of the following is NOT an attribute to classify services?

A. Tangibility

B. Perishability

C. Simultaneity

D. Degree of customer contact.

5. Services differ from manufacturing in all the following ways EXCEPT:

A. Customers typically interact directly with the service delivery process

B. Consumption and production take place simultaneously.

C. Services are intangible.

D. Services can be stored

6. Which of the following contributed to production management from 1930s to 1950s?

a) Managers developed techniques that focused on economic efficiency in manufacturing.

b) Psychologists and social scientists studied human behavior at work.

c) Economists, mathematicians, and computer socialists.

d) All the above

7. Which of these is NOT an example of a business process?

a) Transforming raw materials to finished processes

b) Having lunch at work

c) Meeting with a customer

d) Making a lending decision

8. Economists, mathematicians, and computer socialists contributed to production management newer, more sophisticated analytical approaches.

A. True

B. False

9. Psychologists and social scientists contributed to production management by focusing on economic efficiency in manufacturing.

A. True

B. False

10. F.W. Taylor’s works become more widely known by studying human behavior at work.

A. True

B. False

11. The main objective of scheduling is to find out the best and most economical sequence of operations to be followed in the manufacturing process.

A. True

B. False

12. Scheduling means to decide when to start and when to complete a particular production activity.

A. True

B. False

13. Which of the following contributed to production management from 1930s to 1950s?

A. Managers developed techniques that focused on economic efficiency in manufacturing.

B. Psychologists and social scientists studied human behavior at work.

C. Economists, mathematicians, and computer socialists.

D. All of the above

14. As service sector became more prominent, the change from ……. to …….. emphasized the broadening of our field to …….. organizations.

A. production - operations – service

B. production - operations – manufacturing

C. operations – production – service

D. operations – production – manufacturing

15. Which type of industries can use the concepts and activities of production management?

A. Manufacturing

B. Design and service

C. Retail and marketing

D. All of the above

16. Which of the following is considered a strategic operation decision?

A. Establishing quality assurance procedures

B. The type of technologies that the organization will use,

C. Managing inventory

D. Workforce scheduling

17. The following are tactical decisions of operation management except….

A. Facility location decision.

B. Managing inventory

C. Establishing quality assurance procedures

D. Contracting with vendors

18. The following are functions of production management except……

A. Production Control

B. Inventory Control

C. Purchasing of Machines

D. Maintenance and Replacement of Machines

19. Which of the following is not a function of production management?

A. Identifying costumers needs.

B. Facilities Location and Layout Planning.

C. Selection of Product and Design.

D. All of the above are functions of production management

20. Which of the following decisions is related to selecting the right production process.

A. Selecting the right product

B. Selecting the right design according to the customers' requirements.

C. Selecting the type of technology and material handling system.

D. Selecting the right production capacity.

Chapter Two: CREATING VALUE: Value chain and operations management

1. How did the assembly line affect revenue?

a) It increased speed and increased error

b) It decreased speed and decreased error

c) It increased speed and decreased error

d) It did not change speed or error

2. The value chain analysis is ……

A) the management of systems or processes that create goods and or provide service

B) a sequence of activities and organizations involved in producing and delivering a good or service

C) to understand how all the processes are related to each other and how variations in any process will lead to a change in the overall profit margin.

D) none of the above

3. How does one explain a value chain?

a) A series of steps that include understanding what a customer wants and creating solutions for those wants

b) The process of creating the best product for the lowest prices

c) A budgetary method to manage money and get the greatest value for the money

d) A line of exclusive jewelry that is private-labeled by celebrity designers.

4. Michael Porter proposed three “generic” competitive strategies, which doesn't include-

A. Cost Leadership
B. Differentiation
C. Focus
D. Blue Ocean

5. Porter proposed that a firm’s competitive advantage in an industry is determined by its —that is, the breadth of the company’s or business unit’s target market.

A. competitive edge
B. competitive place
C. competitive scope
D. core competency

6. Cost leadership is a lower-cost competitive strategy that aims at the broad mass market and requires “_____ of efficient-scale facilities, vigorous pursuit of cost reductions from experience, tight cost and overhead control, avoidance of marginal customer

accounts, and cost minimization in areas like R&D, service, sales force, advertising, and so on.

A. aggressive construction
B. defensive construction
C. competitive scope
D. effective construction

7. Cost focus is a low-cost competitive strategy that focuses on a _____ buyer group or geographic market and attempts to serve _____, to the exclusion of others.

A. huge, all the segments
B. particular, only this niche
C. country specific, all target customers

8. No one competitive strategy is guaranteed to achieve success

A. True
B. False
C. Can be possible

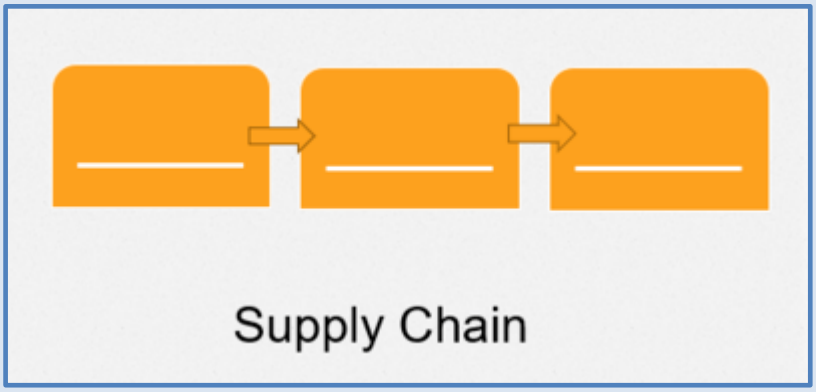
9. It is possible for a company or a business unit to achieve low cost and differentiation simultaneously.

A. True
B. False
C. May be

10. A product or service that an organization's customers place a greater value on than similar offering from a competitor is the definition of:

A. Competitive disadvantage
B. First mover advantage
C. Second mover advantage
D. Competitive strategy
E. Competitive advantage

11. Fill in the space:



A. Company - Customers - Suppliers
B. Customers - Customers - Suppliers
C. Suppliers - Customers - Company
D. Suppliers - Company - Customers

12. Fill in the space: _____ _____ analysis views a firm as a series of business processes that each add value to the product or service.

Answer: Value chain

13. …….. means deciding the path of work and the sequence of operations.

A. Loading
B. Routing
C. Scheduling
D. Controlling

14. …….. means to decide when to start and when to complete a particular production activity.

A. Loading
B. Routing
C. Scheduling
D. Controlling

15. ……. means, the load at each routing point and start-end of an activity or operation are checked for resource help and support.

A. Routing
B. Scheduling
C. Controlling
D. None of the above

Chapter three: Production Planning and Control

1. Which of the following forecasting techniques induce personal bias in a forecast?

A. Qualitative

B. Quantitative

C. Associative

D. Trend forecast

2. Which one of the following is NOT a business application of forecasting?

A. Budgeting

B. Capacity planning

C. Inventory management

D. Quality control

3. Techniques having numerical data include which of the following?

A. Subjective inputs

B. Qualitative technique

C. Quantitative technique

D. Delphi method

4. Within the operations function, which one of the following is a long-term management decision?

A. Control decision

B. Non-operational decision

C. Strategic decision

D. Tactical decision

5. Forecasts help managers by reducing the degree of:

E. Accuracy

F. Precision

G. Uncertainty

H. Reliability

6. Which of the following forecasting technique is used when introducing new products, services, new features and new packaging?

A. Quantitative technique

B. Associative model.

C. Focus group.

D. Judgmental forecast.

7. Which one of the following does not fall under qualitative forecasting method?

a) Opinion pool methods

b) Delphi method

c) Sample survey

d) Trend projection methods

8. Aggregate planning requires which of the following information?

a) Forecast of expected demand

b) Current levels of inventory

c) Policies regarding employment levels

d) All the above

9. To make operations strategy effective it should be:

A. Independent of the organization's strategy

B. Consistent with the organization's strategy

C. Developed by a first line manager

D. Independent of time dimension

10. Organizational strategy is different from operations strategy because it is;

a) Prepared by middle managers

b) Narrower in scope

c) Longer in time horizon

d) All of the above

5. ……. is the maximum production level achievable in realistic work condition and considering normal machine breakdown, maintenance, etc.

a) Design capacity

b) Production capacity

c) Sustainable capacity

d) Effective capacity

6. Forecasting of inflation rate, interest rate, GDP are the focus of…….

a) Economic Forecasting b) Demand Forecast

c) Technology Forecast d) Both A and B

7. Which of the following is not a characteristic of good forecast?

a) Should provide sufficient time with faire degree of accuracy and reliability

b) Should be simple to understand

c) Should provide information relevant to production

d) None of the above

8. Aggregate forecasts are more accurate.

A) True B) False

9. The longer the forecast horizon, the more accurate the forecast is.

A) True B) False

10. Which of the following is the focus of long-range planning?

a) It deals with facility planning b) It deals with capital investment

c) It deals with location planning. d) All of the above

11. Gantt chart gives information about

(A) Scheduling and routing

(B) Sales

(C) Production schedule

(D) Machine utilization

12. On a business trip, Diana's flight is overbooked and she loses her seat. The attendant tells her that the flight is almost always overbooked. The airline has done a poor job in ._____

a) Capacity planning.

b) Correct answer.

c) Materials requirements planning.

d) Scheduling.

13. The time for which the worker or machine or both remain idle due to the shortcomings of the management or workers is known as

(A) Excess time

(B) Idle time

(C) Ineffective time

(D) Work content

14. In break-even analysis, total cost consists of

(A) Fixed cost

(B) Variable cost

(C) Fixed cost + variable cost

(D) Fixed cost + variable cost + overheads

15. Routing is essential in the following type of industry

(A) Assembly industry

(B) Process industry

(C) Job order industry

(D) Mass production industry

16. The production scheduling is simpler and high volume of output and high labor efficiency are achieved in the case of

A. (A) Product layout
B. (B) Process layout
C. (C) Fixed position layout
D. (D) A combination of line and process layout

17. All of the following are examples of Qualitative forecasting except:

A. Judgmental
B. Delphi Method
C. Consumer Survey
D. Naïve Forecasting

Chapter Four: Facility location, layout and production system

1. The disadvantage of product layout is

(A) High initial investment for the specialized facilities

(B) Skilled labor to operate machines

(C) Production time is longer, requiring more goods in inventory

(D) High cost of inspection

2. A low unit cost can be obtained by following

(A) Product layout

(B) Functional layout

(C) Automatic material handling equipment

(D) Specialization of operation

3. Product layout is also known as

(A) Analytical layout

(B) Synthetic layout

(C) Static product layout

(D) None of these

4. Work study is done with the help of

(A) Process chart

(B) Material handling

(C) Stop watch

(D) All of the above

Chapter Five Productivity

1. A tool to measure effective use of resources and usually expressed as the ratio of output to input is known as;

A. Production ratio

B. Productivity

C. Reliability

D. Operations ratio

2. Productivity =

(A) Input / Output

(B) Output / Input

(C) Output – Input

(D) Input – Output

3. The resources utilized for production are

(A) Materials, Machines, Manpower

(B) Materials, Methods, Machines

(C) Machines, Manpower, Methods

(D) Methods, Machine, Manpower

4. Productivity is the ____ of production system.

(A) Measurement

(B) Efficiency

(C) Both (A) and (B)

(D) None of the above

5. Productivity can be measured in which of the following input resource(s)

(A) Material input

(B) Labor input

(C) Capital and Land Input

(D) All of the above

6. Raw material productivity can be increased by

(A) Proper choice of design

(B) Reuse of material

(C) Scrap control

(D) All of the above

7. Preventive maintenance improves

(A) Material productivity

(B) Labor productivity

(C) Machine productivity

(D) Capital productivity

8. Productivity can be increased by

(A) By increasing the output from the same input

(B) By reducing the input for the same output

(C) Both (A) and (B)

(D) None of the above

General Questions

Answer the following questions

Question One Identify if True (T) or False (F).
1. Car insurance and IT consultancy are products.
2. In the early twentieth century, Adam Smith implemented F.W. Taylor's theories and developed scientific management.
3. Chasing demand means always having too much capacity.
4. The correct sequence of operations in production planning is planning- scheduling-loading -routing.
5. Aggregate planning helps in providing customer delight by matching demand and reducing wait time for customers.
6. Production planning includes dispatching.
7. Follow-up involves removing bottlenecks in the flow of work and ensuring that the productive operations are taking place in accordance with the plans.
8. For an organization, capacity would be the ability of a given system to produce output within the specific time period.
9. Process is one or more actions that transform resources into value added goods, not services.

10. The main objective of scheduling is to find out the best and most economical sequence of operations to be followed in the manufacturing process.
11. Value added is the difference between the cost of inputs and the value or price of outputs.
12. In practice we can find goods which accompanied by services so that there is no %100 pure good or service.
13. Manufacturers produce goods for stock, with inventory levels aligned to forecasts of market demand, however, some manufacturers maintain minimum stock levels, relying on the accuracy of demand forecasts and their production capacity to meet demand on a just-in-time basis.
14. The trend projection method is based on the assumption that the factors liable for the past trends in the variables to be projected will play different role in the future, in different manner and to different extent as they did in the past.
15. Aggregate planning will ensure that organization can plan for workforce level, inventory level and production rate in line with its strategic goal and objective.
16. Quantitative forecasting methods are more suitable when there is little historical data available.
17. Sales force opinion are forecasts using data collected from personnel with direct customer contact.

18. The general direction of the demand pattern is called its ‘trend’.
19. A chase strategy means producing exactly what is demanded in the market by the customers at a given time.
20. Strategic capacity planning is essential as it helps the organization in meeting the short term requirements of the organization.

Answer the following questions

Question Two: Choose the right answer from a, b, c and d.

Mach:

1. …….. is the output that an operation can produce continuously, at maximum rate without stopping for any shift changeovers, maintenance or any other delays…... 2. ……. is the maximum production level achievable in realistic work condition and considering normal machine breakdown, maintenance, etc. 3. …… is the optimum production level under pre-defined job and work-schedules, normal machine breakdown, maintenance, etc.	a) Short Term Capacity b) Effective capacity c) Design capacity d) Sustainable capacity

4. Which of the following is the BEST definition of a good?

a) A tangible item which can be owned, stored, and evaluated.

b) A tangible item which cannot be owned, stored, and evaluated.

c) An item that can only be bought at an in-person store.

d) An intangible item which can be owned, stored, and evaluated.

---

5. Effective capacity planning is dependent upon:

a) production facility, product line or matrix and production technology

b) human capital (job design, compensation)

c) operational structure (scheduling, quality assurance) and external structure (policy, safety regulations)

d) all the above

---

6. The statistical methods are used more often and are considered superior than the other techniques of demand forecasting due to the following reasons *except*:

a) The estimation method is scientific and depends on the relationship between the dependent and independent variables.

b) They have high level of objectivity

c) The estimates are less reliable

d) The cost involved in the estimation of demand is the minimum.

---

7. Which of these statements about the operations function is best?

a) Operations is the most isolated of all business functions, rarely needing to interface with marketing, finance, or engineering.

b) Inputs to the operations function can come from many different places.

c) A manufacturing company provides only tangible goods as outputs.

d) The quality and availability of inputs to the operations function do not matter if the operation is well-managed.

---

8. A drawback of using qualitative methods in demand forecasting is:

a) The estimation method is scientific and depends on the relationship between the dependent and independent variables.

b) There is a high degree of subjectivity.

c) The estimates are more reliable

d) The cost involved in the estimation of demand is the minimum

---

9. In scenario where capacity is less than demand, an organization can try to balance both by the following alternative *except*:

a) Including overtime as part of scheduling by creating additional capacity.

b) Hiring temporary workforce.

c) Laying off excess workforce.

d) Outsourcing activity to a sub-contractor

10. During the …….. phase, you have production orders issued to commence the operations and fuel the onward movement of the production line.

a) dispatching

b) follow-up

b) inspection

d) Correction

---

11. The following are tactical decisions of operation management *except*….

a) Work force scheduling

c) Establishing quality assurance procedures

c) Managing inventory

d) The type of technologies that the organization will use,

---

12. Which of the following is *not* of the functions of operation management?

a) Facilities Location and Layout Planning

b) Marketing research

c) Selection of Product and Design

d) Selection of Production Process.

---

13. The set of interrelated management activities, which are involved in manufacturing certain products, is called:

a) Production

b) Production management

c) Process

d) none of the answers

---

14. Why is it generally harder for service industry managers to cope with peaks and troughs in demand for their products?

a) Services are inconsistent.

b) There are no salespeople to help with forecasting.

c) Most service customers are not brand loyal.

d) Service products cannot usually be stored.

---

15. Which of the following people provides goods?

a) police officer

b) fire fighter

c) doctor

d) farmer

---

16. Adam Smith recommended breaking of jobs down into subtasks and recognizes workers to …….. tasks in which they would become highly skilled and efficient.

a) specialized

b) general

c) external

d) all the above

---

17. Hawthorne Studies of Worker Motivation was conducted by:

a) Adam Smith

b) F.W.T. Taylor

c) Frank & Lillian

d) Elton Mayo

---

18. Which of the following is an objective of production management?

a) Ensuring efficiency by reducing redundancy of tasks:

b) Ensuring minimal use of resources.

c) production of goods and services within the parameters of manufacturing cost.

d) all of the above

---

19. Thus, annual and quarterly plans are broken down into labor, raw material, working capital, etc. requirements over a medium-range period. This is called……..

a) capacity planning

b) strategic planning

c) aggregate planning

d) demand planning

---

20. Long Term Capacity an organization is dependent on :

a) design capacity b) production capacity c) sustainable capacity and effective capacity d) all of the above

---

21. Which of the following forecasting techniques induce personal bias in a forecast?

a) Qualitative

b) Quantitative

c) Associative

d) Trend forecast

---

22. Control that focuses on preventing deviation in the quantity and quality of resources used in the operations of the organization is called:

a) proactive control.

b) concurrent control.

c) reactive control.

d) statistical control.

---

23. …….. means deciding the path of work and the sequence of operations.

a) Loading

b) Routing

c) Scheduling

d) Controlling

---

24. According to Porter Value Chain, which of the following is a downstream function of operations?

a) human resource management

b) technology development

c) outbound logistics

d) inbound logistics

---

25. When Apple, Inc. opened retail stores to sell its computers and iPods, this was an example of

a) forward horizontal integration

b) backward horizontal integration

c) forward vertical integration

d) backward vertical integration

---

26. …… facilitates linking of two more complex components of design at very high level of accuracy thus delivering higher productivity.

a) CAM

b) CAD

c) CRM

d) SCM

---

27. Which of the following industries should be located near the area of raw materials?

a) Cycles

b) Televisions

c) Sewing machines

d) Steel mills

Use the information in the right table to answer questions from 27 to 30 to forecast sales using equation y = a + bx

28. a is close to:

A)10139.39 B) 915.734 C) 922.727 D) 10109.09

---

29. b is close to:

A)10139.39394

Years	sales
2009	11500
2010	10000
2011	12000
2012	16000
2013	15000
2014	17000
2015	16000
2016	18000
2017	17000
2018	19000
2019	20600
2020	21000

B) 915.734

C) 922.727

D) 10109.09

---

30. Forecasted demand in 2021 is close to……

A) 22044

B) 21916

C) 22455

D) none of the answers

---

31. Forecasted demand in 2025 is ……

A) 26933

B) 25909

C) 25200

D) none of the answers

Answer the following questions

Question Three: Choose the right answer from A) true or B) false. (20 grades)

1. The main purpose of the product and service design is to satisfy customers.

A) True B) False

2. A project organization would be used when variety is high.

A) True B) False

3. Manufacturing delivers intangible outputs, whilst services produce tangible outputs.

A) True B) False

4. Efficiency means keeping the operation going at all costs.

A) True B) False

5. People that are used to collect data considered one of the factors that can make an operation's control system more effective.

A) true B) false

6. Flexibility means producing to specification.

A) True B) False

7. At McDonald's restaurant, the front office is the counter and the seating area, and the back office is the food preparation area.

A) True B) False

8. The advantages of decentralization include economies of scale. A) True B) False

9. When volume is low we can use only batch organization.

(A) True B) False

10. Higher volume operations will be met with greater efficiency, resulting in lower costs per unit of service or product.

A) True B) False

Answer the following questions

Question 4: Choose the right answer from a, b, c, d

1. Which of the following creates a perfect integration in a company activities?

(a) Operations

(b) Personnel

(c) Suppliers

(d) Marketing

(e) Finance

2. An operation is …… if it is capable of changing what it can do in response to changes in the customer's requirements.

(a) of high quality

(b) flexible

(c) reliable

(d) dependable

(e) none of the above

3. Operations management refers to:

(a) manufacturing of goods

(b) banking service

(c) distribution channels

(d) all the above

(e) none of the above

4. Which of the following is not covered by the term customers?

(a) Citizens reporting a crime

(b) Patients receiving health service treatment

(c) Students in state-funded education

(d) Medical staff in a hospital

(e) All the above is considered customers

5. The …….. objective covers how reliable the organization must be in keeping its promises to its customers.

(a) quality

(b) speed

(c) dependability

(d) flexibility

(e) cost

6. The term ‘volume’ refers to:

(a) the number of times a service has to be produced

(b) the peaks and troughs of demand

(c) the number of different types of product or service offered.

(d) the quantity of outputs of production line

(e) both (a and d)

7. Which of these gives the lowest non-productive work content:

(a) Job

(b) Batch

(c) Flow

(d) Group technology

(e) all of the above

8. Order winning criteria are……..

(a) those characteristics that can exist beyond the order qualifiers,

(b) those characteristics such as design ability and customization that a firm can offer to its customers.

(c) (a and b)

(d) certain characteristics that a firm's products should possess before it can be even considered for business by potential customers.

(e) none of the above

9. Improvement decisions made by the operations function should be in line with:

(a) capital available

(b) skills available

(c) capacity available

(d) only (a)

(e) strategic goals of the organization.

10. An operation decides on its performance objectives based on:

(a) customer needs

(b) the influence of its competitors

(c) the stage of its products in their life cycle

(d) all of the above (e) only (a).

11. Batch operations are not appropriate whenever…

(a) standard products/services are involved

(b) quantities of individual products/services required are not significant

(c) quantities required at any one time are not great enough to justify the dedication of resources to the one product/service.

(d) all the above (e) none of the above

Answer all questions

Answer the following questions

Question 5: Identify if true (T) or false (F) in each of the following

1. Seasonality may only occur at quarterly periods.
2. Production planning is dynamic in nature.
3. The general direction of the demand pattern is called its ‘trend’.
4. Productivity is the total value of inputs to the transformation process divided by the total value of the output produced.
5. Where the demand is for sure it is known as ‘dependent demand’.
6. The capacity of an organization may be defined as its ability to undertake the work demanded by its users.
7. Level capacity is the answer of the question, which basic capacity strategy avoids hiring and layoff costs and the costs of excess capacity?

8. A chase strategy means producing exactly what is demanded in the market by the customers at a given time.

9. The highest mean absolute deviation shows the most accurate forecast.

10. Maintaining high capacity in customer contact areas whilst providing less capacity in noncontact areas is a strategy adopted by manufacturing organizations.

11. One advantages of backward scheduling is less exposed to risk in case of schedule change by the customer

12. Backward schedule allows unexpected work to be loaded

13. In backward scheduling, jobs are scheduled as late as possible within the time allowed by the customer due dates.

14. The main objective of scheduling is to find out the best and most economical sequence of operations to be followed in the manufacturing process.

15. Qualitative forecasting methods are more suitable when there is a little historical data available.

16. Level capacity will build inventory and avoid the costs of excess capacity?

Answer the following questions

Question 6: Choose the right answer from a, b, c, d.

1. Which of the following is independent demand?

a) microchips in the computer

b) the wheels on the bicycle

c) cheese on the pizza

d) finished computer

---

2. An operation in a sequence of operations whose capacity is lower than that of the other operations is ..

a) a bottleneck

b) a faulty operation

c) a good operation

d) none of the answers.

---

3. Which basic production planning strategy that will build inventory and avoid the costs of excess capacity?

a) Level capacity

b) Chase capacity

c) Demand management

d) Coping

---

4. What is the maximum period of short time capacity planning?

A. One month

B. Less than one year

C. Tow years

D. Five year

---

5. What is not applicable for forecasting?

a) Forecasts are rarely perfect.

b) The underling casual system will remain same in the future?

c) Short range forecasts are less accurate than long term forecast

d) Forecast for group of items is accurate than individual item.

---

6. What is applicable for routing?

a) It is flow of work in the plan

b) It depends on material handling

c) Rout sheets include list of Machin tools to be followed

d) All of answers

7. Loading may be defined as:

a) Sending the raw materials to the machine

b) Sending the finished material to store

c) Assign the work to the facilities

d) Uploading a software in machine control panel

8. Which of the following is *not* an aspect of control?

a) To identify resources needed

b) To evaluate actual performance

c) To compare actual performance with goals

d) To take corrective actions

9. According to Porter value chain, which of the following is not a primary activity in an organization?

a) Operations

b) marketing and sales

c) MIS

d) inbound logistics

10. Level capacity means:

c) always having too much capacity

a) adjusting capacity to follow demand

d) keep capacity below demand

b) keeping capacity fixed

11. Which of the following is not an objective of scheduling?

a) ensuring on-time delivery
b) providing optimum efficiencies
c) the operation
d) performs smoothly
e) all of the above are objectives of
f) scheduling

---

12. Organizations should always plan to:

a) adopt the level of capacity which seems to best fit the situation

b) exceed expected demand

c) keep capacity below demand

d) match capacity to demand exactly

---

13. When the benefits of maintaining a stable workforce outweigh all of the other considerations, the firm is better to use …

a) Level capacity

b) Chase demand

c) Demand management

d) Coping

---

14. In the fast food industry, staff are mainly hired on a part-time basis – they are semi-skilled and the shift patterns are varied. This is to …..

a) Level capacity b) Chase demand

c) Demand management d) Coping

---

15. Which of the following is not an advantage of forward scheduling?

a) Lower material costs

b) High labor utilization

c) Flexible

d) None of the answers

---

16. Which of the following will not result in improving operations?

a) increasing working speed

b) improving working methods

c) reducing cost

d) reducing participation

---

17. Which of the following ratios does not express productivity?

a) results achieved to resources consumed

b) output produced to number of hours used

c) output achieved to number of people employed

d) input used divided by output produced

---

18. …… is a useful way for individual company in specific industrial sector to compare their productivity to the industry average.

a) National productivity

b) Industry productivity

c) Organizational productivity

d) All the answers

---

19. Employee productivity can be improved by which of the following:

a) Sound planning in organization

b) Motivation of manpower, training and empowerment

c) Innovating new work methods

d) All the answers

---

20. ……. means, the load at each routing point and start-end of an activity or operation are checked for resource help and support.

a) Routing b) Scheduling

c) Controlling d) None of the above

---

21. Organizational productivity can be improved by the following except:

a) employee's involvement and empowerment

b) economic reduction

c) continuous development of products and services

d) effective leadership and change management

---

22. ……is the optimum production level under pre-defined job and work-schedules, normal machine breakdown, maintenance

a) Design capacity

b) Production capacity

c) Effective capacity

d) Sustainable capacity

---

23. Which of the following factors have lesser effect on the productivity of an organization:

a) government regulations b) inventory management

c) process layout d) process automation

---

24. Which of the following is not the primary activity in an organization value chain?

a) operations

b) marketing and sales

c) human resource development

d) after sales services.

---

25. …….. means deciding the path of work and the sequence of operations.

a) Loading

b) Routing

c) Scheduling

d) Controlling

---

26. Which of the following is not true for "Routing"?

a) it is flow of work in the plant

b) route sheets include list of machine tools that are to be followed

c) it depends upon materials handling facilities

d) none of the above

---

27. Which of the following is considered a support activity in porter value chain?

(a) Human resource management

(b) inbound logistics

(c) distribution

(d) services

---

28. The maximum output possible as indicated by equipment manufacturer under ideal working condition is:

a) Short Term Capacity

b) Production capacity

c) Design capacity

d) Sustainable capacity

---

29. Techniques of forecasting having numerical data include which of the following?

a) Subjective inputs

b) Quantitative technique

c) Qualitative technique

d) Delphi method

30. The advantages of robust production control are as follows:

a) Ensure a smooth flow of all production processes

b) Ensure production cost savings thereby improving the bottom line

c) Control wastage of resources

d) All the above

Suppose that the record of actual demand to identify production in the forecasted period of car manufacturing company Sera is shown in the next table. Use information to answer questions 31-38

Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Quan	1000	1200	1600	1500	1700	1600	1800	1700	1900	2000

31. In the following formula (y = a + bx), b is …….

A) the time

B) the forecasted demand

C) slop (the gradient of the line)

D) the point where the line intercept with the y axis.

32. In the formula (y = a + bx), a is …….

A) the time

B) the forecasted demand

C) slop (the gradient of the line)

D) the point where the line intercept with the y axis.

33. a = ……..

A) 921.21

B) 11333.33

C) 866.67

D) 10933.33

34. b = ……

A) 921.21 B) 11333.33 C) 866.67 D) 10933.33

35. N = …..

A) 10 B) 9 C) 12 D) 55

36. Sum x = …..

A) 10 B) 55 C) 45 D) 54

37. Forecasted demand in 2020 is….

A) -10.281 B) 21733.33 C) 20866.67 D) none of the answers

38. Forecasted demand in 2027 is …

A) 26933.333 B) 21733.33

C) 25200 D) none of the answers

Suppose that the actual and forecasted demand of the company AZ was as follow

Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Actua	2876	3400	3456	5670	3000	4500	5600	4000	4400	4567
Forec	2900	3500	4000	4560	3400	4500	3600	3900	4500	4500

39. Sum absolute Deviation =

a) -210.9 b) 210 c) 4445 d) - 4445

40. Mean absolute Deviation =

a) 21 b) - 21 c) – 4445 d) 444.5

41. Four workers installed 900 square yards of carpeting in eight hours. The productivity of workforce is:

a) 225 square yards per hour

b) 28 square yards per hour

c) 0.355 square yards per hour

d) 112.5 square yards per hour

42. Determine the multi factor productivity using the following information: outputs = 7040 units for $10 each, Labor = $1000, Materials = $520 and overhead $2000.

a) 2 units/dollar

b) 0.5 units/dollar

c) 20 units/dollar

d) none of the answers

Answer the following questions

Question 7: ***Identify if True (T) or False (F). Mark your answer in the answer sheet***

(20 marks)

1. In the early twentieth century, F.W. Taylor implemented Adam Smith's theories and developed scientific management.
2. Services are 100% intangible outputs, whilst products are 100% tangible outputs.
3. Service sectors are included within operations' scope.
4. Qualitative forecasting methods are more suitable when there is little historical data available
5. Planning by itself is enough to manage processes.
6. Organizational strategy is different from operations strategy because it is longer in time horizon.
7. Scheduling means to decide when to start and when to complete a particular production activity.
8. The less the degree of customer involvement, the more challenging the design and management of operations.

9. One of the objectives of production management is ensuring efficiency by decreasing redundancy of tasks.
10. Qualitative forecasting methods are more suitable when there is a little historical data available.
11. Psychologists, socialists and other social scientists contributed to production management by studying techniques and work processes.
12. Economists, mathematicians, and computer socialists contributed to production management newer and more sophisticated analytical approaches.
13. Facility location strategy is a systematic and scientific method of moving, packing and storing of material in appropriate and suitable location.
14. Operations management is a sequence of activities and organizations involved in producing and delivering a good or service.
15. How should the company fulfill its long-term objectives and satisfy its mission is called a corporate strategy.
16. In public service organizations costs of all activities can be identified and compared to a subjective assessment of their contribution to the end benefit delivered for citizens.

17. The set of interrelated management activities, which are involved in manufacturing certain products, is called as production management.

18. Customers must be external to the organization.

19. Materials, land, energy and human and capital resources are the examples of inputs for the organization.

20. The trend projection method assumes that the factors liable for the past trends in the variables to be projected will play their role in the future in different manner and to different extent from what they did in the past.

Answer the following questions

Question 8: ***Choose the right answer from a, b, c and d. Mark your answers in the answer sheet (80 marks)***

1. A tool to measure effective use of resources and usually expressed as the ratio of output to input is known as;

A) Production ratio

b) Productivity

C) Reliability

D) Operations ratio

---

2. Which is not a significant difference between manufacturing and service operations?

a) Cost per unit

b) Standardization of output

c) Labor content of jobs

d) Customer contact

---

3. During operations follow-ups, you need to look out for possible or visible …… that can hinder the smooth flow of your production line at any stage

a) bottlenecks

b) blueprints

c) good operation

d) none of the answers.

---

4. Which of the following is not a tangible output?

a) food

b) chairs

c) excitement

d) books

---

5. Forecasts help managers by reducing the degree of:

a) Accuracy

b) Correctness

c) Uncertainty

d) Reliability

---

6. Productivity can be measured in which of the following input resource(s)

(A) Material input

(B) Labor input

(C) Capital and Land Input

(D) All of the above

---

7. According to Porter Value Chain, which of the following is an upstream function of operations?

a) human resource management

b) technology development

c) outbound logistics

d) inbound logistics

---

8. What is the most important location decision factor in building service facilities for a bank?

a) Closeness to customers

b) Transportation cost

c) Closeness to market

d) Location of competitors

---

9. Non-behavioral errors in facility location decision include the following except…..

a) a lack of proper investigative practice and analysis.

b) a personal factor.

c) ignoring critical factors and industry characteristics.

d) none of the above

---

10. ……..involves determination of the progress of work, removing bottlenecks in the flow of work and ensuring that the productive operations are taking place in accordance with the plans.

a) Follow-up

b) Time management

c) Time study

d) Time booking

---

11. Chasing demand means:

a) adjusting capacity to follow demand

b) keeping capacity fixed

c) always having too much capacity.

d) none of the above

---

12. Which of the following decisions is related to selecting the right production process.

a) Selecting the right product

b) Selecting the right design according to the customers' requirements.

c) Selecting the type of technology of production

d) Selecting the right production capacity.

---

13. …….. means to decide when to start and when to complete a particular production activity.

a) Loading

b) Routing

c) Scheduling

d) Controlling

---

14. The statistical methods are used more often and are considered superior to the other techniques of demand forecasting due to the following reasons *except*:

a) The estimation method is scientific and depends on the relationship between the dependent and independent variables.

b) There is a high degree of subjectivity.

c) The estimates are more reliable

d) The cost involved in the estimation of demand is the minimum.

---

15. …….. is the maximum output possible as indicated by equipment manufacturer under ideal working condition.

a) Design capacity

b) Production capacity

c) Sustainable capacity

d) Effective capacity

---

16. The traditional view of manufacturing management began in eighteenth century when…… recognized the economic benefits of specialization of labor.

a) Adam Smith

b) F.W. Taylor's

c) Frank Gilbreth

d) Lillian Gilbreth

---

17. To make operations strategy effective it should be:

a) Independent of the organization's strategy

b) Consistent with the organization's strategy

c) Developed by a first line manager

d) Independent of time dimension

---

18. A company has 30 employees who work 40 hours a week and achieve revenue of $234000. What is the productivity of employee?

a) $5850 b) $7800 c) $1.33 d) $0.75

---

19. The following are functions of production management except……

a) Production Control

b) Inventory Control

c) customers service

d) Maintenance and Replacement of Machines

---

20. ……. means, the load at each routing point and start-end of an activity or operation are checked for resource help and support.

a) Routing

b) Scheduling

c) Controlling

d) None the above

21. . …….. means deciding the path of work and the sequence of operations.

a) Loading

b) Routing

c) Scheduling

d) Controlling

22. Which of the following is not a part of production planning and control?

a) Follow-up

b) Financial leverage

c) Routing

d) Scheduling

23. The ……. layout is used for products that require a continuous or repetitive manufacturing process.

A) fixed-position-layout

b) cellular manufacturing layout

b) batch system

d) a product layout

24. Alcatel is developing new product; they concern with the rates of technological progress in the market. Which type of forecasts are they using?

a) Demand forecasting

b) Economic forecasting

c) Legal forecasting

d) Technological forecasting

---

25. In qualitative forecast techniques, method that collect input from customers or potential customers regarding their plans is also identified as

a) sales force composite

b) trend projection

c) market survey

d) exponential smoothing

---

26. A fixed-position layout allows the product to remain in the same location while workers and machinery move to it as needed.

a) Fixed-Position Layout

b) product layout

c) Cellular manufacturing layouts (CM)

d) The process layout.

---

27. Effective capacity is the……..

a) Maximum output of a system in a given period

b) Capacity a firm expects to achieve given the current operating constraints

c) Average output that can be achieved under ideal conditions

d) Sum of all the organization's inputs

28. ……is the process of selecting the path, which each part of the product will follow.

a) Routing

b) b) Scheduling

c) c) Follow-up

d) d) Dispatching

29. ……..is the process of setting the productive activities in motion through release of orders and instructions, in accordance with previously planned timing.

a) Time study b) Follow-up c) Dispatching d) None of the above

30. Which of the following is not correct about demand forecasting?

a) Predicts future demand for a product or service.

b) Based on the past demand for the product or service.

c) It is not based on scientific methods.

d) Helps in the managerial decision making.

Suppose that the record of actual production of car manufacturing company MAZA is shown in next table. Answer questions from 31-38

Year	2020			
Quarter	1	2	3	4

Sales	45650	35900	32600	34800

2021			
1	2	3	4
31200	34500	40000	39000

According to the formula y = a + bx

31. a is

A) the time

B) the forecasted production

C) the slop (the gradient of the line)

D) the point where the line intercept with the y axis.

32. x is …….

A) the time

B) the forecasted production

C) slop (the gradient of the line)

D) the point where the line intercept with the y axis.

33. N =

A) 2

B) 8

C) 10

D 36

34. b =

A) 850.000

B) -285.119

C) -1454.286

D) none of the answers

35. a =

A) 31178.571

B) 37989.286

C) 27351.429

D) none of the answers

36. Forecast of production for 2022 quarter one:

A) 38828.571

B) 40440.000

C) 35423.214

D) none of the answers

37. Forecast of production for 2022 quarter four:

A) 34567.857

B) 41378.571

C) 44802.857

D) none of the answers

38. Forecast of production for 2023 quarter two:

A) 43078.571

B) 33997.619

C) 47711.429

D) none of the answers

Suppose that the forecasted production of XYZ company in the period from 2015 to 2020 was in 1000s units 42, 44, 40, 55, 55, 62 sequentially and the actual sales was in 1000s units 40, 40, 44, 60, 64, 66 sequentially.

39. The mean absolute deviation =

A) 28

B) 4.667

C) 16

D) 2.667

40. Which mean absolute deviation shows the least accurate forecast:

a) the lowest mean absolute deviation

b) the medium mean absolute deviation

c) the highest mean absolute deviation

d) none of the above

Question 10: Answer the flowing questions

1. Which of the following is not a benefit of production planning and control?

a) It ensures that optimum utilization of production capacity is achieved, by proper scheduling of the machine items which reduces the idle time as well as over use.

b) Since it overlooks all aspects of production, quality of final product is always maintained.

c) It ensures that production time is kept at optimum level and thereby increasing the turnover time.

d) It ensures that inventory levels are maintained at maximum levels at all time

---

2. Which of the following decisions is related to selecting the right production process.

a) Selecting the right product

b) Selecting the right design according to the customers' requirements.

c) Selecting the type of technology and material handling system.

d) Selecting the right production capacity.

3. Which of the following is related to selecting the right production process?

a) deciding about the type of technology

b) deciding about the types of machines

c) deciding about material handling system d) all the above

---

4. ……means deciding the path of work and the sequence of operations.

a) Loading

b) Routing

c) scheduling

d) Controlling

---

5. …….. means to decide when to start and when to complete a particular production activity.

a) Loading

b) Routing

c) scheduling

d) Controlling

---

6. Decisions relating to the aggregate planning involve:

a) long-term forecasting

b) short-term forecasting

c) medium-term forecasting

d) both short-term, medium-term and long-term forecasting

---

7. Which of the following is not correct about selecting the product and design?

a) Care must be taken while selecting the product and design because the survival and success of the company depend on it.

b) The product must be selected only after detailed evaluation of all the other alternative products.

c) After selecting the right product, the right design must be selected.

d) The design must be according to the operation manager personal view.

---

8. Which of the following is correct about selecting the product and design?

a) Care must be taken while selecting the product and design because the survival and success of the company depend on it.

b) The product must be selected only after detailed evaluation of all the other alternative products.

c) After selecting the right product, the right design must be selected.

d) The design must be according to the customers' requirements.

e) It must give the customers maximum value at the lowest cost. So, production management must use techniques such as value engineering and value analysis.

f) all the above

---

9. Which of the following is a function of operation management?

a) Facilities Location and Layout Planning

b) Selection of Product and Design,

c) Selection of Production Process,

d) all the above

---

10. The statistical methods are used more often and are considered superior than the other techniques of demand forecasting due to the following reasons except:

a) The estimation method is scientific and depends on the relationship between the dependent and independent variables.

b) There is a minimum element of subjectivity.

c) The estimates are more reliable

d) The cost involved in the estimation of demand is the minimum.

11. The statistical methods are used more often and are considered superior than the other techniques of demand forecasting due to the following reasons except:

a) The estimation method is scientific and depends on the relationship between the dependent and independent variables.

b) They have high level of objectivity

c) The estimates are less reliable

d) The cost involved in the estimation of demand is the minimum.

---

12. which of the following is a function of operation management?

a) Selecting Right Production Capacity

b) Production Planning c) Production Control

d) all the above

---

13. …….. is the maximum output possible as indicated by equipment manufacturer under ideal working condition.

a) Design capacity b) Production capacity c) Sustainable capacity d) Effective capacity

---

14. 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.

a) Production/operations management

b) operation planning and control

c) operations

d) all the above

---

15. Which of these statements about the operations function is best?

a) Operations is the most isolated of all business functions, rarely needing to interface with marketing, finance, or engineering.

b) Inputs to the operations function can come from many different places.

c) A manufacturing company provides only tangible goods as outputs.

d) The quality and availability of inputs to the operations function do not matter if the operation is well-managed.

---

16. Which of these is NOT a flow that moves up and down the supply chain?

a) Information b) Physical c) Procedural d) Monetary

---

17. Which of these statements about the transformation process is best?

a) Inputs to operations usually come from only one place and take one form.

b) The availability of inputs usually has little impact on the operations function.

c) Operations are highly dependent on the quality of inputs.

d) Operations activities are usually independent of other business activities such as engineering and marketing.

---

18. Company A makes widgets and sells them to Company B, who incorporates some software and other materials to produce gadgets. Company B sells these gadgets to Company C, the end user. Which is the best statement regarding the relationship among Companies A, B, and C?

a) Company B is upstream from Company A.

b) Company B is a second level supplier of Company A.

c) Company C is downstream from both Company A and Company B.

d) Company A is a first level supplier for Company C.

---

19. The capacity planning function is closely linked with which two key interorganizational supply chain participants?

a) Finance and Accounting b) Suppliers and Customers c) Marketing and Human Resources d) Government.

---

20. Which of the following is a quantitative method of sales forecasting?

a) Delphi technique b) Jury of executive opinion c) Regression analysis d) Pol of sales force opinion

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