VELS
INSTITUTE OF SCIENCE, TECHNOLOGY & ADVANCED STUDIES (VISTAS)
(Deemed to be University Estd. u/s 3 of the UGC Act, 1956)
PALLAVARAM | PERIYAPALAYAM | THALAMBUR

DCMBA-25

Operations Management

MBA
ODL MODE
(Semester Pattern)

School of Management Studies and Commerce
Centre for Distance and Online Education
Vels Institute of Science, Technology and Advanced Studies (VISTAS)
Pallavaram, Chennai - 600117

Vels Institute of Science, Technology and Advanced Studies

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Master of Business Administration (MBA)
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DCMBA-25: Operations Management
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FOREWORD

Dr.Ishari K Ganesh
Chancellor

Vels Institute of Science, Technology and Advanced Studies (VISTAS), Deemed-to-be University, was established in 2008 under section 3 of the Act of 1956 of the University Grants Commission(UGC), Government of India, New Delhi.

VISTAS has blossomed into a multi-disciplinary Institute offering more than 100 UG & PG Programmes, besides Doctoral Programmes, through 18 Schools and 46 Departments. All the Programmes have the approval of the relevant Statutory Regulating Authorities such as UGC, UGC-DEB, AICTE, PCI, BCI, NCTE and DGS.

Our University aims to provide innovative syllabi and industry-oriented courses, and hence, the revision of curricula is a continuous process. The revision is initiated based on the requirement and approved by the Board of Studies of the concerned Department/School. The courses are under Choice Based Credit Systems, which enables students to have adequate freedom to choose the subjects based on their interests.

I am pleased to inform you that VISTAS has been rendering its services to society to democratize the opportunities of higher education for those who are in need through Open and Distance Learning (ODL) mode.

VISTAS ODL Programmes offered have been approved by the University Grants Commission (UGC) – Distance Education Bureau (DEB), New Delhi.

The Curriculum and Syllabi have been approved by the Board of Studies, Academic Council, and the Executive Committee of the VISTAS, and they are designed to help provide employment opportunities to the students.

The MBA ODL Programme Study Materials have been prepared in the Self Instructional Mode (SIM) format as per the UGC-DEB (ODL & OL) Regulations 2020. It is highly helpful to the students, faculties and other professionals. It gives me immense pleasure to bring out the ODL programme with the noble aim of enriching learners' knowledge. I extend my congratulations and appreciation to the Programme Coordinator and the entire team for bringing up the ODL Programme in an elegant manner.

At this juncture, I am glad to announce that the syllabus of this ODL Programme has been made available on our website, **www.vistascdoe.in**, for the benefit of the student community and other knowledge seekers. I hope that this Self Learning Materials (SLM) will be a supplement to the academic community and everyone.

CHANCELLOR

FOREWORD

Dr.S.Sriman Narayanan
Vice-Chancellor

My Dear Students!

Open and Distance Learning (ODL) of VISTAS gives you the flexibility to acquire a University degree without the need to visit the campus often. VISTAS-CDOE involves the creation of an educational experience of qualitative value for the learner that is best suited to the needs outside the classroom. My wholehearted congratulations and delightful greetings to all those who have availed themselves of the wonderful leveraged opportunity of pursuing higher education through this Open and Distance Learning Programme.

Across the World, pursuing higher education through Open and Distance Learning Systems is on the rise. In India, distance education constitutes a considerable portion of the total enrollment in higher education, and innovative approaches and programmes are needed to improve it further, comparable to Western countries where close to 50% of students are enrolled in higher education through ODL systems.

Recent advancements in information and communications technologies, as well as digital teaching and e-learning, provide an opportunity for non-traditional learners who are at a disadvantage in the Conventional System due to age, occupation, and social background to upgrade their skills.

VISTAS has a noble intent to take higher education closer to the oppressed, underprivileged women and the rural folk to whom higher education has remained a dream for a long time.

I assure you all that the Vels Institute of Science, Technology and Advanced Studies would extend all possible support to every registered student of this Deemed-to-be University to pursue her/his education without any constraints. We will facilitate an excellent ambience for your pleasant learning and satisfy your learning needs through our professionally designed curriculum, providing Open Educational Resources, continuous mentoring and assessments by faculty members through interactive counselling sessions.

VISTAS, Deemed- to- be University, brings to reality the dreams of the great poet of modern times, Mahakavi Bharathi, who envisioned that all our citizens be offered education so that the globe grows and advances forever.

I hope that you achieve all your dreams, aspirations, and goals by associating yourself with our ODL System for never-ending continuous learning.

With warm regards,

VICE-CHANCELLOR

Course Introduction

The Course **DCMBA-25: Operations Management** has been divided into five blocks and consisting of 15 Units.

Block-1: Introduction to Operations Management has been divided into three Units. Unit-1 describes history and Definition, Production vs. Operations, Manufacturing vs. Service Operations, Unit-2 explains functions of production systems and Unit-3 deals with Production Operations Management vs. Operations Strategy.

Block-2: **Location, Layout and Forecasting** has been divided into three Units. Unit-4 deals with Plant Location, Factors Influencing Location, Plant Layout, Unit-5 explains about the Types of Layout, Forecasting Technique: Qualitative and Quantitative and Unit-6 describes about the Delphi Method, Regression Analysis and Forecasting Error.

Block-3: **Planning** has been divided in to three Units. Unit-7 describes about Capacity Planning, Aggregate Production Planning (APP), Unit-8 explains about the Disaggregation: Master Production Scheduling (MPS), Material Requirement Planning (MRP) and Unit-9 deals with the Production Planning and Control (PPC).

Block-4: Quality has been divided into three Units. Unit-10 describes the Evolution of Quality, Quality Definition and Contributions by W. Edwards Deming, Unit-11 explains the Dimensions of Quality, Process Quality vs Product Quality and Unit-12 deals with the Seven Basic Quality Tools – Plan-Do-Check-Act (PDCA) Cycle.

Block-5: Inventory Management has been divided into three Units. Unit-13 describes about the Inventory Management, Types of Inventory Models, Independent Demand vs Dependent Demand, Unit-14 explains about the Basic Economic Order Quantity (EOQ) Model Analysis: ABC and VED and Unit-15 deals with Push vs Pull system – Just-In-Time (JIT) vs Material Requirement Planning (MRP).

DCMBA25: Operations Management

Block-1: Introduction

Block-1: I**ntroduction to Operations Management** has been divided in to Three Units.

Unit-1: History and Definition Production vs. Operations Manufacturing vs. Service Operations explains about the Meaning of "Production", Meaning of “Operations”, Difference between Goods and Services, Nature of Production and Operations, Production / Operations as a System, Production / Operations as an Organizational Function, Production / Operations as a Conversion / Transformation Process, Production / Operations as a Means of Creating Utility, Production Function, Importance of Production Function, The Historical evolution of production/operations management and Manufacturing vs Service Operations.

Unit-2: Functions, Production Systems and Types of Production Systems deals with the Functions of production/Operations managers, Types of Production systems, Problems of POM, Roles and Responsibility of an Operations Manager, Operations managers’ responsibilities include, Productions/Operations Management Problems, the boundary of the operations system, Process Planning and Types of Production Process.

Unit-3:Operations Strategy, Operations Management vs Operations Strategy presents about What is Strategy?, Operations Strategy, Operations Strategy Formulation, Operations Management vs Operations Strategy, The framework of Operations Strategy, Factors affecting production and Operations Management today.

In all the units of Block -1 I**ntroduction to Operations Management**, the Check your progress, Glossary, Answers to Check your progress and Suggested Reading has been provided and the Learners are expected to attempt all the Check your progress as part of study.

Unit-1

Production vs Operations vs Service Operations

STRUCTURE

Overview

The meaning of Operations Management and how it differs from Production Management will be discussed in this unit. Additionally, a detailed explanation of the categories, importance, and scope has been provided.

Objectives

Managing any business that creates customer-demanded products is more difficult today than it has ever been. While all other functional managers are involved in planning, organizing and controlling in their

own field of work, production/operations managers who are in charge of manufacturing the products have the direct responsibility of getting the job done. They must be the leaders in the task of producing products demanded by the customers most efficiently and effectively. The production/operations managers are involved in planning, organizing, co-coordinating, executing, and controlling of all activities that create goods and/or services to satisfy the needs of their customers. Of all the functional areas of management, production management (which is also referred to as operations management) is considered to be crucial in

1.1. Meaning of "Production"

Production implies the creation of goods and services to satisfy human needs. It involves conversion of inputs (resources) into outputs (products). It is a process by which, raw materials and other inputs are converted into finished products. Earlier the word "manufacturing" was used synonymously with the word "production", but nowadays, we use the term "manufacturing" to refer to the process of producing only tangible goods whereas the word "production" (or operation) is used to refer to the process of creating both goods (which are tangibles) as well as services (which are intangibles). Any process which involves the conversion of raw materials and bought-out components into finished products for sale is known as production. Such conversion of inputs adds to the value or utility of the products produced by the conversion or transformation process. The utility or addedvalue is the difference between the value of outputs and the value of inputs. The value addition toinputs is brought about by alteration, transportation, storage or preservation and quality assurance.

1.2. Meaning of the Operations

The term "operations" describes a function or system that converts inputs into higher-value outputs. Materials, machinery, labor, and capital are commonly turned into outputs through operations (goods and services). In a productive system, if the outputs are strictly tangible goods,such a system is referred to as a “production system” and the transformation process is referred to as “production”. Nowadays, the service system in which the output is predominantly a service or even a pure service, is also treated as a productive system and often referred to as an “operating system” instead of a “production system”

1.3. Difference between Goods and Services

I. In most cases, services are intangible, whereas products are tangible (i.e., can be touched and seen).

II. Because services cannot be stored, they are frequently generated and consumed concurrently. Goods, on the other hand, can be manufactured and inventoried prior to consumption or use.

III. Services are often unique, for example insurance policies, medical treatment procedures, haircut styles, etc.

IV. Services have high customer interaction, services are often difficult to standardize and automate because customer interaction demands uniqueness. The service product may have to be customized in most of the service offerings.

V. Services are often knowledge based, for example educational, health-care, legal and consultancy services and, therefore, difficult to standardize and automate.

VI. Services are frequently dispersed because services may have to deliver to the client/customer at his/her place.

1.4. Nature of Production and Operations

The manufacturing function can be better understood by understanding it as:

I. Production/operations as a system,

II. Production/operations as a process, and

III. Production/operations

As an organizational function,

I. production/operations

II. Production/operations as a process of conversion or transition

III. Utility creation through production and operations.

This viewpoint is also known as the "production systems concept." A system is defined as a group of interconnected elements. The systems approach views any organization or entity as an arrangement of interrelated parts that interact in ways that can be specified and to some extent predicted. Production is viewed as a system which converts a set of inputs into a set of desired outputs. A production system has the following elements or parts:

(i) Inputs,

(ii) Conversion process or transformation process,

(iii) Outputs

(iv) Transportation subsystem,

(v) Communication subsystem and

(vi) Control or decision making subsystem.

1.5. Production / Operations as a System

1.5.1.Production/Operations as an Organizational Function

To create goods and services, all organizations whether manufacturing goods or providing services perform four basic functions. They are

(i) Marketing function

(ii) Production or Operations function.

(iii) Finance function and

(iv) Human Resources function. Production is considered as a crucial function which creates goods and services whereas marketing function generates demand for products or obtains customers' orders, finance function keeps track of how well the organization performs and takes care of all cash inflows and cash outflows, and human resources function looks into the people aspect of the organization and the best utilization of people in the organization. Production function plays a central role in achieving the objectives of any business organization.

1.5.2.Production / Operations as a Conversion / Transformation Process

Because it comprises of processes or activities that use personnel, materials, machinery, and equipment to convert inputs into outputs, the conversion or transformation sub-system is the heart of a production system. Cutting, drilling, machining, welding, painting, and other manufacturing activities, as well as ancillary processes like packing and selling, are all part of the conversion process. Any conversion process is made up of a series of discrete actions known as "operations," which are steps in the overall process of creating a product or service that lead to the ultimate result.

1.5.3.Production/Operations as a Means of Creating Utility

Outputs Sections of steel, sheets Customer satisfaction Petroleum Products for Automobiles Customer satisfaction Postgraduates (Educated persons) Customers that are happy arrive at their destinations the process of increasing the value of outputs or producing utility in outputs is referred to as production. "Utility" refers to the ability to meet human wants. Various types of utilities are formed during the conversion of raw materials into completed commodities, adding value to the outputs.

The following are examples of utilities:

Form utility: This is achieved by altering the size, shape, form, weight, color, and scent of inputs in order to improve the utility of the outputs for clients. For example, iron ore is transformed into steel, and wood is transformed into furniture.

Place utility: This is created by moving inputs from one location to another or carrying inputsfrom one location to another to be converted into outputs. Iron ore and coal, for example, are transported from mines to steel plants and employed in the conversion process.

Time utility: This is created by storing or preserving raw materials or finished items that are in plentiful supply at the time, so that they can be used later.

Possession utility: This is formed when one individual transfers possession or ownership of an item to another. When a company buys goods from a supplier, for example, the items' possession utility increases once they are delivered to the company.

Service utility: the utility derived by providing a service to a consumer. A doctor, lawyer, or engineer, for example, develops service utility for a client/customer by providing direct service to the client/customer.

Knowledge utility: this is formed when a person is given knowledge. A sales presentation or advertisement on a product, for example, communicates some product information to the customer, so transferring knowledge time the operations were being conducted out.

1.5.4.Production Function

Production function may be defined as the creation of useful products for sale with the help of inputs such as materials, machines, labour, land, capital and management. The production function represents basically a physical relationship between inputs and outputs. It may be represented as Q = f (a, b, c, d...)

where ‘Q’ is the quantity of output and a, b, c, d, etc., represent the quantities of various inputs such as material, machine hours, labour hours, energy, etc., The production function specifies the amount of outputs resulting from the amount of inputs used during a specified period of time. The productive use of the resources is described by the term productivity. Productivity is an index that measures outputs (goods and services) relative to the inputs (materials, energy and other resources).

Output It is usually expressed as, Productivity = Input

Productivity is also known as productive efficiency or the efficiency of the

production process. Itindicates how well a productive process is carried out to convert a set of inputs into a set of outputs of value to the customer which also provides reasonable profits to the manufacturer or seller.

1.5.5.Importance of Production Function

Any corporate organization's main role is production. Organizations exist primarily to make goods and/or offer services, and the production function creates goods and services. Any other function, such as marketing, finance, or human resources, would be unnecessary without the production function. Furthermore, more than half of all employees in a company work in the production department. Furthermore, in most organizations, the production function is in charge of a significant amount of the assets. Consumption of goods and services is an essential component of any society, and the production function permits the development of commodities and services for the benefit of society's members.

1.6. The Historical Evolution of Production/Operations Management

Even though systems of production have existed since ancient times (for example, the great wall of China and Egyptian pyramids were built long time ago) the production of goods for sale and the modern factory system had their roots in the Industrial Revolution (which began in the 1770'sin England and spread to other countries in Europe and later to the US in 19th century).

However, the substitution of machine power to human power started with the most significant invention of steam engine by James Watt in 1764. Followed by invention of spinning jenny (1770) and power loom (1785). Adam Smith advocated the concept of "division of labor" in his book "The Wealth of Nations" in 1776 and in 1832, Charles Babbage recommended the use of scientific methods for analyzing production problems.

However, the era of scientific management started with the work of F.W. Taylor in 1878 who studied work methods in great detail to identify the best methods for doing each job. Taylor's book "The Principles of Scientific Management" published in 1911, laid the foundation for the field of production management. A number of other pioneers also contributed to this movement including the following:

Frank Gilbreth and his wife Lillian Gilbreth were recognized for their contribution to the development of the "Principles of motion economy" and the concept of "Therbligs" in 1911.

Henry Gantt recognized the value of non-monetary rewards to motivate workers and developed widely used system of scheduling (machine loading) called "Gantt chart" in 1912, Harrington Emerson applied Taylor's ideas to develop organizational structure and encouraged the use of experts to improve organizational efficiency.

Henry Ford developed the concept of mass production and assembly lines with conveyors in 1913, in his automobile plant. Ford also used the concepts of "interchangeable parts" and division of labor (of Adam Smith) which enabled him to tremendously increase the production rate in his factories.

F.W. Harris developed the concept of "Economic Order Quantity" in 1915 which is still recognized as a classical work in inventory control systems. In 1931, Dodge and Romig and W. Shewhart developed the concept of sampling inspection and use of statistical tables for acceptance sampling plans. Earlier in 1924, Shewhart developed the concept of statistical quality control and use of control charts to control the quality of on-going processes.

The "human relations movement" was started by Elton Mayo in 1930's, through his famous experiments at Western Electric's Hawthorne plant and his findings came to be known as "Hawthorne effect". His studies revealed that in addition to physical and technical aspects of work, worker motivation is critical for improving productivity.

During the 1940's, Abraham Maslow developed motivational theory known as "Hierarchy of Needs Theory" which was later refined by Frederick Herzberg as "Motivation-Hygiene" theory in 1950s. Douglas McGregor added "Theory X" and "Theory Y" in 1960. In 1970, William Ouchi added "Theory Z" which combined the Japanese approach and the traditional Western approach to management.

After World War II, operations research and quantitative techniques were applied to production management resulting in decision models for forecasting, inventory management, project management and other areas of production management. Widespread use of personal computers and user-friendly software have popularized application of these quantitative techniques in production management since the 1980's. Development in Management Information Systems (MIS) and Decision Support Systems (DSS) provided a further boost to the developments in production management.

Advanced manufacturing technology enabled production managers to use Computer-Aided- Design (CAD), Computer-Aided-Manufacturing

(CAM), Computer Numerically Controlled (CNC) machines, Robots, Computer Integrated Manufacturing (CIM), Flexible Manufacturing System (FMS), etc., in the field of production management.

Moreover, a number of Japanese manufacturers have developed modern management practices that have increased the productivity of their operations and the quality of their products. The new approaches in production management emphasize quality (Total Quality Management) and continuous improvement (Kaizen), worker teams and empowerment to achieve customer satisfaction. The Japanese have spawned the "quality revolution" and adopted Just-In-Time (JIT) production system to put themselves in the forefront of time-based competition.

1.7. Manufacturing Vs Service Operations

Generally speaking, process efficiency is the most important to manufacturing operations while production and marketing are inseparable to service operations. Manufacturing's tangible output can be consumed overtime, less labor and more equipment are used in production, since automation has increased capital intensity while as a result reduced customer contact.

Consumers rarely take part in the manufacturing process, many manufacturing operations have emphasized efficiency while compromising flexibility, the methods for monitoring and using resources are sophisticated while producing.

On the other hand, service operations are different from those of manufacturing operations. Consumption and production of services takes place simultaneously or closely, and there are more labor and more customer participation, which means service businesses, usually are more customer-oriented. While elementary methods are frequently used for monitoring and using resources. To be specific, there are mainly six differences between manufacturing operations and service operations.

Basic organize style in operation

Basically, manufacturing companies usually make production and purchase plans based on the demand of the market and their customers. Then human resources and equipment are settled to produce. So the manufacturing companies operation management is mainly product-cantered the aim is to control the process of production, keep the quality of outcomes and reduce cost. Yet the service organizations seem organized differently as they have greater amount of interaction with their customers. There are more uncertainties in the process, so specific plans cannot be made in advance, and the results are diverse if the service

personals or the customers change. For that reason, the service operations are human-centered.

Design of products and operation systems

In manufacturing factories, the products and production systems can be designed separately because one same product can be produced by different manufacturing systems (i.e. two equipment's with different automation degree). However in the service operations, the service provides system is part of the whole "service" itself. Different service provides system have different characteristics which make the service not the same, so those two systems must be designed together within the service operations.

The use of inventory in adjusts supply and demand

Since the companies cannot decide the demand of the market while their productivities are controllable, the manufacturing companies can use their inventory to deal with unexpected demand increases. So those companies should pay more attention to plan reasonable inventory strategy. To most of those service companies, their products cannot be inventoried as readily as goods. They cannot produce service in advance and store them for later customers, so what they can do is to make better use their service abilities while the demand happens.

Customer's effect

The production systems in the manufacturing companies are usually enclosed to customers, manufacturing firms generally evaluate their products quality from internal perspective rather than external (customer's) perspective, and thus they can have few influences on the manufacturing operations. However, customers take part in the service operations; they may have positive and negative effects to the process. So the service companies need to make full use of those good effects and try to minimize the undesirable ones.

Boundaries of function division and human resource characteristic

In the manufacturing companies, there are clear boundaries within the operation, marketing and human resource management. The time and places are different between producing and selling the goods. Besides most products need to transport through a complex channel before the customers get them. As a result, there must have different people take response of different departments. Moreover, since the manufacturing operations are product-centered, the working process and quality are strictly controlled, which means human's behavior will have few influences

to the results. Nevertheless, to the service companies, the human factor is critical while operating. Managing people must become a critical part of line manager's job in service operations. So the three parts which had been mentioned at the beginning have to be integrated while managing.

Measure the output

Clearly, the output of the manufacturing operations can be easily measured through count the yield and test the product quality. However, in the service operations, the quantitative indicators are unsuitable for measuring the output service. Productivity measurement it is more complex in service industries owing to the inherent characteristics of services. Besides, the qualitative indicators of service are more difficult to define than those of manufacturing operations. Furthermore, as a lot of service organizations have multiplex goal such as long-term benefits and social benefits, evaluating these organizations could be even harder.

In a word, although there are some basic features in common, different type of output of manufacturing and service operations lead to dissimilar emphasis of the two operations. As a result, while dealing with these two kinds of operations, the management methods would not be the same.

Let Us Sum Up

In this unit, you have learned the following:

- Operation is that part of as organization, which is concerned with the transformation of a range of inputs into the required output (services) having the requisite quality level.
- An operation was 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.
- Operation managers are concerned with planning, organizing, and controlling the activities, which affect human behaviour through models. Planning is the activity that establishes a course of action and guide future decision-making.
- Organizing is the activities that establish a structure of tasks and authority. Controlling is the activities that assure the actual performance in accordance with plannedperformance.
- Joseph G .Monks defines Operations Management as the process where by resources, flowing within a defined system, are combinedand transformed by a controlled manner to add value in accordance with policies communicated by

management.

- Operations Management is concerned with the conversion of inputs into outputs, using physical resources, so as to provide the desired utilities to the customer while meeting the other organizational objectives of effectiveness, efficiency and adaptability

Check Your Progress

1. Production Management starts with _____
2. Job descriptions are important too_____
3. It is defined as the number of orders to be picked simultaneously by a picker in an assignment_____

Glossary

Automation: Act of converting the controlling of a machine or device to a more automatic system.

Cost Leadership: A firm attempts to gain competitive advantage by reducing its economic costs below that of its competitors.

Differentiation: Firm seeks to be unique in its industry along some dimensions that are widelyvalued by buyers.

Focus Strategy: Choice of a narrow competitive scope within an industry.

Green Productivity: It signifies a new paradigm aimed at the pursuit of productivity growth while protecting the environment.

Labor Productivity: Quantity of output produced by one unit of production input in a unit oftime.

Manufacturing: Tangible items that are usually produced in one location and purchased inanother.

Operations Management: Management of an organization's productive resources or its production system.

Production: Conversion of inputs – men, machines, materials, money, methods and management (6 Ms) into output through a

	transformation process
Productivity:	Output/input
Services:	Intangible products that are consumed as they are created.
Total Factor Productivity:	Year-by-year change in the output where a number of factors are taken into consideration.
Wastivity:	1/productivity

Model Questions

1. Explain briefly Operations Management.
2. Explain briefly Production and Operations Management.
3. Explain briefly about Operations or Production System.
4. History of Operations Management?

Answers to Check Your Progress

1. Aggregate planning
2. All of the above
3. Order extent

Suggested Readings

1. Anand, G., & Gray, J. V. (2017). Strategy and organization research in operations management. *Journal of Operations Management*, 53–56, 1– 8.
2. Ba, S., & Nault, B. R. (2017). Emergent themes in the Interface between economics of information systems and Management of Technology. *Production and Operations Management*, 26 (4), 652– 666.
3. Bockstedt, J., Druehl, C., & Mishra, A. (2015). Problem-solving effort and success in innovation contests: The role of national wealth and national culture. *Journal of Operations Management*, 36, 187– 200.
4. https://corporatefinanceinstitute.com/resources/knowledge/strategy/operations-management/
5. https://managementhelp.org/operationsmanagement/

Unit-2
Production Systems

STRUCTURE

Overview

In this Unit what discussed about Functions, Production Systems, and Types of Production Systems

Objectives

After reading this lesson, you will be able to:

- Introduce the terms 'production/operations managers', 'Roles and Responsibility of an Operations Manager' and 'service operations'
- Enlist the types of operations
- Explain the responsibilities of the operations manager in manufacturing and boundary of the operations system.

2.1. Functions of Production/Operations Manager

The major functions of production managers may be categorized as shown below:

1. **Production Techniques:** Equipment Design, Process Design, Plant Layout and Shop Layout, Design of Materials Handling System.
2. **Capacity Management:** Forecasting Demand, Delivery Commitment, Facility Location and Resource Allocation.
3. **Industrial Engineering (or Work Study):** Method Study, Work Measurement.
4. **Production Planning and Control:** Estimating, Forecasting, Routing, Scheduling, Dispatching and Progressing.
5. **Inventory Control:** Purchasing, Storing and Controlling Inventory Levels and Material Issues.
6. **Quality Control:** Inspection, Quality Control, Quality Assurance and Reliability, Statistical Quality Control and Total Quality Control.
7. **Maintenance:** Servicing, Repairing, Breakdown/Preventive Maintenance, Spare Parts Inventory Control and Equipment Replacement. Skills Needed for Production/Operations Managers

The production managers need the following skills or competencies:

(i) Technical Competence:

   a. Basic understanding of technology with which the production system works.

   b. Adequate knowledge of the work they are to manage.

(ii) Behavioral Competence: Interpersonal relationships, the ability to work with other people.

2.2. Types of Production Systems

Broadly production systems can be classified as:

a. Manufacturing systems and service systems.

b. Series and parallel production systems.

c. Continuous flow and intermittent production systems.

These production systems are discussed in detail in the following paragraphs.

1. Manufacturing Systems and Service Systems

Production systems that produce goods are often referred to as manufacturing systems and the production of tangible goods is called

manufacturing. Some common examples of manufactured goods are chemicals, steel, cement, automobiles, aeroplanes, beverages, packaged food and furniture.

Production systems that produce services are referred to as service systems. Services are intangible products that satisfy some need of a consumer including the enhancement of tangible goods. Examples of services systems are: healthcare services, legal assistance, financial services, accounting services, educational services, transportation services and warehousing services.

Products can also be combination of goods and services. Restaurants produce the tangible products along with the intangible services of delivery, cleaning of dishes and providing pleasant environment to the customers. (More about manufacturing systems and service systems will be discussed later in this chapter.)

2. Series and Parallel Production Systems

Production systems may exist in series; for example, when completed products are shipped from the factory to a warehouse, they are leaving the factory system only to arrive at a second production system, called a warehouse. The factory and the warehouse are two production systems which are in series. Production system may also exist in parallel, such as when a number of factories produce similar products and supply several market areas. These factories may be considered as one large production system (i.e., an industry). For example, several factories producing automobile spare parts are treated as part of larger system known as automobile spare parts industry.

3. Continuous Flow and Intermittent Production Systems

Continuous Flow Production Systems are those where the facilities are standardized as to routings and flow. A standard set of processes and sequence of processes can be adopted. Continuous flow production systems are represented by production and assembly lines, large scale office operations and chemical processes.

Intermittent Production Systems are those where facilities must be flexible enough to handle a wide variety of products and sizes. In situations such as this no single sequence of operations is appropriate. Transportation facilities between operations must be flexible to accommodate a wide variety of routes that the inputs may require. Considerable storage between operations is required so that individual operations can be carried on some-what independently, resulting in ease of scheduling and better utilization of men and machines. Intermittent production is

represented by custom or job-order machine shops, hospitals, and batch chemical processes.

2.3. Problems of POM

The problems involved in production management require two major types of decisions relating to:

I. Design of the production system and

II. Operation and control of the production system.

Decisions related to the design of production system are long-run decisions whereas, decisions related to operations and control of the production system are short-run decisions.

The problems involve the relative balance of the emphasis on such factors as cost, service and reliability of both functional and time performance, which depends on the basic purposes of the total enterprise and on the general nature of goods and services produced. In general,

manufacturing organizations emphasize more on cost, consistent with quality and delivery commitments whereas, service organizations may emphasize reliability and service, consistent with cost objectives (for example, hospitals).

Long-Run Decisions

Long-run decisions related to the design of the production system are:

I. Selection and Design of Products: Product selections and designs with productive capability (i.e. reducibility of products) are interdependent.

II. Selection of Equipment and Processes: Selection of the most economic equipment and processes among the various alternatives considered, the firm's capability to invest in capital assets and its basic approach to production (i.e., job, batch, mass or continuous production) must be considered.

III. Production Design of Parts Processed: Production design aims at selection of equipment, processes, and tools for economic production which set limits on the cost of outputs.

IV. Job Design: It involves basic organization of work as well as matching workers to their jobs in order to reduce fatigue and improve productivity.

V. Location of the System: It is a trade-off decision since there is no one best location for a productive system to be located. The

balance of cost factors determined by various considerations is critical.

VI. Facility Layout: This involves decisions related to design capacity, basic modes of production, shifts of working, use of overtime and subcontracting. In addition, operations and equipment must be located in relation to each other such that the overall material handling cost is minimized. Other factors involved are heating, lighting and other utility requirements, the allocation of storage space, washing space and the design of the building to house the layout.

Short-Run Decisions

Short-run decisions related to the operations and control of the system are:

1. **Inventory and Production Control:** Decisions made are concerned with allocation of productive capacity consistent with demand and inventory policy. Feasible schedules must be worked out and the load on machines and labor and the flow of production must be controlled.
2. **Maintenance and Reliability of the System:** Decisions must be made regarding the maintenance effort, maintenance policy and practice recognizing the fact that machine down time may lead to idling of labor and production stoppage resulting in lost sales.
3. **Quality Control: Decisions** must be made to set permissible levels of risk that bad parts are produced and shipped or the risk that good parts are scrapped due to sampling inspection. Inspection costs must be balanced with the probable losses due to passing defective materials or products. Decisions regarding controlling the quality of on-going processes must be taken.
4. **Labor Control:** Labor is the major cost element in most products and services. Hence, work measurement and wage incentive systems must be developed to control labor costs and to increase labor productivity.
5. **Cost Control** and Improvement: Day-to-day decisions which involve the balance of labor, material and overhead costs must be made by production supervisors.

   The relative importance of these problems of production management varies considerably depending on the nature of the production system. The production manager must be able to sense the relative importance of these various problems in a given situation

and take appropriate decisions to solve these problems.

2.4. Roles and Responsibility of an Operations Manager

Some people, particularly, those professionally involved in operations management, argue that operations management involves everything an organization does. In this sense, every manager is an operations manager, since all managers are responsible for contributing to the activities required to create and deliver an organization's goods or services. However, others argue that this definition is too wide, and that the operations function is about producing the right amount of a good or service, at the right time, of the right quality and at the right cost to meet customer requirements.

A stereotypical example of an operations manager would be a plant manager in charge of a factory, such as an automobile assembly plant. But other managers who work in the factory in departments like quality assurance, production and inventory control and line supervisions can also be considered to be working in operations management. In service industries, managers in hotels, restaurants, banks, airline operations, hospital and stores are operations managers. In the not-for-profit sector, the manager of a nursing home or day centre for older people is an operations manager, as they are the managers of a local government tax collection office and the manager of a charity shop staffed entirely by volunteers.

Operations managers are responsible for managing activities that are part of the production of goods and services. Their direct responsibilities include managing the operations process, embracing design, planning, control, performance improvement, and operations strategy. Their indirect responsibilities include interacting with those managers in other functional areas within the organization whose roles have an impact on operations. Such areas include marketing, finance, accounting, personnel and engineering.

2.5. Operations Managers Responsibility include

- 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. For organizations in the not-for-profit sector, the ability to manage costs is no less important.

The chief role of an operations manager is planning and decision making. As an operations manager in an organization, he exerts considerable influence over the degree to which the goals and objectives of the organization are realized.

Most decisions involve many possible alternatives that can have quite different impacts on costs or profits. Consequently, it is important to make informed decisions.

- Decision making is a central role of all operations managers.
- Decisions need to be made in: Designing the operations system
- Managing the operations system ы Improving the operations system
- Operations management professionals make a number of key decisions that affect the entire organization. These include the following:
- The processes by which goods and services are produced
- The quality of goods or services
- The quantity of goods or services (the capacity of operations)
- The stock of materials (inventory) needed to produce goods or services
- The management of human resources
- You can put them under the following questions

What: What resources will be needed, and in what amounts?

When: When will each resource be needed? When should the work be scheduled? When should materials and other supplies be ordered? When is corrective action needed?

Where: Where will the work be done?

How: How will the product or service be designed? How will the work be done (organization, methods, equipment)?

How will resources be allocated? Who: Who will do the work?

The operations function consists of all activities directly related to producing goods or providing services. Hence, it exists both in manufacturing and assembly operations, which are goods-oriented, and in areas such as health care, transportation, food handling, and retailing, which are primarily service-oriented.

2.6. Productions/Operations Management Problems

POM is a functional field of business with clear line management responsibilities. Problems of management in the production/operations function basically concerns two types of decision: Those relating to the design or establishment of the production/operations system.

Those relating to the operation, performance and running of the production/operations system.

Problems in the design of production/operations system are as follows:

i. Design/specification of goods/service,

ii. Location of facilities,

iii. Layout of facilities/resources and materials handling,

iv. Determination of capacity/capability,

v. Design of works or jobs,

vi. Involvement in determination of remuneration system and work standards.

Problems in the operation of system are:

1. Planning and scheduling of activities,
2. Inventory (Stock) control,
3. Quality control,
4. Maintenance and replacement,
5. Involvement in performance measurement.

Every business organization will embrace these problems areas to a greater or lesser extent. The relative emphasis will differ between companies and industries, and also over a period of time. Problems in the first section are of long term nature and will assume considerable importance at only infrequent intervals. Problems in the second section

will be of a recurring nature, i.e. they are of short term nature.

2.7. The boundary of the Operations system

The simple transformation model given in the following diagram provides significant understanding and powerful tool for looking at operations in many different contexts. It helps the decision maker to analyse and design operations in many types of organization at many levels.

This model can be developed by identifying the boundaries of the operations system through which an organization's goods or services are provided to its customers or clients. The diagram shows this boundary and added three components that are located outside it:

Suppliers-Customers

The environment

In any business, the set of suppliers provides inputs to the operations system. They may supply raw materials (for example sugarcane manufacturers provide sugarcane to Sugar Manufacturing units such as EID Parry / Sakthi Sugar etc; TVS is providing various nuts and bolts to automobile manufacturers/other equipment manufacturers), components (Prical provides speed measuring device to two wheeler manufacturers such as Hero Honda, Yamaha), finished

Products (for example a pharmaceutical company providing drugs to a hospital, or an office supplies company providing it with stationery) or services (as in the case of a law firm providing legal advice).

The customers (or clients) are the users of the outputs of the transformation process. The boundary drawn in the above diagram, represents the transforming process can be thought of as the boundary of the organization, so that the whole organization is viewed as an operations system, with its customers external to it. This may be an appropriate way of viewing a small organization, whose outputs go directly to its external customers.

However, many macro operations are made up of a number of micro operations, or sub- systems. Only the outputs of the final micro operation go directly to a customer or client who is not part of the organization that is carrying out the macro operation. The final user or client of the good or service is the organization's external customer, and the users or clients of the outputs of the other micro operations internal customers. Most of the operations in a large organization serve internal, rather than external customers. For example, if you are the manager of a human resources department, a printing unit or a building maintenance section within a large

organization, your customers are internal: they are other sub-systems within the larger organization that are external to your operations system but internal to the organization as a whole.

All operating systems are influenced by the organization's environment. This environment includes both other functional areas within the organization, each with its own policies, resources, forecasts, goals, assumptions and constraints, and the wider world outside the organization – the legal, political, social and economic conditions within which it is operating.

Changes in either the internal or the external environment may affect the operations function. Traditionally, organizations have kept the operations function separate from both its customers and its suppliers, in order to protect it from environmental disturbances (Thompson, 1967). This can lead to a 'closed system' mentality, in which the operations function loses contact with external customers and suppliers, and focuses only on the transformation process that it controls. A closed system tends to limit flexibility and result in a loss of competitiveness. An 'open system' mentality, in which communication with customers and suppliers is encouraged, seeks to reduce the barriers between the operations function and its environment, in order to enhance the organization's competitiveness.

An added complication is that, as organizations become more complex, it becomes increasingly difficult to draw neat boundaries around the operations function. Operations management must therefore focus its attention on key interfaces within the organization, as well as on interfaces between the organization and its external customers and suppliers. Most operations systems are part of a supply chain that involves materials, information and customers, and the distribution of finished goods or services to customers or clients. It is therefore the responsibility of the operations function to co-ordinate the flow of information that links these activities through the supply chain. Thus, while some operations managers are concerned only with the transformation process within a single organizational unit, such as a factory or service outlet, many are involved in managing operations across several organizational units or even across separate organizations.

2.8. Process Planning

Any business, the success predominantly depends upon the effective production/operations process. There are numerous types of production processes and there are also many ways of classifying or grouping them

for descriptive purposes. Classifying production/ operations processes by their characteristics can provide valuable insights into how they should be managed.

In general, the processes by which goods and services are produced can be categorized in two traditional ways.

1. Firstly, we can identify continuous, repetitive, intermittent and job shop production process.
2. Second and similar classification divides production processes into Process production, Mass production, Batch production and jobbing production.

We will briefly introduce these methods in the following paragraphs.t Job shop.

A wide variety of customized products are made by a highly skilled workforce using general- purpose equipment. These processes are referred to as jumbled-flow processes because there are many possible routings through the process.

Examples: Home renovating firm, stereo repair shop, restaurants. Intermittent (batch) flow

A mixture of general-purpose and special-purpose equipment is used to produce small to large batches of products.

Examples: Clothing and book manufacturers, winery, caterer.

2.9. Types of Production Process

Repetitive flow (mass production)

The product or products are processed in lots, each item of production passing through the same sequence of operations, i.e. several standardized products follow a predetermined flow through sequentially dependent work centers. Workers typically are assigned to a narrow range of tasks and work with highly specialized equipment.

Examples: Automobile and computer assembly lines, insurance home office. Continuous flow (flow shop)

Commodity like products flow continuously through a linear process. This type of process will theoretically run for 24 hrs / day, 7 days / week and 52 weeks / year and, whilst this is often the objective, it is rarely achieved.

Examples: chemical, oil, and sugar refineries, power and light utilities.

These four categories represent points on continuum of process organizations. Processes that fall within a particular category share many

Characteristics that fundamentally influence how a process should be managed. The second and similar classification divides production processes into: Process Production

Processes that operate continually to produce a very high volume of a standard product are termed “Processes”. This type of process involves the continuous production of a commodity in bulk, often by chemical rather than mechanical means, such as oil and gas. Extra examples of continuous processes oil refinery, electricity production and steel making.

Mass Production

It is conceptually similar to process production, except that discrete items such as motorcars and domestic appliances are usually involved. A single or a very small range of similar items is produced in very large numbers. In other words, processes that produce high-volume and low-variety products are termed line or mass processes. Because of the high volumes of product it is cost-effective to use specialized labor and equipment.

Batch Production

Processes that produce products of medium variety and medium volume are termed “batch processes”. It occurs where the number of discrete items to be manufactured in a period is insufficient to enable mass production to be used. Similar items are, where possible, manufactured together in batches. In other words, batch processes cover a relatively wide range of volume and variety combination. Products are grouped into batches whose batch size can range from two to hundreds.

Jobbing Production (Project Type Production)

Processes that produce high-variety and low-volume products are known as “jobbing”. Although strictly consisting of the manufacture of different products in unit quantities (in practice corresponds to the intermittent process mentioned above). This type of production assumes a one-of-a-kind production output, such as a new building or developing a new software application. The equipment is typically designed for flexibility and often general purpose, meaning it can be used for many different production requirements.

Often, it is a practice that a firm has more than one type of operating process in its production system to manage the resources optimally. Sometime, the labor may not be available; on other occasion, the raw material may be short; market may slow down or go up exponentially. For instance, a firm may use a repetitive-flow process to produce high volume

parts but use an intermittent-flow process for lower-volume parts.

A link often exists between a firm's product line and its operating processes. Job shop organizations are commonly utilized when a product or family of products is first introduced. As sales volumes increase and the product's design stabilizes, the process tends to move along the continuum toward a continuous-flow shop. Thus, as products evolve, the nature of the operating processes used to produce them evolves as well.

Efficiency of the production process

The creation of goods and services requires changing resources into goods and services. Productivity is used to indicate how good an operation is at converting inputs to outputs efficiently. The more efficiently we make this change the more productive we are. The production/operations manager's job is to enhance (improve) this ratio of outputs to inputs.

Productivity: It is the ratio of outputs (goods and service) divided by one or more inputs (such as labor, capital or management)

Productivity is a measure of operational performance. Thus improving productivity means improving efficiency. This improvement can be achieved in two ways:

1. Reduction in inputs while output remains constant, or
2. Increase in output while inputs remain constant.

Both represent an improvement in productivity. Production is the total goods and services produced. High Production may imply only that more people are working and that employment levels are high (low unemployment), but it does not imply high productivity.

Productivity measures can be based on a single input (Single Factor Productivity or Partial Productivity) or on more than one input (Multi-Factor Productivity) or on all inputs. The choice depends on the purpose of the measurement.

Single-factor Productivity

It indicates the ratio of one resource (input) to the goods and services produced (outputs).

For example, for labour productivity, the single input to the operation would be employee hours.

Let us Sum Up

In this unit, you have learned the following:

Production and operations management can be defined as conversion of input into output according to demand of the consumers in the market. The purpose of production management is to produce maximum product with a minimum cost. Production function refers to creation of various utility in order to satisfy large number of consumers in the market. Production system refers to optimum utilization of production elements like men, material, machine, money and management in production process so that qualitative production can be possible with a minimum cost. There are different type of production which can be utilized by the production unit in order to have quantitative and qualitative production.

Production management system ensures benefit to the consumers, suppliers, employees, organization and society. The duties and responsibilities of a production manager is to look after plant, product, process, program and people so that the product can be available in time in a desirable cost. It is necessary to take different decisions during production system. The decisions are strategic decisions, operational decisions and controlled decisions which can help the production manager in order to produce qualitative product with a low cost.

Check your Progress

1. Which of the following functions of Production Planning and Control is related to the timetable of activities_____.
2. Which of the following processes is not a part of the Production Planning and Control system_____.
3. The objectives of Production Planning and Control are _____

Glossary

Types of Production systems: There are three common types of basic production systems: the batch system, the continuous system, and the project system.

Process Planning: Process planning is a preparatory step before manufacturing, which determines the sequence of operations or processes needed to produce a part or an assembly. This step is more important in job shops, where one-of-a-kind products are made or the same product is made infrequently.

Boundary of the operations system: The boundary drawn in around the transforming process can be thought of as the boundary of the

organization, so that the whole organization is viewed as an operations system, with its customers external to it.

Model Questions

1. Define production management system.
2. What is production process?
3. What do you mean by place utility?
4. Justify the concept of knowledge utility.

Answers To Check Your Progress

1. Scheduling
2. Integration of processes
3. All of the above

Suggested Readings

1. Boyer et al. (2011) Operations Management: Strategy, Global Supply Chain and Service Operations 1st Edition, Cengage Learning
2. Gerard. C and Christian. T, (2018), Matching Supply with Demand: An Introduction to Operations Management, McGraw Hill
3. Roger Schroeder, Susan Goldstein, M. Johnny Rungtusanatham (2019). Operations Management, McGraw-Hill Education

Unit-3
Operations Strategy

STRUCTURE

Overview

In this Unit discuss about what is Operations Strategy, Operations Management vs Operations Strategy.

Objectives

After completion of this Unit you will be able to explain:

- How the a strategy will work out at a company
- How to frame a operational strategy and
- The Effects of a strategy

3.1. What is Strategy?

Strategy can be defined as follows (Johnson et al., 2008)

'Strategy is the direction and scope of an organization over the long term: ideally, which matches its resources to its changing environment, and in particular its markets, customers or clients so as to meet stakeholder expectations.'

Strategy can be seen to exist at 3 main levels of corporate, business and functional:

Corporate level Strategy

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

Business Level Strategy

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

Functional Level Strategy

This is where the functions of the business (e.g. operations, marketing, and finance) make long-range

Plans which support the competitive advantage being pursued by the business strategy- How does the function contribute to the business strategy?

What is Operations Strategy?

Operations strategy is the total pattern of decisions which shape the long-term capabilities of any type of operation and their contribution to overall strategy, through the reconciliation of market requirements with operations resources (Slack and Lewis, 2011).

From the previous definition operations, strategy is concerned with the reconciliation of market requirements and operations resources. It does this by:

Satisfying market requirements (measured by competitive factors) by setting appropriate performance objectives for operations

Taking decisions on the deployment of operations resources which effect the performance objectives for operations

Using a market-based approach to operations strategy an organization makes a decision regarding the markets and the customers within those markets that it intends to target. The organization's market position is one in which its performance enables it to attract customers to itsproducts or services in a more successful manner than its competitors. Competitive factors are how a product/service wins orders (for example price, quality and delivery speed). A resource- based view of operations strategy works from the inside-out of the firm, rather than the outside- in perspective of the market-based approach. Here there is an assessment of the operations decisions regarding:

- Structural decisions - physical arrangement and configuration of resources.

- Infrastructural decisions - activities that take place within the operation's structure.

The nature and complexity of formal and informal processes and tangible and intangible resourcesis central to the resource- based view of strategy; that is externally unobservable (within firm) factors are at least as important as observable industry market (between firm) factors in determining competitive advantage. It has been found that not all companies pursue strategy in accordance with a pure market-based approach and it has been found that competitiveness is not just a matter of simply improving performance along specific competitive dimensions in response to market needs, but incorporates the development of capabilities that provide specific operating Advantages. Thus the resource-based view of strategy is that operations take a more active role in providing long-term competitive advantage.

What makes the development of operation strategy particularly challenging is that not only should the market-based and resource-based views of strategy need to be considered at a point in time, but the changing characteristics of markets and the need to develop operations capabilities over time means a dynamic, as well as a static view of strategy, is required.

3.2. Operations Strategy - Formulation

There are many alternative procedures for developing an operations strategy for a particular organization. These will generally require an analysis of market requirements (marketing) and the operation's resource capabilities (operations). The procedure covered here is the Hill framework.

Hill framework for Operations Strategy Formulation

Hill (2005) provides an iterative framework that links together the corporate objectives; which provide the organizational direction, the marketing strategy; which defines how the organization will compete in its chosen markets, and the operations strategy; which provides capability to compete in those markets.

The framework consists of five steps:

a) Define corporate objectives

b) Determine marketing strategies to meet these objectives

c) Assess how different products win orders against competitors

d) Establish the most appropriate mode to deliver these sets of

products

e) Provide the infrastructure required to support operations

***Step 1:* Corporate Objectives**

Step 1 involves establishing corporate objectives that provide a direction for the organization and performance indicators that allow progress in achieving those objectives to be measured.

The objectives will be dependent on the needs of external and internal stakeholders and so will includefinancial measures such as profit and growth rates as well as employee practices such as skills Development and appropriate environmental policies.

Step 2: Marketing Strategy

This involves identifying target markets and how to compete in these markets.

Step 3: How Do Products Win Orders in the Market Place?

This is the crucial stage in Hill's methodology where any mismatches between the requirements of the organization's strategy and the operations' capability are revealed. This step provides the link between corporate marketing proposals and the operations processes and infrastructure necessaryto support them.

This is achieved by translating the marketing strategy into a range of competitive factors (e.g. price, quality, delivery speed) on which the product or service wins orders. These external competitive factors provide the most important indicator as to the relative importance of the internal operations performance objectives.

The five basic internal operation's performance objectives allow the organization to measure its operation's performance in achieving its strategic goals. The performance objectives are Quality, Speed, Dependability, Flexibility and Cost.

At this stage it is necessary to clarify the nature of the markets that operations will serve by identifying the relative importance of the range of competitive factors on which the product or service wins orders. Hill distinguishes between the following types of competitive factors which relate to securing customer orders in the marketplace.

Order-winning factors – They are key reasons for customers purchasing the goods or services and raising the performance of the order-winning factor may secure more business

Qualifying factors – Performance of qualifying factors must be at a certain

level to gain business from customers, but performance above this level will not necessarily gain further competitive advantage.

From the descriptions above it can be seen that it is therefore essential to meet both qualifying and order-winning criteria in order to be considered and then win customer orders.

***Step 4:* Delivery System Choice (Structural Decisions) and Step 5 Infrastructure choice (Infrastructural Decisions)**

Steps 4 and 5 of Hill's methodology involves putting the processes and resources in place which provide the required performance as defined by the performance objectives. Hill categorizes operations decision areas into delivery system choice, (structural decisions) and infrastructure choice (infrastructural decisions).

Delivery system choice concerns aspects of the organization's physical resources such as service delivery systems and capacity provision (chapter 10). Operations Infrastructural decisions describe the systems, policies and practices that determine how the structural elements covered in step 4 are managed

Lean Operations

The term Lean was first used by John Krafcik in his article "Triumph of the Lean Production System" which appeared in 1988. This paper found that productivity and quality levels in car assembly plants was not determined by an assembly plant's location. However plants that operated with a "lean" production policy were able to manufacture a wide range of models, yet maintain high levels of quality and productivity.

The message was further disseminated by the book "The Machine That Changed the World" (1991) by Womack & Roos. The term 'lean' approach aims to meet demand instantly, deliver perfect quality and eliminate waste in all its forms.

Three key elements of Lean Operations are eliminate waste, involve everyone and continuous improvement.

Eliminate Waste

Waste is considered as any activity which does not add value to the operation. Oh no (1988) classified 7 wastes, the priority should be to avoid these wastes, only then to cut:

- Overproduction – making too much too early
- Waiting – Need to keep a flow of material/customers
- Unnecessary Motions – ergonomics and layout

- Transporting – unnecessary movements/handling
- Processing – Too much capacity in one machine instead of a number of smaller ones
- Inventory – Raw material, work in progress and finished goods
- Defects – costs of defects tend to escalate the longer they remain undetected

The 7 service customer wastes can be the basis for an improvement programme (Bicheno, 2008):

- *Delay* on the part of customers waiting for service, for delivery, in queues, for response,not arriving as promised.
- *Duplication*. Having to re-enter data, repeat details on forms and answering queries from several sources within the same organization.
- *Unnecessary movements*. Queuing several times, poor ergonomics in the serviceencounter.
- *Unclear communication* and the wastes of seeking clarification.
- *Incorrect inventory*. Out-of-stock, unable to get exactly what is required, substituteproducts or services.
- *Opportunity lost* to retain or win customers, failure to establish rapport, ignoringcustomers, unfriend lines, and rudeness.
- *Errors* in the service transaction, product defects in the product-service bundle, lost ordamaged goods.

Involvement of Everyone

Some organizations view the lean approach as consisting almost exclusively of waste elimination.However effective waste elimination is best achieved through changes in staff behavior.

Lean aimsto create a new culture in which all employees are encouraged to contribute to improvement effortsthrough generating ideas. In order to undertake this level of involvement the organization will provide training to staff in a wide range of areas, including techniques such as statistical process control (SPC) and more general problem solving techniques.

Continuous Improvement (CI)

Continuous Improvement or Kaizen, the Japanese term, is a philosophy which believes that it is possible to get to the ideals of Lean by a continuous stream of improvements over time.

Continuous Improvement is needed because customer's views are continually changing and standards are rising. Kaizen is about moving tacit knowledge to explicit knowledge

- Tacit – 'Know-How' based on years of experience but may not be written down
- Explicit – Written down in principles and procedures

CI enables ideas held tacitly to be explicitly incorporated by the organization. Principles for implementing a continuous improvement effort include:

- *Create a mind-set for improvement*. Do not accept that the present way of doing things isnecessarily the best.
- *Try and try again*. Don't seek immediate perfection but move to your goal by smallimprovements, checking for mistakes as you progress.
- *THINK*. Get to the real cause of the problem - ask why? five times.
- *Work in Teams*. Use the ideas from a number of people to brainstorm new ways.
- *Recognize that improvement knows no limits*. Get in the habit of always looking for betterways of doing things.

Visual control is used to facilitate continuous improvement work. Visibility is achieved through what is called the five S's (seiri, seiton, seiso, seiketsu, shitsuke) which roughly translate as organisation, tidiness, cleanliness, maintenance and discipline.

To achieve these factors visibility measures include Andon signs (colored lights), control systems such as the Kanban and performance charts such as Statistical Process Control (SPC) charts.

Implementing Lean

As stated earlier the 'lean' approach aims to meet demand instantly, deliver perfect quality and eliminate waste in all its forms. One of the ways it does this is through replacing the traditional

Push production system with a pull production system sometimes called 'lean synchronization'. Other techniques include setup reduction and total preventative maintenance.

Push Production Systems

In a push production system a schedule pushes work on to machines which is then passed throughto the next work center.

At each production stage a buffer stock is kept to ensure that if any production stage fails then the subsequent production stage will not be starved of material.

The higher the buffer stocks kept at each stage of the line, the more disruption can occur without the production line being halted by lack of material.

Advantages

- Buffers insulate stages against disruption in other stages

Disadvantages

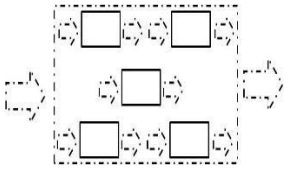
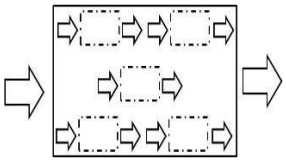
- Because buffers insulate system from problems the problems are not visible so no onetakes responsibility for fixing them.
- Buffer stock leads to high inventory and slower lead times
- Production is not connected to demandAdvantages
- No buffers so problems visible (whole line stops) so people take responsibility for fixingthem.
- No or low buffer stock leads to low inventory and faster lead times
- Production is connected (pulled) to demand Disadvantages
- No protection against unforeseen disruptions to supply chain

3.3. Operations Management Vs Operations Strategy

- To provide a plan for the *operations function* so that it can make the best use of itsresources.
- To make sure that all the tasks performed by the operations function are the right tasks – Operational effectiveness and strategy must be aligned
- To specifies the policies and plans for using the organization's resources to support itslong-term competitive strategy
- To align with the company's business strategy and enable the company to achieve itslong-term plan.

Operations Function – Managing the resources needed to produce the company's products orservices.

Operations – Management Vs. Strategy

Activity	Operations Management	Operations strategy
Capacity decisions	Short – term (1-12 Months)	Long-term (1-10 Years)
Level of analysis	 Micro level of the process	 Macro level of the total operation
Demand – Time	1-12 Months	1-10 Years
Level of aggregation	Detailed	Broad
Level of abstraction	Concrete	Philosophical
Operational	Operational effectiveness – The ability to perform operations tasks more efficiently than competitors.	Strategy, on the other hand, is a plan for competing in the marketplace. So Operational effectiveness and strategy must be aligned.

3.4. The Framework of Operations Strategy

Strategy Steps for formulation

- Define corporate objectives (Operations performance objectives) based on missions
- Determine marketing strategies to meet these objectives
- Assess how different products against competitors
- Provide the structure required to support operations
- Provide the infrastructure required to support operations Driving test

3.5. Factors affecting production and Operations Management Today

Having understood the nature and types of production systems and also various kinds of decisions made by operations managers, it is necessary to know the factors affecting POM today. Of the many factors affecting POM today, six factors are significant. They are :

1. Reality of global competition,
2. Quality, customer service and cost challenges,
3. Rapid expansion of advanced production technology,
4. Continued growth of service sector,
5. Scarcity of production resources, and
6. Social responsibility issues.

The impact of these factors on production and operations management today is discussed ingreater detail in the following paragraphs.

1. Reality of Global Competition

The world is rapidly transforming itself into a single global economy which is also referred to as a global village or global landscape. Markets once dominated by local or domestic firms are now vulnerable to competition from firms in all corners of the world. A country's borders no longer provides protection from intense competition from foreign firms. To succeed in global competition, companies must offer quality products at reasonable costs. Also, as companies expand their business to include foreign markets, so too must the operations management function take a broader, more global perspective in order for companies to remain competitive. The trend towards globalization has placed increased emphasis on the logistics of where to locate facilities and the issues associated with moving materials over long distances.

2. Quality, Customer Service and Cost Challenges

Another key factor affecting POM today is quality. Successful firms now recognize that quality is no longer limited to the POM function, but is important in all functional areas throughout the entire Production and Operations Management organization, a new concept known as total quality management (or TQM in short). However, POM is primarily responsible to ensure that the firm is able to produce the products in the required quantities, in the required quality level, delivering the products to the customers at the desired time schedule and at the minimum possible cost.

Quality is no longer limited to the technical requirements of the goods being produced on the manufacturing shop floor. Service quality (i.e., how we deal with our customers on a wide variety of issues affecting customer satisfaction) is equally important. How companies integrate product quality and service quality, to properly meet the needs of the customers is a major challenge to today's managers. Improving quality in all respects of the business improves customer satisfaction and increases customer loyalty. Today's customers are demanding better quality, more variety and increased responsiveness to their needs — all at lower prices.

3. Rapid Expansion of Advanced Production Technology

Advances in technology in recent years have also had a significant impact on the POM function. Computer Numerical Control (CNC) technology, increased automation and robotics have enabled the companies to improve the quality of products that are being manufactured. Information technology facilitates collection of data on individual customers so that the products can be mass customised to meet the needs of individual customers.

However, advances in technology place new requirements on the workforce and even on customers especially in service operations. For example, skilled workers are replacing unskilled workers in all types of operations. Employees must now have computer skills to use internet and carryout e-business. An organization’s workforce is nowadays becoming more and more educated and should be considered as its most valuable asset.

4. Continued Growth of Service Sector

The service sector is now growing far more rapidly than the manufacturing sector and more and more workforce is now employed in the service sector. For example, the motion picture industry employs more people in the United States than does the auto parts industry. Computer software service is the fastest growing service in the service sector.

Even though the majority of issues and concerns faced by managers in both the service sector andthe manufacturing sector are the same, the special nature of services imposes additional constraints which vary with the kind of service provided.

5. Scarcity of Production Resources

Operations managers are faced with the problem of scarce production resources and matching the production resources with anticipated product demand. They are constrained to obtain the scarce resources

such as materials and labour at the minimum possible cost and utilise the same with maximum efficiency. Operations managers nowadays devote much of their energy to inventory and materials management, scheduling operations and personnel, reduce wastage of materials and labour, cut costs and improve productivity in order to improve the competitive positions of their companies. They are responsible to prepare intermediate plans to consider whatto buy, from whom to buy, when to buy and how much to buy to manage the scarce material resources and also to co-ordinate personnel decisions such as hiring, lay-offs overtime and subcontracting to make best use of the human and equipment resources.

6. Social Responsibility Issues

A new challenge facing operations managers is to make production systems environmentally compatible, yet efficient. This can be achieved by reducing production of harmful by-products, recycling waste materials and energy, reducing packaging, using closed water systems for cooling and waste discharge and even scheduling employee work hours to reduce traffic and air pollution. Using environmentally sound production methods is not only the social responsibility but also a means of achieving economic benefits. The other ethical issues arising in many aspectsof operations management are :

a. **Worker Safety:** Providing adequate training, maintaining equipment in good working conditions and maintaining a safe working environment.

b. **Product Safety:** Providing products that minimise risk of injury to user or damage to propertyor the environment

c. **Quality:** Honouring warranties, avoiding hidden defects.

d. Obeying government regulations, regarding regulation of environment.

e. **The Community:** Being a good neighbour, providing employment opportunities to the localpeople and improving the standard of living of the community surrounding the company.

f. **Closing Facilities:** Taking into account the impact on the community and honoringcommitments that have been made.

To conclude, we can summaries the current issues facing operations managers are as below.

1. Speeding up the time it takes to get new products into production.

2. Developing flexible production systems to enable mass customization of products and services.
3. Managing global production networks and managing the supply chain (i.e., managing the flow of information, materials and services from material suppliers through factories and warehouses to the end customer).
4. Developing and integrating new process technologies into existing production systems.
5. Achieving high quality quickly and keeping it up in the face of restructuring (i.e., achieving quality parity with the competition through total quality management).
6. Managing a diverse workforce.
7. Conforming to environmental constraints, ethical standards and government regulations.

Why is operations excellence fundamental to strategic success?

'Operations' is the activity of managing the resources and processes that produce and deliver goods and services. All operations transform resource inputs into outputs of products and services and can be analyzed at three levels: that of the business itself; as part of a greater network of operations; and at the level of individual processes within the operation.

Operations management contributes to the success of any organization by reducing costs, by increasing revenue by reducing capital employed and by providing the basis for future innovation.

What is strategy?

Strategic decisions are those that set broad objectives that direct an enterprise towards its overall goal, plan the path that will achieve these goals, stress long-term rather than short-term objectives and deal with total picture rather than with individual activities, and are often seen as above or detached from routine day-to-day activities. However, it is not easy to totally characterize strategy or strategic decisions. Some organizations make no explicit strategic decisions, as such. Rather, they develop over time, often with strategies that 'emerge' from their ongoing experience of doing business. Furthermore, the strategy that is espoused by an organization may not always be reflected in what it actually does. This is why strategy is often taken to be the 'pattern of decisions' that indicate the company's overall path.

What is operations strategy?

Operations strategy is the total pattern of decisions that shape the long-term capabilities of any kind of operation and their contribution to overall strategy, through the ongoing reconciliation of market requirements and operation resources. All businesses have markets, all businesses own or deploy resources; therefore, all businesses are concerned with the reconciliation of markets and resources.

How should operations reflect overall strategy?

An operations strategy will be one of several functional strategies that are governed by the decisions that set the overall strategic direction of the organization. This is called the 'top-down'

Approach. So, corporate strategy should be reflected in the strategies of each business unit, which should, in turn, inform the strategy of each business function.

Operations strategy how can operations strategy learn from operational experience?

An alternative view to the top-down perspective (one that is based on observing how strategy happens in practice) is the bottom-up perspective, which stresses how strategic ideas emerge over time from actual experiences.

Companies adopt strategies partly because of their ongoing experience, sometimes with no high-level decision making involved. The idea of strategy being shaped by experience over time is also called the concept of emergent strategies. Shaping strategy from the bottom up requires an ability to learn from experience and a philosophy of continual and incremental improvement.

How do the requirements of the market influence operations strategy?

Two important elements within markets are customers and competitors. The concept of market segmentation is used to identify target markets that have a clear set of requirements and where a company can differentiate itself from current, or potential, competitors. On the basis of this, the company takes up a market position.

This market position can be characterized in terms of how the company wishes to compete for customers' business. By grouping competitive factors into clusters under the heading of generic performance objectives (quality, speed, dependability, flexibility and cost), market requirements are translated into a form useful for the development of the operation.

How can the intrinsic capabilities of an operation's resources influence operations strategy?

Over time, an operation may acquire distinctive capabilities, or competences, on the basis of its resources and the accumulation of its experiences. These capabilities may be embedded within a company's intangible resources and its operating 'routines'. So, they concern both what the operation has and what it does.

'Operations' shapes these capabilities (consciously or unconsciously) through the way it makes a whole series of decisions over time. These decisions can be grouped under the headings of capacity, supply network, process technology and development and organization.

What is the 'content' of operations strategy?

The 'content' of operations strategy is the building block from which any operations strategy willbe formed. This includes the definition attached to individual performance objectives, together with a prioritization of those performance objectives. It also includes an understanding of the structure and options available in the four decision areas of capacity, supply networks, process technology and development and organization.

Performance objectives and decisions areas interact in a way that can be described by the operations strategy matrix. When devising an operations strategy it is important to ensure that, in terms of the matrix, the strategy is comprehensive (all obvious aspects are at least considered) and has the critical intersections identified.

What is the 'processes of operations strategy?

The 'process' of operations strategy are the procedures that are, or can be, used to formulate operations strategy. It determines how an operation pursues the reconciliation between its market requirements and operations resources in practice. The practical reality of putting operations strategies together and making them happen in practice is complex, but, at a simple level, has four stages: formulation, implementation, monitoring and control. The success of effective operations strategy process is also closely linked to the style and skills of the leaders who do it.

How is operations strategy developing?

Although the 'mainstream' view of operations strategy is straightforwardly the strategic management of the operation's resources and processes, the subject can still be interpreted in different ways. For example, operations strategy can be interpreted as being equivalent to 'supply

strategy', or 'functional strategy', or as the firm's 'operating model', and as 'strategy execution'.

Let Us Sum Up

In this Unit you have learned about the How the a strategy will work out at a company, How to frame a operational strategy and the effects of a strategy

Check Your Progress

1. The correct sequence of operations in the Production Planning and Control process is _____.
2. Production Planning and Control function is crucial for ensuring cost savings and efficiency in _____.
3. The control activity in Production Planning and Control is performed _____ of the plan.

Glossary

Cost-effectiveness. For many companies, their goals and benchmarks are all tied to the bottom line. The responsibility of the operations manager is to ensure all processes across the company are being handled most cost-effectively.

Organization and Efficiency: These terms can be used very broadly, but for operations managers, they often mean the ability to remain organized across a variety of different tasks and ensuring things are completed in the most efficient way possible. This doesn't always mean taking something on yourself. It can also lend itself to appropriate hand-offs, using software to ease the burden, or even removing certain tasks entirely.

Compliance: Depending on your industry, compliance will be something that the operations manager should not only understand but have full management over. You'll want to ensure the processes you create as an operations manager are compliant based on any rules

and regulations your company is expected to follow.

Objective planning: As companies plan to become more efficient and profitable, they will often look to create objectives they're hoping to achieve in a certain amount of time. The operations manager will play a big role in formulating both strategic and operational objectives across the teams. They'll be the level-headed player in these discussions, often determining what objectives are realistic, and what might be unattainable.

Profitability: Although profitability could be argued as a responsibility in each of these listed so far, it's still something an operations manager should be monitoring. Operations managers may be tasked with examining financial data and using the numbers to help increase the company's profitability in several ways.

Budgets: Financial budgets are sometimes managed at the team level, but an operations managershould still review them before they are finalized. To maintain efficiency and gain profitability, budget management must be monitored consistently. This often falls into the operations manager's bucket.

Quality control and KPIs: The operations manager will typically be required to perform quality control checks and monitor specific KPIs. These playback into profitability, budget, and planning.

Training and recruitment: Many operations managers also act as an arm of human resources (HR) so they may be tasked with things like recruiting, employee training, as well as general supervision of staff. Since they are familiar with the specific details of the company's process, they are often the ideal individual to take on these responsibilities.

Customer service: To be profitable, you need customers. An

operations manager might be tasked with increasing the quality of customer service. This can include any number of thingslike re-training employees, soft skills or sales training, and more.

Model Questions

1. Define the terms "Production", "Production system" and "Production Management".
2. Discuss the following views of the nature of production:
   a. Production as a system.
   b. Production/operations as an organizational function.
   c. Production/operations as a conversion process.
   d. Production/operations as a means of creating utility.
3. What is a "Production function"? State its importance.
4. Discuss the statement "Production is a means of creating utility."
5. State the objectives of production/operations management.

Answers to Check Your Progress

1. Routing – Scheduling – Dispatching – Follow up
2. Production
3. After execution

Suggested Readings

1. Ajay Garg (2020). Production and Operations Management, Tata McGraw-Hill Education,
2. Stevenson J. William (2007), Operations Management, th Edition, TMH,
3. Lee J. krajewski and Larry P.Ritzman, (2007), Operations Management strategy and analysis, th Edition,Pearson Education / Prenctice Hall of India.

Block-2: Introduction

Block-2: Location, Layout and Forecasting - has been divided in to Three Units.

Unit-4: Plant Location – Factors influencing location – Plant Layout deals with Plant Location, Need for the plant location analysis, Factors influencing Manufacturing Plant Location and Plant Layout.

Unit-5 : Types of Layout – Forecasting – Forecasting technique: Qualitative and Quantitative explains about Types of layout, Introduction to Production Planning, Objectives of Production Planning, Characteristics of a good production plan, Key factors of a production plan, Planning activities, Communicate the plan, Forecasting, Forecasting Methods and Categories of Forecasting Methods.

Unit-6: Delphi Method – Regression Analysis – Forecasting Error presents about Delphi Technique: Definition, History, Characteristics, History of Delphi technique, Characteristics of the Delphi technique, Uses of Delphi technique, What is Regression Analysis?, A decision about Independent Variables, Intercept or Constant, Interpretation and Assessment, Forecast error and How do you calculate forecast error?.

In all the units of Block -2 **Location, Layout and Forecasting**, the Check your progress, Glossary, Answers to check your progress and Suggested Reading has been provided and the Learners are expected to attempt all the Check your progress as part of study.

Unit-4
Plant Location Analysis

STRUCTURE

Overview

In this Unit what is Plant Location, Factors influencing location, Plant Layout been explained in detail.

Objectives

After reading this lesson, you will be able to:

- Understand the meaning and definition of Plant Location
- Understand the need for Plant Layout

4.1. Plant Location

Every business is facing the issue of selecting the suitable location for their factory plant. Units concerning both manufacturing as well as the assembling of the products are on a very large scale affected by the decisions involving the location of the plant. Location of the plant itself becomes a very important factor concerning service facilities, as the plant location decisions are strategic and long-term in nature. Plant location refers to the choice of region and the selection of a particular site for setting up a business or factory. An ideal location is on where the cost of the product is kept to minimum, with a large market share, the least risk and the maximum social gain. It is the place of maximum net advantage or which gives lowest unit cost of production and distribution. For

achieving this objective, small-scale business can make use of location analysis for this purpose.

The strategic nature of the decision on Plant location, require very detailed analysis due to several reasons. But the choice is made only after considering various costs associated and comparing the benefits of different alternative sites. It is a strategic decision that cannot be changed once taken. If changed, it can happen at the cost of huge cash outflow as well as considerable deployment of various firm's resources. Each individual plant is a case in itself. The major reasons are,

1. Wrong plant location generally affects cost parameters i.e. poor location can act as a continuous stimulus of higher cost. Marketing, transportation, quality, customer satisfaction are some of the other factors which are greatly influenced by the plant location decisions – hence these decisions require in-depth analysis.
2. Once a plant is set up at a location which is not much suitable, it is a very disturbing as well as very expensive process to shift works of a company to some other place, as it would largely affect the cycle of production.
3. The investments involved in the in setting up of the plant premises. buying of the land etc. are very large and especially in the case of big multinational companies, the investments can go into millions of rupees, so economic factors of the location should be very minutely and carefully checked and discussed in order to achieve good returns on the money which has been invested.

4.2. Need for the Plant location Analysis

Location analysis is a dynamic process where the business analyses and compares the appropriateness or otherwise of alternative sites with the aim of selecting the best site for a given firm. It consists of the following:

Demographic Analysis

It involves study of population in the area in terms of total population, age of the population group, per capita income of the state, country and at times, the district, adjacent district per capita incomes, educational level, occupational structure etc. This will give an insight about the market, availability of manpower and composition of trained manpower.

Trade Area Analysis

It is an analysis of the geographic area that provides continued clientele

to the firm. The business would also see the feasibility of accessing the trade area from alternative sites. It involves the transportation cost, mode of transportation, availability of infrastructure such as road, railway lines and sea and air ports and facilities such as storages, climate condition, which may also influence the firm's decision.

Competitive Analysis

It helps to judge the nature, location, size and quality of competition in a given trade area.

Traffic analysis

To have a rough idea about the number of potential customers passing by the proposed site during the working hours of the shop, the traffic analysis aims at judging the alternative sites in terms of pedestrian and vehicular traffic passing a site. This will give an idea about how other business units evaluate the site.

Site economics

Alternative sites are evaluated in terms of establishment costs and operational costs under this. Costs of establishment is basically cost incurred for permanent physical facilities but operational costs are incurred for running business on day to day basis, they are also call d as running costs.

4.3. Factors influencing Manufacturing plant location

Plant location decisions are needed when a new plant is to be set up or when the operations involved in the company at the present location need to be expanded but expansion becomes difficult because of the poor selection of the site for such operations. These decisions are sometimes taken because of the social or the political conditions engulfing the working of a company.

The way the works of a company have to be performed, largely depends upon the industrial policies issued by the government. Any change that creeps in the industrial policy of the government which favors decentralization and hence does not permit any change or any expansion of the existing plant – requires strictly evaluated location decisions. We will broadly put the factors into four heads;

Operational Factors

Operational factors that play a key role in factory location or relocation are diverse, touching on everything from cost consciousness and labor management to strategic direction and regulatory compliance. Other

elements in the plant opening equation include government stimulus programs such as fiscal incentives -- and geographical convenience availability of land / power and other related infrastructure. A company's top brass may take various steps to analyze plant location issues and remedy problems with factory site selection. Senior executives may develop an objective understanding of the best locations to pick, why some sites are inappropriate, how to avert logistical nightmares with respect to worker commutes and how the site-search team can collaborate effectively with corporate manufacturing personnel to make the search a success.

1. Availability of qualified employees
2. Stable climate
3. Secure area due to good policing
4. Socially acceptable in the surrounding region Materials Management.

Materials management deals with the mixture of processes and tools a company relies on to determine how much merchandise it has at a given point, to instill in warehouse personnel the need to prevent product decay, to arrange for shipping companies to quickly access storage areas and to expand factory capacity while heeding the importance of profit management and sales growth. Simply put, materials administration helps the business produce items it can sell, minimize waste and make more money. Materials falling under the items management function include finished goods, work-in-process merchandise and raw materials.

1. Raw material availability and the transport of these resources to the plant at minimal cost
2. Forecast of present and future demand and supply of theproduct being produced.
3. Availability of waste disposal sites: the manufacturing plant must be as environmentally aspossible
4. Availability of governmental support, tax benefits, and other incentives Connection

Plant location considerations connect with the material management work stream in corporate processes, especially in businesses with a large manufacturing base or those relying heavily ona continued stream of supplies to make money. Examples include large grocery stores and multi- channel food distribution centers.

The operational symbiosis between the two concepts often helps

corporate management do away with the primary dilemma of modern business management: how to produce goods quickly and not too far from distribution centers so customers can have them when needed.

1. Availability of the market and potential for future growth
2. The cost of transporting goods and services to people must be minimal
3. Competition analysis in the region using relevant market intelligence.

Deal Economics

Before locating -- or relocating -- a factory or production process, company principals sit department heads and business consultants at a table, asking them to ponder costs associated with the move. Senior executives focus on clarity of thought and idea generation and do not let the group trundle off with a hazy idea of what relocation expenses will be. In this context, deal economics includes things like land cost, factory construction, labor expense, fiscal implications and production capacity.

1. Land availability in terms of future expansion of the plant and the ability of the soil to supporta factory
2. Labor and raw material availability and the transport of these resources to the plant atminimal cost
3. Availability of transportation and communication facilities like airports, railway, telephone,etc
4. Availability of infrastructure: running water, electricity, schools, hospitals, libraries, etc.

Furthermore, political, technical and economic considerations must also be taken into account before setting up a new manufacturing plant.

4.4. Plant Layout

The efficiency of any production system depends on well-organized factors such as various machines, production facilities and employee's amenities located in a plant. Properly laid out plant can ensure the smooth and rapid movement of material, from the raw material stage to the end product stage. Plant layout deals with new layout as well as improvement in the existing layout.

Plant layout can be defined as the arrangement of physical facilities such as machinery, equipment, furniture etc. within the factory building in such a manner so as to have quickest flow of material at the lowest cost and

with the least amount of handling in processing the product from the receipt of material to the shipment of the finished product.

Overall objective of plant layout is to design a physical arrangement that most economically meets the required output – quantity and quality. Plant layout ideally involves allocation of space and arrangement of equipment in such a manner that overall operating costs are minimized.

The problems related to plant layout are generally observed because of the various developments that occur. These developments generally include adoption of the new standards of safety, changes in the design of the product, decision to set up a new plant, introducing a new product, withdrawing the various obsolete facilities etc.

Objectives of a good plant layout

1. Proper and efficient utilization of available floor space 2. Giving good and improved workingconditions
2. To ensure that work proceeds from one point to another point without any delay
3. Provide enough production capacity
4. Minimizing delays in production
5. Reduce material handling costs
6. Reduce hazards to personnel
7. Utilize labour efficiently
8. Increase employee morale
9. Reduce accidents
10. Provide for volume and product flexibility
11. Provide ease of supervision and control
12. Provide for employee safety and health
13. Allow ease of maintenance
14. Allow high machine or equipment utilization
15. Improve productivity

Sometime, providing comfort to the workers and catering to worker's taste and liking, better control over the production cycle by having greater flexibility for changes in the design of the product may also be objective behind designing the layout.

Principles of a good plant layout

1. A good plant layout is the one which is able to integrate its workmen, materials, machines inthe best possible way.
2. A good plant layout is the one which sees very little or minimum

possible movement of thematerials during the operations.

3. A good layout is the one that is able to make effective and proper use of the space that isavailable for use.
4. A good layout is the one which involves unidirectional flow of the materials during operations without involving any back tracking.
5. A good plant layout is the one which ensures proper security with maximum flexibility.
6. Maximum visibility, minimum handling and maximum accessibility, all form other importantfeatures of a good plant layout.

Let Us Sum Up

In this unit you have learned about the following:

The product development process can be complex and lengthy. It took sixteen years for Bob Montgomery and others at his company to develop the Power Ski Jet board, and this involvedthousands of design changes. It was worth it, though: the Jet board was an exciting, engine- propelled personal watercraft – a cross between a high-performance surfboard and a competition water-ski/wakeboard that received extensive media attention and rave reviews. It was showered with honors, including Time magazine's "Best Invention of the Year" award. Stories about the

Jet board appeared in more than fifty magazines around the world, and it was featured in several movies, over twenty-five TV shows, and on YouTube.

Montgomery and his team at Power Ski enjoyed taking their well-deserved bows for the job they did designing the product, but having a product was only the beginning for the company. The next step was developing a system that would produce high-quality Jet boards at reasonable prices.

Check Your Progress

1. _____ involves anticipating bottlenecks in advance and identifying steps that will ensure a smooth flow of production.
2. Regulating the production process to ensure an orderly flow of materials is the objective of _____.
3. When the size of an organization increases, the functions under production control should _____.

Glossary

Production planning: During production planning, managers determine how goods will be produced, where production will take place, and how manufacturing facilities will be laid out.

Production control: Once the production process is under way, managers must continually schedule and monitor the activities that make up that process. They must solicit and respond to feedback and make adjustments where needed. At this stage, they also oversee the purchasing of raw materials and the handling of inventories.

Quality control: The operations manager is directly involved in efforts to ensure that goods are produced according to specifications and that quality standards are maintained.

Model Questions

1. What is meant by Plant Location?
2. Define Location?
3. State the steps in Plant location?
4. State the advantages of Village Site?

Answer to Check Your Progress

1. Production planning
2. Production control
3. None of the above

Suggested Readings

1. Chase, R.B., Ravi Shankar & Jacobs, F.R. (2018), Operations & Supply Management. 15th Edition,
2. Ravi Anupindi, Sunil Chopra et al (2013) Managing Business Process Flows: Principles of Operations Management, Pearson
3. Edward Pound, Jeffrey Bell, Mark Spearman (2014) Factory Physics for Managers_ How Leaders Improve Performance in a Post-Lean Six Sigma World-McGraw-Hill Education.

Unit-5
Layout and Forecasting

STRUCTURE

Overview

In this Unit what is Types of, Layout, Forecasting, Fore casting technique: Qualitative and Quantitative also been explained in detail.

Objectives

After reading this lesson, you will be able to:

- learn the importance of forecasting for decision making
- use forecasting techniques in operations management
- understand different quantitative techniques of forecasting
- know trend analysis, exponential smoothing, decomposition methods, and causal methodof forecasting
- find out the suitability of forecasting models

5.1. Types of Layout

There are mainly four types of plant layout:

a) Product or line layout

b) Process or functional layout

c) Fixed position or location layout

d) Combined or group layout

Product or Line layout

In an industrial set up, sometime, the machines and equipment are arranged in one line depending upon the sequence of operations required for the product. The raw materials and semi-finished materials move from one workstation to another sequentially without any backtracking or deviation. Under this, machines are grouped in one sequence. Therefore materials are fed into the first machine and finished goods travel automatically from machine to machine, the output of one machine becoming input of the next, e.g. in a paper mill, bamboos are fed into the machine at one end and paper comes out at the other end.

The raw material moves very fast from one workstation to other stations with a minimum work in progress storage and material handling. The grouping of machines is done on following general principles. All the machine tools or other items of equipment's must be placed at the point demanded by the sequence of operations

- There should no points where one line crossed another line.
- Materials may be fed where they are required for assembly but not necessarily at one point.ы All the operations including assembly, testing packing must be included in the line

Advantages of Product layout

1. Low cost of material handling, due to straight and short route and absence of backtrackingы Smooth and continuous operations
2. Continuous flow of work
3. Lesser inventory and work in progress
4. Optimum use of floor space
5. Simple and effective inspection of work and simplified production control Lower manufacturing cost per unit

Disadvantages of Product layout

1. Higher initial capital investment in special purpose machine

(SPM) ы High overhead charges

2. Breakdown of one machine will disturb the production process.
3. Lesser flexibility of physical resources

Thus, these types of layouts are able to make better utilization of the equipment that is available, with greater flexibility in allocation of work to the equipment and also to the workers one should be very cautious about any imbalance caused in one section is not allowed to affect the working of the other sections.

Process or functional layout

In this type of layout machines of a similar type are arranged together at one place.

For example, machines performing drilling operations are arranged in the drilling department, machines performing casting operations be grouped in the casting department. Therefore the machines are installed in the plants, according to various processes in the factory layout. Hence, such layouts typically have drilling department, milling department, welding department, heating department and painting department etc. The process or functional layout is followed from historical period. It evolved from the handicraft method of production. The work has to be allocated to each department in such a way that no machines are chosen to do as many different job as possible i.e. the emphasis is on general purpose machine. The work, which has to be done, is allocated to the machines according to loading schedules with the object of ensuring that each machine is fully loaded.

Advantages of Process layout

1. Lower initial capital investment is required
2. There is high degree of machine utilization, as a machine is not blocked for a single product
3. The overhead costs are relatively low
4. Breakdown of one machine does not disturb theproduction process
5. Supervision can be more effective and specialized.
6. Greater flexibility of resources

Disadvantages of Process layout

1. Material handling costs are high due to backtracking
2. More skilled labor is required resulting in higher costы Work in

progress inventory is high needing greater storage space

3. More frequent inspection is needed which results in costly supervision

Thus, the process layout or functional layout is suitable for factories / businesses which have job order production; that is involving non-repetitive processes and customer specifications and non-standardized products, e.g. tailoring, light and heavy engineering products, made to order furniture industries, jewelry etc.

Fixed position or location layout

Fixed position layout involves the movement of manpower and machines to the product which remains stationary. The movement of men and machines is advisable as the cost of moving them would be lesser. This type of layout is preferred where the size of the job is bulky and heavy. Example of such type of layout is locomotives, ships, boilers, generators, wagon building, aircraft manufacturing, etc.

Advantages of Fixed position layout

1. The investment on layout is very small.
2. The layout is flexible as change in job design and operation sequence can be easily incorporated.
3. Adjustments can be made to meet shortage of materials or absence of workers by changingthe sequence of operations.

Disadvantages of Fixed position layout

1. As the production period being very long so the capitalinvestment is very high.
2. Very large space is required for storage of material andequipment near the product.
3. As several operations are often carried out simultaneously so there is possibility of confusionand conflicts among different workgroups.

Combined or group layout

Certain manufacturing units may require all three processes namely intermittent process (job shops), the continuous process (mass production shops) and the representative process combined process [i.e. miscellaneous shops]. In most of industries, only a product layout or a process layout or a fixed location layout does not exist. Thus, in manufacturing concerns where several products are produced in repeated

numbers with no likelihood of continuous production, combined layout is followed. Generally, a combination of the product and process layout or other combination are found, in practice, e.g. for industries involving the fabrication of parts and assembly, fabrication tends to employ the process layout, while the assembly areas often employ the product layout.In soap, manufacturing plant, the machinery manufacturing soap is arranged on the product line principle, but ancillary services such as heating, the manufacturing of glycerin, the power house, the water treatment plant etc. are arranged on a functional basis.

5.2. Introduction to Production Planning

In any product manufacturing company, considerable time is spent on planning the output to be produced. Production planning means to fix the production goals and to estimate the resources which are required to achieve these goals. It prepares a detailed plan for achieving the production goals economically, efficiently and in time.

It forecasts each step in the production process. It forecasts the problems, which may arise in the production process. It tries to provide remedial measures to resolve these issues. It also tries to remove the causes of wastage.

Thus, Production Planning may be defined as

“Production Planning is concerned with the determination, acquisition and arrangement of all facilities necessary for future operations.”

Production planning provides answers for two major questions, viz.,

- What work should be done?
- How much time will be taken to perform the work?

So, production planning decides the ways and means of production. It shows the direction. It is based on sales forecasting. It is a pre-requisite of production control.

5.3. Objectives of Production Planning

The need, main functions or objectives of production planning in any organization could be: Effective utilization of all the resources in the organization Steady flow of production process without any hurdles / bottlenecks

Estimate the resources – men, machinery and material requirements for the future ы Ensures optimum inventory level, without blocking the organization’s resources

Co-ordinates activities of various departments

- Minimize wastage of raw materials
- Improves the labor productivityы Helps to capture the market
- Provides a better work environment ы Facilitates quality improvement
- Results in consumer satisfactionы Reduces the production costs
- Now let's discuss each objective of production planning one by one

We will give a brief introduction about these points in the following paragraphs.

Effective utilization of resources

Production planning results in effective utilization of resources, plant capacity and equipment's. This results in low cost and high returns for the organization. Thus, the operations manager in charge, need to have discussion with various departments – such as purchases, inventory, sales and human resources to arrive better utilization of all the resources.

Steady flow of production

Production planning ensures a regular and steady flow of production. Here, all the machines are put to maximum use. This results in a regular production, which helps to give a routine supplyto customers. Moreover, to ensure the steady flow, the plan should include an element of human resource plan to maintenance of all the equipment's.

Estimate the resources

Production planning helps to estimate the resources like men, materials, etc. The estimate is made based on sales forecast. So production is planned to meet sales requirements.

Ensures optimum inventory

Production planning ensures optimum inventory. It prevents over-stocking and under-stocking. Necessary stocks are maintained. Stock of raw material is maintained at a proper level in order to meet the production demands. Stock of finished goods is also maintained to meet regular demands from customers.

Co-ordinates activities of departments

Production planning helps to co-ordinate the activities of different departments. For instance, the department has to coordinate with

marketing department to set the targets / goals for production department to sell the goods. This results in profit to the organization.

1. Minimize wastage of raw materials

Production planning minimizes wastage of raw materials. It ensures proper inventory of raw materials and materials handling. This helps to minimize wastages of raw material and ensures production of quality goods. This will result in minimum rejections; thus, proper production planning and control results in minimum wastage.

2. Improves the labor productivity

Production planning improves the labor productivity. Here, there is maximum utilization of manpower. Training is provided to the workers. The profits are shared with the workers in form of increased wages and other incentives. Workers are motivated to perform their best. This results in improved labor efficiency.

3. Helps to capture the market

Production planning helps to give delivery of goods to customers in time. This is because of regular flow of quality production. So the company can face competition effectively, and it can capture the market.

4. Provides a better work environment

Production planning provides a better work environment to the workers. Workers get improved working conditions, proper working hours, leave and holidays, increased wages and other incentives. This is because the company is working very efficiently.

5. Facilitates quality improvement

Production planning facilitates quality improvement because the production is checked regularly. Quality consciousness is developed among the employees through training, suggestion schemes, quality circles, etc.

6. Results in consumer satisfaction

Production planning helps to give a regular supply of goods and services to the consumers at far prices. It results in consumer satisfaction. If the product / brand are not available regularly in the market, it will create lot of chaos in the market and in the consumer mind. Also, there is a scope for the firm to lose the market share to the competitors.

7. Reduces the production costs

Production planning makes optimum utilization of resources, and it minimizes wastage. It also maintains optimum size of inventories. All this

reduces the production costs. Thus, in the planning, elements of financial implications are also involved.

5.4. Characteristics of a good production plan

Any manufacturing or service company success and higher productivity highly depend upon an effective and efficient production plan. Effective planning is fundamental in any business; however, making a plan is not an easy task. It is a complex process that covers a wide range of diverse activities, which relate and link materials, equipment and human resources available in the organization and complete the work. Production planning is like a roadmap to reach destination set by the top management. It helps you know where you are going and how long it will take you to get there.

Advantages of an effective production plan and scheduling:

a. Reduces labor by eliminating wasted time and improving process flow
b. Reduces inventory costs by reducing the need for safety stocks and excessive work-in-processinventories
c. Optimizes equipment usage and maximizes capacity
d. Utilizes human resources to their full potential
e. Improves on-time deliveries of products and services

5.5. Key factors of a production plan

Effective planning hinges on a sound understanding of key activities that entrepreneurs and business managers should apply to the planning process. Here are some examples:

Forecast Market Expectations

To plan effectively you will need to estimate potential sales with some reliability. Most businesses don't have firm sales or service figures. However, they can forecast sales based on historical information, market trends and/or established orders.

Inventory Control

Reliable inventory levels feeding the pipeline have to be established and a sound inventory system should be in place.

Availability of Equipment and Human Resources

Also known as open time, this is the period of time allowed between processes so that all orders flow within your production line or service.

Production planning helps you manage open time, ensuring it is well-utilized, while being careful not to create delays. Planning should maximize your operational capacity but not exceed it. It's also wise not to plan for full capacity and leave room for the unexpected priorities and changes that may arise.

Standardized Steps and Time

Typically, the most efficient means to determine your production steps is to map processes in the order that they happen and then incorporate the average time it took to complete the work. Remember that all steps don't happen in sequence and that many may occur at the same time. After completing a process map, you will understand how long it will take to complete the entire process. Where work is repeated or similar, it is best to standardize the work and time involved. Document similar activities for future use and use them as a base-line to establish future routings and times. This will speed up your planning process significantly. During the process map stage, you may identify waste. You can use operational efficiency/lean manufacturing principles to eliminate waste, shorten the process and improve deliveries and costs. BDC Consulting can assist businesses in process mapping and other operational efficiency principles and tools.

Risk Factors

Evaluate these by collecting historical information on similar work experiences, detailing the actual time, materials and failures encountered. Where risks are significant, you should conduct a failure mode effect analysis method (FMEA) and ensure that controls are put in place to eliminate or minimize them. This method allows you to study and determine ways to diminish potential problems within your business operations. This type of analysis is more common in manufacturing and assembly businesses.

5.6. Planning activities

All other activities are initiated from the production plan and each area is dependent on the interaction of the activities. Typically, a plan addresses materials, equipment, human resources, training, capacity and the routing or methods to complete the work in a standard time. In order to do a good sales forecast, you should base it on a history of firm orders.

The production plan initially needs to address specific key elements well in advance of production in order to ensure an uninterrupted flow of work as it unfolds.

Material Ordering

Materials and services that require a long lead time or are at an extended shipping distance, also known as blanket orders, should be ordered in advance of production requirements. Suppliers should send you materials periodically to ensure an uninterrupted pipeline

Equipment Procurement

Procuring specialized tools and equipment to initiate the production process may require a longer lead time. Keep in mind that the equipment may have to be custom made or simply difficult to set up. This type of equipment may also require special training Bottlenecks These are constraints or restrictions in the process flow and should be assessed in advance so you can plan around them or eliminate them before you begin production. When you assess possible bottlenecks, be aware that they may shift to another area of the process. Dealing with bottlenecks is a continual challenge for any business Human Resources Acquisitions and Training Key or specialized positions may demand extensive training on specialized equipment, technical processes or regulatory requirements. These employees should be interviewed thoroughly about their skills. When hiring them, allow sufficient time for training and be sure that they are competent in their work before the job begins. This will ensure that your process or service flows smoothly

The production plan provides a foundation to schedule the actual work and plan the details of day-to-day activities. As sales orders come in, you will need to address them individually based on their priority. The importance of the sales order will determine the work flow and when its hould be scheduled. After this, you should evaluate whether or not you are ready for production or to offer the service. You will need to determine:

1. If the inventory is available at the point where work is to start? If not, then the work needs to be rescheduled when supplies become available. There is no point in scheduling work that you will not be able to complete
2. Are your resources available? Do you have the necessary staff to complete the task? Are the machines being used?
3. Does the standard time fit within the open time allowed? If not, then the work should be rescheduled
4. You should be careful to minimize risk factors; allowing too many what-ifs can delay delivery and be counter productive

5.7. Communicate the plan

After you have determined that you have met the criteria to start production, you will need to communicate the plan to the employees who will implement it. You can plan the production on spreadsheets, databases or software which usually speeds the process up. However, a visual representation is preferred as a means to communicate operation schedules to floor employees. Some businesses post work orders on boards or use computer monitors to display the floor schedule.

The schedule also needs to be available to employees ahead of time and kept up to date.Consider change

One of the many challenges of production planning and scheduling is following up with changes to orders. Changes happen every day; you may lack materials; delivery time is moved up or work parameters have to be adapted. You will need to adjust your plan in line with these changes and advise the plant. Dealing with change is not always easy and may take as much effort as creating the original production plan. You will need to follow up with the various departments involved in order to rectify any problems. As well, computer software can be helpful in tracking changes, inventory, employees and equipment.

5.8. Forecasting

Forecasting means peeping into the future. As future is unknown and is anybody's guess but the business leaders in the past have evolved certain systematic and scientific methods to know the future by scientific analysis based on facts and possible consequences. Thus, this systematic method of probing the future is called forecasting. In this way forecasting of sales refers to an actof making prediction about future sales followed by a detailed analysis of facts related to future situations and forces which may affect the business as a whole.

Foresight is not the whole of management, but at least it is an essential part of management and accordingly, to foresee in this context means both to assess the future and make provisions for it, that is forecasting is itself in action already. Forecasting is a kind of future picture wherein proximate events are outlined with some distinctness, while remote events appear progressively less distinct and it entails the running of the business as foresee and provide means to run the business over a definite period.

As far as the marketing manager is concerned the sales forecast is an estimate of the amount of unit sales for a specified future period under the

proposed marketing plan or program. It may also be defined as an estimate of sales in rupees of physical units for a specified future period under a proposed marketing plan or program and under an assumed set of economic and other force outside the organization for which the forecast is made.

When we consider the function of production and operations management, no doubt Production and Operation departments will produce goods as per the sales program given by the sales department, but it has to prepare forecast regarding machine capacity required, materials requiredand time required for production and so on. This needs the knowledge of what exactly happened in the production shop in previous periods.

Making of a proper forecast requires the assessment of both controllable and uncontrollable factors (both economic and non-economic) inside and outside the organization. All business and industrial activities revolve around the sale and its future planning. To know what a business willdo we must know its future sales. So, sales forecasting is the most important activity in the business because all other activities depend upon the sales of the concern. Sales forecasting is a guiding factor for a firm because it enables the firm to concentrate its efforts to produce the required quantities, at the right time at reasonable price and of the right quality. Sales forecasting is the basis of planning the various activities i.e.; production activities, pricing policies, programme policies and strategies, personnel policies as to recruitment, transfer, promotion, training, wages etc.

The period of forecasting, that is the time range selected for forecasting depends on the purpose for which the forecast is made. The period may vary from one week to some years. Depending upon the period, the forecast can be termed as ‘Short range forecasting’, medium range forecasting’ and ‘Long range forecasting’. ‘Short range forecasting period may be one week, two weeks or a couple of months. Medium range forecasting period may vary from 3 to 6 months. Long range forecasting period may vary from one year to any period. The objective of above said forecast is naturally different.

In general, short term forecasting will be more useful in production planning. The manager who does short range forecast must see that they are very nearer to the accuracy.

In long range forecast, the normal period used is generally 5 years. In some cases it may extends to 10 to 15 years also. The purpose of long range forecast is:

- To work out expected capital expenditure for future developments or to acquire new facilities,
- To determine expected cash flow from sales,
- To plan for future manpower requirements,
- To plan for material requirement,
- To plan for Research and Development. Here much importance is given to long range growthfactor.

\In case of medium range forecasting the period may extend over to one or two years. The purpose of this type of forecasting is:

- To determine budgetary control over expenses,
- To determine dividend policy,
- To find and control maintenance expenses,
- To determine schedule of operations,
- To plan for capacity adjustments.

In case of short-term forecast, which extends from few weeks to three or six months and the following purposes are generally served:

- To estimate the inventory requirement,
- To provide transport facilities for dispatch of finished goods,
- To decide workloads for men and machines,
- To find the working capital needed,
- To set-up of production run for the products,
- To fix sales quota,
- To find the required overtime to meet the delivery promises.

Everyone who use the forecast for one purpose or the other expects that they need that forecast should be accurate. But it is practically impossible to forecast accurately. But decisions are made every day to run the business by using the best information available with them. Management scientists have developed various methods for forecasting. One has to decide which method has to be used to suit the information available with him and to suit his needs. The manager, who is concerned with forecasting, must have knowledge of factors influencing forecast. Various factors that influence the forecast are:

1. Environmental changes,
2. Changes in the preference of the user,

3. Number of competitive products,
4. Disposable income of the consumer.

Operations Planning

In forecasting the production important factors to be considered are:

i. Demand from the marketing department,
ii. Rate of labours absenteeism,
iii. Availability of materials,
iv. Available capacity of machines,
v. Maintenance schedules,
vi. Delivery date schedules.

Steps in forecasting

Whatever may be the method used for forecasting, the following steps are followed inforecasting.

a. Determine the objective of forecast: What for you are making forecast? Is it for predicting the demand? Is it to know the consumer's preferences? Is it to study the trend? You have to spell out clearly the use of forecast.
b. Select the period over which the forecast will be made? Is it long-term forecast or medium- term forecast or short-term forecast? What are your information needs over that period?
c. Select the method you want to use for making the forecast. This method depends on the period selected for the forecast and the information or data available on hand. It also depends on what you expect from the information you get from the forecast. Select appropriate method for making forecast.
d. Gather information to be used in the forecast. The data you use for making forecasting to produce the result, which is of great use to you. The data may be collected by:
    1. Primary source: This data we will get from the records of the firm itself.
    2. Secondary source: This is available from outside means, such as published data, magazines, educational institutions etc.
    3. Make the forecast: Using the data collected in the selected method of forecasting, the forecastis made.

5.9. Forecasting Methods

Methods or techniques of sales forecasting: Different authorities on marketing and production have devised several methods or techniques of sales or demand forecasting. The sales forecasts may be result of what market people or buyers say about the product or they may be the result of statistical and quantitative techniques. The most common methods of sales forecasting are:

1. Survey of buyer's intentions or the user's expectation method: Under this system of sales forecasting actual users of the product of the concern are contacted directly and they are asked about their intention to buy the company's products in an expected given future usually a year. Total sales forecasts of the product then estimated on the basis of advice and willingness of various customers. This is most direct method of sales forecasting. The chief advantages of this method are:

a) Sales forecast under this method is based on information received or collected from the actualusers whose buying actions will really decide the future demand. So, the estimates are correct.

b) It provides a subjective feel of the market and of the thinking behind the buying intention of the actual uses. It may help the development of a new product in the market.

c) This method is more appropriate where users of the product are numbered and a new productis to be introduced for which no previous records can be made available.

d) It is most suitable for short-run forecasting.

2. Collective opinion or sales force composite method: Under this method, views of salesmen, branch manager, area manager and sales manager are secured for the different segments of the market. Salesmen, being close to actual users are required to estimate expected sales in their respective territories and sections. The estimates of individual salesmen are then consolidated to find out the total estimated sales for thecoming session. These estimates are then further examined by the successive executive levels in the lightof various factors like proposed changes in product design, advertising and selling prices, competition etc. before they are finally emerged for forecasting.

3. Group executive judgment or executive judgment method: This is a process of combining, averaging or evaluating, in some other way, the opinions and views of top executives. Opinions are sought from the executives of different fields i.e., marketing; finance; production etc. and

forecasts are made.

4. Experts' opinions: Under this method, the organization collects opinions from specialists in the field outside the organization. Opinions of experts given in the newspapers and journals for the trade, wholesalers and distributors for company's products, agencies or professional experts are taken. By analyzing these opinions and views of experts, deductions are made for the company's sales, and sales forecasts are done.

5. Market test method: Under this method seller sells his product in a part of the market for sometimes and makes the assessment of sales for the full market on the bases of results of test sales. This method is quite appropriate when the product is quite new in the market or good estimators are not available or where buyers do not prepare their purchase plan.

6.Trend projection method: Under this method, a trend of company's or industry's sales is fixed with the help of historical data relating to sales which are collected, observed or recorded at successive intervals of time. Such data is generally referred to as time series. The change in values of sales is found out. The study may show that the sales sometimes are increasing and sometimes decreasing, but a general trend in the long run will be either upward or downward. It cannot be both ways. This trend is called secular trend. The sales forecasts with the help of this method are made on the assumption that the same trend will continue in the future. The method which is generally used in fitting the trend is the method of least squares or straight line trend method. With this method a straight line trend is obtained. This line is called 'line of best fit'.

By using the formula of regression equation of Y on X, the future sales are projected.Calculation of trend.

The trend can be calculated by the least square method as follows:

i. Find time deviations (X) of each period from a certain period and then find the sum of time deviation (∑X).

ii. Square the time deviation of each period (X2) and then find the sum of squares of each period (∑X2).

iii. Multiply time deviations with the sales of each period individually (XY) and add the productof the column to find (∑XY).

iv. To find the trend (Y) this is equal to a + bX. The value of a and b may be determined by either of the following

Two ways:

(a) Direct method. This method is applicable only when ∑X = 0. To make ∑X = 0, it is necessarythat the time deviations should be calculated exactly from the midpoint of the series. Then, the values of a and b will be calculated as follows:

∑ ∑ a (average) = NY and b (rate of growth) = XXY2. This method is simple and direct.

(b) Indirect method. This method is somewhat difficult. This method can be applied in both the cases where ∑X has any positive or negative values or ∑X is not equal to zero. The values of a and b are calculated by solving the following two equations:

∑Y = na + b∑X

∑XY = a∑X + b∑X2

By calculating the values of 'a' and 'b' in the above manner, the sales can be forecasted for any future period by applying the formula Y = a + bX.

7**. Moving average method:** This is another statistical method to calculate the trend through moving averages.

It can be calculated as follows:

An appropriate period is to be determined for which the moving average is calculated. While determining the period for moving averages, the normal cycle time of changes in the values of series should be considered so that short-term fluctuations are eliminated. As far as possible, the period for moving averages should be in odd numbers such as period of 3, 5 or 7 years. The period in even numbers will create a problem in centralising the values of averages. The calculated values of moving averages present the basis for determining the expected amount of sale.

Operations Planning

8. Criteria of a good forecasting method: It cannot be said which method of sales forecasting is the best because everyone has merits and demerits of its own. The suitability of a method depends on various factors such as nature of the product, available time and past records, wealth and energy, degree of accuracy and the forecaster etc. of an enterprise. However, in general, a good forecasting method must possess the following qualifications.

1. **Accuracy:** Accuracy of the forecasting figures is the life blood of the business because many important plans and programmes,

policies and strategies are prepared and followed on the basis of such estimates. If sales forecasts are wrong, the businessman suffer a big loss. Hence, the method of forecasting to be applied must amount to maximum accuracy.

2. **Simplicity:** The method for forecasting should be very simple. If the method is difficult or technical, then there is every possibility of mistake. Some information are collected from outsideand that will remain unanswered or inaccurate replies will be received, if the method is difficult. Management must also be able to understand and have confidence in the method.
3. **Economy:** The method to be used should be economical taking into account the importance of the accuracy of forecast. Costs must be weighed against the importance of the forecast to the operations of the business.
4. A**vailability:** The method should be such for which the relevant information may be available immediately with reasonable accuracy. Moreover, the technique must give quick results and useful information to the management.
5. **Stability:** The data of forecasting should be such wherein the future changes are expected to be minimum and are reliable for future planning for some time.
6. **Utility:** The forecasting technique must be easily understandable and suitable to the management.

5.10. Categories of Forecasting Methods

Qualitative Forecasting

Qualitative forecasting techniques are subjective, based on the opinion and judgment of consumers and experts; they are appropriate when past data are not available. They are usually applied to intermediate- or long-range decisions.

In the following, we discuss some examples of qualitative forecasting techniques:

Executive Judgment (Top Down)

Groups of high-level executives will often assume responsibility for the forecast. They will collaborate to examine market data and look at future trends for the business. Often, they will usestatistical models as well as market experts to arrive at a forecast.

Sales Force Opinions (Bottom up)

The sales force in a business are those persons most close to the customers. Their opinions are of high value. Often the sales force personnel are asked to give their future projections for their area or territory. Once all of those are reviewed, they may be combined to form an overall forecast fordistrict or region.

Delphi Method

This method was created by the Rand Corporation in the 1950s. A group of experts are recruited to participate in a forecast. The administrator of the forecast will send out a series of questionnaires and ask for inputs and justifications. These responses will be collated and sent out again to allow respondents to evaluate and adjust their answers. A key aspect of the Delphi method is that the responses are anonymous, respondents do not have any knowledge about what information has come from which sources. That permits all of the opinions to be given equal consideration. The set of questionnaires will go back and forth multiple times until a forecast is agreed upon.

Market Surveys

Some organizations will employ market research firms to solicit information from consumers regarding opinions on products and future purchasing plans.

Quantitative Forecasting

Quantitative forecasting models are used to forecast future data as a function of past data. They are appropriate to use when past numerical data is available and when it is reasonable to assume that some of the patterns in the data are expected to continue into the future. These methods are usually applied to short- or intermediate-range decisions. Some examples of quantitative forecasting methods are causal (econometric) forecasting methods, last period demand (naïve), simple and weighted N-Period moving averages and simple exponential smoothing, which are categorizes as time-series methods. Quantitative forecasting models are often judged against each other by comparing their accuracy performance measures. Some of these measures include Mean Absolute Deviation (MAD), Mean Squared Error (MSE), and Mean Absolute Percentage Error (MAPE).

We will elaborate on some of these forecasting methods and the accuracy measure in the following sections

Causal (Econometric) Forecasting Methods (Degree)

Some forecasting methods try to identify the underlying factors that might influence the variable that is being forecast. For example, including information about climate patterns might improve the ability of a model to predict umbrella sales. Forecasting models often take account of regular seasonal variations. In addition to climate, such variations can also be due to holidays and customs: for example, one might predict that sales of college football apparel will be higher during the football season than during the off-season.

Several informal methods used in causal forecasting do not rely solely on the output of mathematical algorithms, but instead use the judgment of the forecaster. Some forecasts take account of past relationships between variables: if one variable has, for example, been approximately linearly related to another for a long period of time, it may be appropriate to extrapolate such a relationship into the future, without necessarily understanding the reasons for the relationship.

One of the most famous causal models is regression analysis. In statistical modeling, regression analysis is a set of statistical processes for estimating the relationships among variables. It includes many techniques for modeling and analyzing several variables, when the focus is on the relationship between a dependent variable and one or more independent variables (or 'predictors'). More specifically, regression analysis helps one understand how the typical value of the dependent variable (or 'criterion variable') changes when any one of the independent variables is varied, while the other independent variables are held fixed.

Let Us Sum Up

In this unit, you have learned about the following:

Production, planning and control (PPC) is referred to as operations planning and control because the production planning and control techniques used in production systems manufacturing tangible goods can also be employed in operations or services systems providing services. Three stages in production planning and control functions are Planning: Choosing the best course of action among several alternatives. Operations: Execution as per plan. Control: Maintaining the performance by comparing the actual results with performance standards set and taking appropriate corrective action if necessary to reduce variance. There are 3 phases of PPC that is Planning, Action and Control. The control functions are Dispatch and Follow up.

Check Your Progress

1. Production planning is essential for _____.
2. Production control within a company depends on _____.
3. ____ responsible for the order of processing each activity under Production Planning and Control.

Glossary

Intangibility: Manufacturers produce tangible products—things that can be touched or handled, such as automobiles and appliances. Service companies provide intangible products, such as banking, entertainment, or education.

Customization: Most manufactured goods are standardized. Services, by contrast, are often customized to satisfy the specific needs of a customer. For example, when you go to the hairdresser, you ask for a haircut that looks good on you because of the shape of your face and the texture of your hair.

Customer contact: You could spend your entire working life assembling cars in Detroit and never meet a customer who bought a car that you helped to make. But if you were a restaurant server, you'd interact with customers every day. In fact, their satisfaction with your product would be determined in part by the service that you provided. Unlike manufactured goods, many services are bought and consumed at the same time.

Model Questions

1. Illustrate the factors affecting plant location.
2. Outline the factors affecting plant location with the application.
3. Discuss in detail about the plant layout with the application.
4. Compare the difference between process and product layout.
5. Explain in detail about the cellular layout with the application.
6. Explain in detail about the Forecasting and its error.
7. Discuss in detail about the qualitative forecasting using Delphi method.

8. Discuss in detail about the quantitative forecasting using regression analysis.
9. Compare the difference between the Qualitative and Quantitative techniques ofForecasting.
10. Explain in detail about the demand forecasting using regression method.

Answers to Check Your Progress

1. All of the above
2. All of the above
3. Sequencing

Suggested Readings

1. Russell and Taylor (2010), Operations Management along Supply Chain, Wiley.
2. Slack N, Chambers and S, Johnston R(2010), Operations management 6th edition, Prentice Hall.
3. Krajewski, Lee J and Ritzman, Larry P (2015), Operations Management: Processes and Value Chains, Pearson.

Unit-6

Delphi Method, Regression Analysis and Forecasting Error

STRUCTURE

Overview

In this Unit what is Delphi Method, Regression Analysis, Forecasting Error also been explained in detail.

Objectives

After reading this lesson, you will be able:

- Understand the meaning and definition of Delphi Method
- Understand the History of Delphi Method
- Define the decision about Independent Variables

6.1. Delphi Techniques

The Delphi technique is a systematic and interactive forecasting method that was originally conceived as a way to obtain the opinion of a panel of

experts without necessarily bringing them together face to face. The experts answer a questionnaire in two or more rounds. After each round, a facilitator provides an anonymous summary of the experts' forecast from the previous round as well as the reasons they provided for their judgments. Thus, experts are encouraged to revise their earlier answers in the light of the replies of other members of their panel. It is believed that during this process, the range of the answers vis-i-vis the variations, will decrease and the group will converge towards the "correct" answers. Finally, the process is stopped after a pre-defined stop criterion (e.g., number of rounds, the achievement of consensus, stability, and consistency of the results), and the mean or median scores of the final rounds determine the results.

Delphi is based on the principle that forecasts from a structured group of experts that are more accurate and valid than those from an unstructured group of individuals. The technique can be adapted for use in face-to-face meetings, and then is called mini-Delphi or Estimate-Talk- Estimate (ETE). The person coordinating the Delphi technique is known as a facilitator and facilitates the responses of their panel of experts, who are selected for a reason, usually that they hold knowledge on an opinion or view. The facilitator sends out questionnaires, forms, check-list, etc. and if the panel of experts accepts,they follow instructions and present their views. Responses are collected and analyzed, and then common and conflicting viewpoints are identified. If consensus is not reached, the process continues through thesis and antithesis, to gradually work towards synthesis, and building consensus.

6.1.1. History of Delphi techniques

The name "Delphi" is derived from the Oracle of Delphi. The authors of the method were not happy with this name because it implies "something oracular, something smacking a little of the occult." The Delphi method is based on the assumption that group judgments are more valid than individual judgments. It was developed at the beginning of the Cold War to forecast the impactof technology on warfare. In 1944, General Henry H. Arnold ordered the creation of the report for the U.S. Army Air Corpson the future technological capabilities that might be used by the military. Different approaches were tried, but the shortcomings of traditional forecasting methods, such as **theoretical approach, quantitative models,** or **trend extrapolation,** in areas where precise scientific laws have not been established yet, quickly became apparent. To combat these shortcomings, the Delphi method was developed by Project RAND during the 1950-1960s (1959) by Olaf Helmer, Norman Dalkey, and

Nicholas Rescher. It has been used ever since, together with various modifications and reformulations, such as the Imen-Delphi procedure.

Experts were asked to give their opinion on the probability, frequency, and intensity of possible enemy attacks. Other experts could anonymously give feedback. This process was repeated several times until a consensus emerged.

6.1.2. Characteristics of the Delphi technique

We enumerate below a few key characteristics of the Delphi technique:

Structuring of information flow

The initial contributions from the experts are collected in the form of answers to questionnaires and their comments to the answers.

The panel director, also called facilitator, controls the interactions among the participants by processing the information and filtering out irrelevant content. This avoids the negative effects offace-to-face panel discussions and solves the usual problems of group dynamics.

Regular feed back

Participants comment on their forecasts, the responses of others, and on the progress of the panel as a whole. At any point in time, they can revise their earlier statements. While in regular group meetings, the participants tend to stick to their previously stated opinions and often conform too much to the group leader, the Delphi method prevents it.

The anonymity of the participants

Usually, all participants maintain anonymity. Their identity is not revealed even after the completion of the final report. This stops them from dominating others in the process using their authority or personality, frees them to some extent from their personal bias, minimizes the 'bandwagon effect,' allows them to freely express their opinions, encourages open critique, and admits errors by revising earlier judgments.

6.1.3. Uses of Delphi technique

Delphi has been widely used for business forecasting and has certain advantages over other structured forecasting approaches. Initially, applications of the Delphi technique were in the field of science and technology forecasting. The objective of the method was to combine expert opinions on the likelihood and expected development time of the particular technology in a single indicator. One of the first such reports, prepared in 1964 by Gordon and Helmer, assessed the direction of long-

term trends in science and technology development, covering such topics as scientific breakthroughs, population control, automation, space progress, war prevention, and weapon systems. Other forecasts were dealing with vehicle-highway systems, industrial robots, intelligent internet, broadband connections, and technology in education. Later the Delphi method was applied in other areas, especially those related to public policy issues, such as economic trends, health, and education. It was also used successfully and with high accuracy in business forecasting. The Delphi method has also been used as a tool to implement multi-stakeholder approaches for participative policy-making in developing countries.

The government of Latin America and the Caribbean (LAC) have successfully used the Delphi method as an open-ended public-private sector approach to identify the most urgent challenges for their regional ICT- for- development of LAC Action Plan. The major weakness of the Delphi method is that future developments are not always predicted correctly by a consensus of experts. Firstly, the issue of ignorance is important. If panelists are misinformed about a topic, the use of Delphi may only add confidence to their ignorance. Secondly, sometimes unconventional thinking of amateur outsiders may be superior to expert thinking. One of the initial problems of the method was its inability to make a complex forecast with multiple factors. Potential future outcomes were considered as if they did not affecteach other.

Later on, several extensions to the Delphi method were developed to address this problem, such as cross-impact analysis that takes into consideration the possibility that the occurrence of one event may change probabilities of other events covered in the survey. Still, the Delphi method can be used most successfully in forecasting single scalar indicators. Despite these shortcomings, today, the Delphi method is a widely accepted forecasting tool. It has been used successfully for thousands of studies in areas varying from technology forecasting to drug abuse.

6.2. What is Regression Analysis?

Objective of Regression analysis is to explain variability in dependent variable by means of one or more of independent or control variables.

Applications

There are four broad classes of applications of regression analysis.

- Descriptive or explanatory: interest may be on describing “What factors influence variability independent variable?” For example, factor contributing to higher sales among company’s sales force.

- Predictive, for example setting normal quota or baseline sales. We can also use estimated equation to determine “normal” and “abnormal” or outlier observations.
- Comparing Alternative theoretical explanations,
  - Consumers use reference price in comparing alternatives,
  - Consumers use specific price points in comparing alternatives.

Decision purpose,

- Estimating variable and fixed costs having calibrated cost function.
- Estimating sales, revenues and profits having calibrated demand function.
- Setting optimal values of marketing mix variables.
- Using estimated equation for “What if” analysis.

Data Requirement

- Measurement on two or more variables one of which must be dependent.
- Dependent variable must have interval or ratio scale measurement.
- If independent variables are nominal scaled (e.g. brand choice), then appropriate caution must be maintained so that results from analysis can be interpreted. For example, it may be necessary to create variables that take values 0 and 1 or dummy variables.

Steps in Regression Analysis

1. Decide on purpose of model and appropriate dependent variable to meet that purpose.
2. Decide on independent variables.
3. Estimate parameters of regression equation.
4. Interpret estimated parameters, goodness of fit and qualitative and quantitative assessment of parameters.
5. Assess appropriateness of assumptions.
6. If some assumptions are not satisfied, modify and revise estimated equation.
7. Validate estimated regression equation.

We will examine these steps with the assumption that purpose of model

is already been decidedand we need to perform remaining steps.

6.3. Decision about Independent Variables

Here are some suggestion for variable(s) to be included in regression analysis as independentvariables.

- Based on theory.
  - Economic, sales is a function of price,
  - Psychological, behavioural intention and attitude toward a product,
  - Biological, fertilizer usage, generally increase plant growth.
- Prior research,
  - Replicate findings for earlier efforts.
  - Extend results for alternative product category.
  - Bring new insights to earlier efforts.
- Educated “Guesses”, good idea or common sense.
- Statistical approaches.
  - Stepwise Forward, add a variable that contributes most to explaining dependent variable, continue this, until either no variables are left to add or none of remaining variables contribute inexplaining variation in dependent variable.
  - Stepwise Backward, add all variables to the model and remove one variable at a time, starting with one that explains least amount of variation in dependent variable.
  - All Subset, estimate all combinations containing two variables at a time, then three variables ata time etc. Then, choose a subset that has most stable set of independent variables.

All variables contained in dataset.

- Estimating Parameters
- Method of least squares, or
- Method of maximum likelihood, or
- Weighted least squares, or
- Method of least absolute deviations.

We will examine several alternative approaches to estimate parameters including situation wherewe have only two observations.

A Simple Regression Model can be written asValue of Dependent variable = Constant +

Slope × Value of Indep. variable + Errory = a + b × x + E

- Constant (a), Slope (b) and Error (E) are unknown.
- You observe N pair of values of dependent and independent variables.
- Regression analysis provides reasonable (statistically unbiased) values for slope(s) andintercept.

Assumptions of Regression Equation

- On an average difference between the observed value (yi) and the predicted value (ˆyi) is zero.
- On an average the estimated values of errors and values of independent variables are not relatedto each other.
- The squared differences between the observed value and the predicted value are similar.
- There is some variation in independent variable. If there are more than one variable in theequation, then two variables should not be perfectly correlated.

We could also make following observations about slope and intercept.

6.4. Intercept or Constant

- Intercept is the point at which the regression intercepts y-axis.
- Intercept provides a measure about the mean of dependent variable when slope(s) are zero.
- If slope(s) are not zero then intercept is equal to the mean of dependent variable minus slope×mean of independent variable. Slope
- Change is dependent variable as we change independent variable.
- Zero slope means that independent variable does not have any influence on dependent variable.
- For a linear model, slope is not equal to elasticity. That is because, elasticity is percent changein dependent variable, as a result one percent change in independent variable.

6.5. Interpretation and Assessment

In this step, I envision explaining obtained results and providing insights

about set of variables. This should be both from conceptual point of view as well as statistical perspective. Furthermore,statistical measures could either be qualitative1 such as r-square (R2) or quantitative measure like F-statistic. When computing R2, we do not make any additional assumptions. On the other hand, application of F-statistics we need additional assumptions. F-statistics is used to test whether set of repressors significantly explain variations in the dependent variable. To use F- statistic or t-statistic, we require two additional assumptions. First, which is our fourth assumption, require that error values be normally and identically distributed. Finally, we also need to decide on appropriate probability level to reject or accept our null hypothesis. I will usually follow prob. of 0.05 to reject null hypothesis. This in common language says that I will accept the null hypothesis 19 times out of 20 and reject it once out of 20. Here is a summary of steps that one could follow in testing a hypothesis.

1. Decide on null hypothesis. Most computer programs, unless we specify, test using the F- statistic whether all regressor slopes are equal to zero. The t-statistic test whether a particular regressor is equal to zero.
2. Decide on probability level at which to reject the null hypothesis. You may recall this as alpha(α) level associated with Type I error. Although the most scientific research traditions use probability level of 0.05, you might be risk-taker and willing to use something else like 0.25.

6.6. Forecast error

Forecast error is the difference between the actual and the forecast for a given period. Forecast error is a measure forecast accuracy. There are many different ways to summarize forecast errors in order to provide meaningful information to the manager.

6.6.1. How do you calculate forecast error?

There are many standards and some not-so-standard, formulas companies use to determine the forecast accuracy and/or error. Some commonly used metrics include: Mean Absolute Deviation (MAD) = ABS (Actual – Forecast) Mean Absolute Percent Error (MAPE) = 100

* (ABS (Actual – Forecast)/Actual)

When demand planning, distributors may assume that the same demand for the same items will occur at the same time in the same quantity each year. This type of complacency can result in forecast error, which can

have a negative impact on both the company and its customers.

Let us sum up

Intermediate range capacity planning which has a time horizon or duration for the next 6-18 months. The intermediate range capacity may be varied by such alternatives such as hiring or laying off labour, purchasing or making new tools and minor equipment's and outsourcing/subcontracting etc. Short range planning which has a time horizon or duration of less than one month. This is concerned with day to day planning such as daily scheduling of activitiesand machine loading or weekly scheduling process which involves making adjustments to eliminate the variance between planned output and actual output. Many decisions about design ofthe production system and operation of the production system may have an impact on capacity.

Check your Progress

1 The initial stage of the supply chain process is the _____.

2. The term supply chain management was first coined by _____.

3. In supply chain management, after planning, the next step involves _____.

Glossary

Customization: Most manufactured goods are standardized. Services, by contrast, are often customized to satisfy the specific needs of a customer. For example, when you go to the hairdresser, you ask for a haircut that looks good on you because of the shape of your face and the texture of your hair.

Customer contact: You could spend your entire working life assembling cars in Detroit and never meet a customer who bought a car that you helped to make. But if you were a restaurant server, you'd interact with customers every day. In fact, their satisfaction with your product would be determined in part by the service that you provided. Unlike manufactured goods, many services are bought and consumed at the same time.

Model Questions

1. Describe the production planning based on the time horizon.
2. Illustrate the capacity plan with the examples.

3. Explain about the aggregate production plan with the examples.
4. Describe about the Master Production Schedule with the examples.
5. Explain about the Material Requirement Planning (MRP) with the examples.

Answer to Check Your Progress

1. Planning stage
2. Keith Oliver
3. Building a strong relationship with suppliers

Suggested Readings

1. Russell & Taylor (2010), Operations Management along Supply Chain, Wiley.
2. Slack N, Chambers S, Johnston. R (2010) Operations management 6th Prentice Hall.
3. Ba, S., & Nault, B. R. (2017). Emergent themes in the Interface between Economics of information systems and Management of Technology, *Production and Operations Management*, **26**(4), 652– 666.

Block-3: Introduction

Block-3: Planning has been divided in to three Units.

Unit-7 : Capacity Planning – Aggregate Production Planning (APP) explains about the concept of Capacity Planning, Capacity requirement, Implications of Plant Capacity, Aggregate Planning, Aggregate Planning Strategies, Aggregate planning guidelines, Aggregate Production Planning (APP), Linking and short term and Long term Planning, Purpose of Aggregate Planning and the Steps in aggregate planning.

Unit-8 : Disaggregation: Master Production Scheduling (MPS) – Material Requirement Planning (MRP) deals with Master Production Scheduling (MPS), MPS as a primary Input to MRP, Data sources for MPS, Time-Phased Order Point, From Production Plan to Master Production Schedule, Importance of Master Production Schedule (MPS), Benefits of Master Production Schedule, Functions of Master Production Scheduling (MPS), Seven proven steps for creating great MPS, Material Requirement Planning (MRP), MRP Objectives, Functions served by MRP, Manufacturing Resources Planning and Enterprise Resources Planning.

Unit-9: Production Planning and Control (PPC) presents about the concept of Production Planning and Control (PPC) Introduction, Objectives and Benefits, Functions of Production control, Types of Production Systems, Product Design, Types of Production, Marketing Aspects, Scope of Production Planning and Control, Principles of Production Planning and Control, Limitations of Production Planning and Control Function, Production Planning and Control in Different Production System, PPC in process industry and the Factors Affecting the Choice of Manufacturing Process.

In all the units of Block -3 **Planning**, the Check your progress, Glossary, Answers to Check your progress and Suggested Reading has been provided and the Learners are expected to attempt all the Check your progress as part of study.

Unit-7

Capacity Planning and Aggregate Production Planning

STRUCTURE

Overview

In this Unit we will discuss about Capacity Planning and its types, Aggregate Production Planning (APP) etc.

Objectives

After reading this lesson, you will be able to:

- Upon reading this unit you will get to know:
- Necessity of aggregate planning
- Linkage between different levels of production planning Steps in aggregate planning
- Sources of medium range production capacityManagerial importance of aggregate planning.

7.1. Capacity Planning - Introduction

The effective management of capacity is the most important responsibility of production and operations management. The objective of capacity management i.e., planning and control of capacity, is to match the level of operations to the level of demand.

Capacity planning is concerned with finding answers to the basic questions regarding capacity such as:

(i) What kind of capacity is needed?

(ii) How much capacity is needed?

(iii) When this capacity is needed?

Capacity planning is to be carried out keeping in mind future growth and expansion plans, market trends, sales forecasting, etc. Capacity is the rate of productive capability of a facility. Capacity is usually expressed as volume of output per period of time.

Capacity planning is required for the following:

- Sufficient capacity is required to meet the customers demand in time,
- Capacity affects the cost efficiency of operations,
- Capacity affects the scheduling system,
- Capacity creation requires an investment,
- Capacity planning is the first step when an organization decides to produce more or new products.

Capacity planning is mainly of two types:

1. Long-term capacity plans which are concerned with investments in new facilities and equipment's. These plans cover a time horizon of more than two years.
2. Short-term capacity plans which takes into account work-force size, overtime budgets, inventories etc.

Capacity refers to the maximum load an operating unit can handle. The operating unit might be aplant, a department, a machine, a store or a worker. Capacity of a plant is the maximum rate of output (goods or services) the plant can produce. The production capacity of a facility or a firm is the maximum rate of production the facility or the firm is capable of producing. It is usually expressed as volume of output per period of time (i.e., hour, day, week, month, quarter etc.). Capacity indicates the ability of a firm to meet market demand - both current and future. Effective Capacity can be

determined by giving due consideration to the following factors:

Facilities - design, location, layout and environment.Product - Product design and product-mix.

Process - Quantity and quality capabilities of the process or to be followed.

Human factors - Job content, Job design, motivation, compensation, training and experience oflabour, learning rates and absenteeism and labour turn over.

Operational factors - Scheduling, materials management, quality assurance, maintenancepolicies, and equipment break-downs.

External factors - Product standards, safety regulations, union attitudes, pollution controlstandards.

Measurement of capacity

Capacity of a plant is usually expressed as the rate of output, i.e., in terms of units produced per period of time (i.e., hour, shift, day, week, month etc.). But when firms are producing different types of products, it is difficult to use volume of output of each product to express the capacity of the firm. In such cases, capacity of the firm is expressed in terms of monetary value (production value) of the various products produced put together.

Capacity Planning Decisions

Capacity planning involves activities such as:

i. Assessing the capacity of existing facilities.

ii. Forecasting the long-range future capacity needs.

iii. Identifying and analyzing sources of capacity for future needs.

iv. Evaluating the alternative sources of capacity based on financial, technological andeconomic considerations.

v. Selecting a capacity alternative most suited to achieve strategic mission of the firm.

Capacity planning is necessary when an organization decides to increase its production or introduce new products into the market or to increase the volume of production to gain the advantages of economies of scale. Once the existing capacity is evaluated and a need for new or expanded facilities is determined, decisions regarding the facility location and process technology selection are undertaken. When the long-range capacity needs are estimated through long-range forecasts for products, a firm may find itself in one of the two following situations:

1. A capacity shortage situation where present capacity is not enough to meet the forecast demand for the product.
2. An excess or surplus capacity situation where the present capacity exceeds the expected future demand.

Factors affecting determination of plant capacity

I. Capital investment required,

II. Changes in product design, process design, market conditions and product life cycles,

III. Flexibility for capacity additions,

IV. Level of automation desired,

V. Market demand for the product, Operations Planning

VI. Product obsolescence and technology obsolescence and

VII. Type of technology selected.

Forms of capacity planning:

Based on time-horizon

1. Long-term capacity planning and
2. Short-term capacity planning

Based on amount of resources employed

1. Finite capacity planning and
2. Infinite capacity planning

Factors Affecting Capacity Planning: Two kinds of factors affecting capacity planning are:

1. Controllable Factors: amount of labor employed, facilities installed, machines, tooling, shifts of work per day, days worked per week, overtime work, subcontracting, preventive maintenance and number of production set ups.
2. Less Controllable Factors: absenteeism, labor performance, machine break-downs, material shortages, scrap and rework, strike, lock-out, fire accidents, natural calamities (flood, earthquake etc.) etc.

7.2. Capacity Requirements

Capacity Requirement Planning : Capacity requirement planning (CRP) is a technique which determines what equipment and labour/personnel capacities are required to meet the production objectives (i.e., volume of products) as

per the master production schedule and material requirement planning (MRP-I).

Capacity Requirement Planning Strategies:

Two types of capacity planning strategies used are:

1. “Level capacity” plan and
2. “Matching capacity with demand” plan.

“Level capacity” plan is based in “produce-to-stock and sell” approaches wherein the production systems are operated at uniform production levels and finished goods inventories rise and fall depending upon whether production level exceeds demand or vice versa from time period to time period (say every quarter).

“Matching capacity with demand” Plan: In this plan, production capacity is matched with the demand in each period (weekly, monthly or quarterly demand). Usually, material flows and machine capacity are changed from quarter to quarter to match the demand. The main advantages are low levels of finished goods inventory resulting in lesser inventory carrying costs. Also, the back-ordering cost is reduced. The disadvantages arehigh labour and material costs because of frequent changes in workforce (hiring, training and lay-off costs, overtime or idle time cost or subcontracting costs).

Optimum Plant Capacity: Plant capacity has a great influence on cost of production with increasing volume of production, economies of scale arises which results in reduction in average cost per unit produced. For a given production facility, there is an optimum volume of output per year that results in the least average unit cost. This level of output is called the “best operating level” of the plant. As the volume of output increases outward from zero in a particular production facility, average unit costs fall. These declining costs are because of the following reasons:

(i) Fixed costs are spread over more units produced,

(ii) Plant construction costs are less,

(iii) ssReduced costs of purchased material due to quantity discounts for higher volume of materials purchased and

(iv) Cost advantages in mass production processes. Longer production runs (i.e., higher batch quantity of products produced) have lesser setup cost per unit of product

Produced, lesser scrap etc., resulting in savings which will reduce the cost of production per unit. This is referred to as “economies of scale”. But this reduction in per unit cost will be only up to certain volume of production.

Additional volumes of outputs beyond this volume results in ever-increasing average unit production cost. This increase in cost per unit arise from increased congestion of materials and workers, which decreases efficiency of production, and due to other factors such as difficulty in scheduling, damaged products, reduced employee morale due to excessive work pressure, increased use of overtime etc., resulting in “diseconomies of scale”. Hence, the plant capacity should be such that the optimum level of production which gives the minimum average cost of production per unit should be possible. This plant capacity is referred to as optimum plant capacity.

Balancing the Capacity: In firms manufacturing many products (a product line or a product-mix) the load on different machines and equipments vary due to changes in product-mix. When the output rates of different machines do not match with the required output rate for the products to be produced, there will be an imbalance between the work loads of different machines. This will result in some machine or equipment becoming a “bottleneck work center” thereby limiting the plant capacity which will in-turn increase the production costs per unit.

To overcome problem of imbalance between different machines, additional machines or equipment’s are added to the bottleneck work-center to increase the capacity of the bottle-neck work center to match with the capacity of other work centers. Adding new machines or equipment’s to bottleneck work centers to remove the imbalance in capacity between various work centers is found to be economical than giving excessive overtime to workers working in bottle-neck centers which increases production costs. Another method to remove imbalance is to subcontract excess work load of bottleneck centers to outside vendors or subcontractors. Anotherway to balance capacities is to try to change the product mix by manipulating the sales for different products to arrive at a suitable product-mix which loads all work centers almost uniformly.

7.3. Implications of Plant Capacity

There are two major cost implications of plant capacity:

i. Changes in output of an existing plant of certain installed capacity affect the production costs.

ii. Changes in the plant capacity by changing the size of a plant have significant effects on costs.

Factors influencing Effective Capacity: The effective capacity is influenced by –

1. Forecasts of demand,
2. Plant and labor efficiency,

3. Subcontracting,
4. Multiple shift operation,
5. Management policies.

Forecasts of demand: Demand forecast is going to influence the capacity plan in a significant way. As such, it is very difficult to forecast the demand with accuracy as it changes significantly with the product life-cycle stage, number of products. Products with longer lifecycle usually exhibit steady demand growth compared to one with shorter life-cycle. Thus the accuracy of forecast influences the capacity planning.

Plant and labour efficiency: It is difficult to attain 100 per cent efficiency of plant and equipment. The efficiency is less than 100 percent because of the enforced idle time due to machine breakdown, delays due to scheduling and other reasons. The plant efficiency varies from equipment to equipment and from organization to organization. Labour efficiency contributes to the overall capacity utilisation. The standard time set by industrial engineer is for a representative or normal worker. But the actual workers differ in their speed and efficiency. The actual efficiency of the labour should be considered for calculating efficiency. Thus plant and labour efficiency are very much essential to arrive at realistic capacity planning.

Subcontracting: Subcontracting refers to offloading, some of the jobs to outside vendors thus hiring the capacity to meet the requirements of the organization. A careful analysis as to whether to make or to buy should be done. An economic comparison between cost to make the component or buy the component is to be made to take the decision.

Multiple shift operation: Multiple shifts are going to enhance the firm's capacity utilization. But especially in the third shift the rejection rate is higher, specially for process industries where investment is very high it is recommended to have a multiple shifts.

Management policy: The management policy with regards to subcontracting, multiplicity of shifts (decision regarding how many shifts to operate), which work stations or departments to be run for third shift, machine replacement policy, etc., are going to affect the capacity planning.

Factors favoring over capacity and under capacity

It is very difficult to forecast demand as always there is an uncertainty associated with the demand. The forecasted demand will be either higher or lower than the actual demand. So always there is a risk involved in creating capacity based on projected demand. This gives rise toeither over capacity or under capacity.

The over capacity is preferred when:

a. Fixed cost of the capacity is not very high.

b. Subcontracting is not possible because of secrecy of design and/or quality requirement.

c. The time required to add capacity is long.

d. The company cannot afford to miss the stipulated delivery date and cannot afford to lose thecustomer.

e. There is an economic capacity size below which it is not economical to operate the plant.

The under capacity is preferred when:

a. Fixed cost of the capacity is very high.

b. Shortage of products does not affect the company (i.e., lost sales can be compensated).

c. The technology changes fast, i.e., the rate of obsolescence of plant and equipment are high.

d. The cost of creating the capacity is prohibitively high.

7.4. Aggregate Planning

Aggregate planning is an intermediate term planning decision. It is the process of planning the quantity and timing of output over the intermediate time horizon (3 months to one year). Within this range, the physical facilities are assumed to be fixed for the planning period. Therefore, fluctuations in demand must be met by varying labour and inventory schedule. Aggregate planning seeks the best combination to minimize costs.

Production planning in the intermediate range of time is termed as 'Aggregate Planning'. It is thus called because the demand on facilities and available capacities is specified in aggregate quantities. For example aggregate quantities of number of Automobile vehicles, Aggregate number of soaps etc. Here the total expected demand is specified without regard to the product mix that makes up the specified figure. While dealing with production problems, the planning process is normally divided in three categories.

a. Long range Planning which deals with strategic decisions such as purchase of facilities, introduction of new products, processes etc.

b. Short term planning which deals with day-to-day work, scheduling and sometimes inventory problems.

c. Intermediate Planning or Aggregate Planning, which is in between

long range and short termplanning, which is concerned in generally acceptable planning taking the load on hand and the facilities available into considerations. In aggregate planning the management formulates a general strategy by which capacity can be made to satisfy demand in a most economical way during a specific moderate time period, say for one year. The aggregate planning is made operational through a master schedule that gives the manufacturing schedule (Products and dates of manufacture). Generally, day-to-day schedules are prepared from master schedule. Facility planning and scheduling has got very close relationship with aggregate planning.

7.5. Aggregate Planning Strategies

The variables of the production system are labor, materials and capital. More labor effort is required to generate higher volume of output. Hence, the employment and use of Overtime (OT) are the two relevant variables. Materials help to regulate output. The alternatives available to the company are inventories, back ordering or subcontracting of items.

These controllable variables constitute pure strategies by which fluctuations in demand and uncertainties in production activities can be accommodated. Vary the size of the workforce: Output is controlled by hiring or laying off workers in proportion to the changes in demand. Vary the hours worked: Maintain the stable workforce, but permit idle time when there is a ‘slack’ and permit Overtime (OT) when demand is ‘peak’. Vary inventory levels: Demand fluctuations particularly increase in demand can be met by large amount of inventory. Subcontract: In case of upward shift in demand from low level. Required production rates can be met by using the capacities available with the external vendors. This is also known as subcontracting.

7.6. Aggregate planning guidelines

1. Determine corporate policy regarding controllable variables.
2. Use a good forecast as a basis for planning.
3. Plan in proper units of capacity.
4. Maintain the stable workforce.
5. Maintain needed control over inventories.
6. Maintain flexibility to change.
7. Respond to demand in a controlled manner.
8. Evaluate planning on a regular basis. Properties of Aggregate Planning:

To facilitate the production manager the aggregate planning must have the followingcharacteristics:

i. Both output and sales should be expressed in logical over all unit of measuring. For example, an automobile manufacturing company can say 1000 vehicles per year, without giving the number of each variety of vehicle. Similarly a paint industry can say 10,000 litres of paint and does not mention the quantities of each variety of colour.

ii. Acceptable forecast for some reasonable planning period, say one year.

iii. A method of identification and fixing the relevant costs associated with the plant. Availability of alternatives for meeting the objective of the organization.

iv. Ability to construct a model that will permit to take optimal or near optimal decisions for the sequence of planning periods in the planning horizon.

v. Facilities that are considered fixed to carry out the objective.

7.7. Aggregate Production Planning (APP)

If the demand for a company products was absolutely stable, there would be no need for aggregate planning. The company can develop a production process and a workforce level that would produce exactly the amount demanded every month in a repeating cycle, while maintaining practically no inventory. However this is seldom found to be true and the demand mix among the products do fluctuate over time.

The problem facing the company is to create production, inventory and the workforce plans far enough in advance to satisfy the anticipated demand at minimum total cost without harming the company's long terms strategy and viability.

The output of the planning process should be a period by period plan of how much of each product type to produce, how much to add or remove from the inventory, how much the workforce to be increased or decreased, how much over time work should be planned and, if applicable, how much production should be subcontracted.

As the aggregate plan is based on satisfying expected intermediate term demands, it is necessary that accurate forecasts of these demands be made. Due importance must be given to seasonal factor while arriving at forecasts. In addition, intermediate range wage rates, material prices and holding costs also affect optimal plans.

All these parameters must be properly considered. Aggregate Planning is necessary in Production and Operations Management (POM) because it provides for, fully loaded facilities and minimizes overloading and under loading, thus reducing costs. Adequate production capacity to meet expected aggregate demand.

Getting the most output for the amount of resources available, which is important in times of scarce production resources. Aggregate planning is the key to managing change in POM because the changing patterns of customer demand and the plans for providing production resources that adapt to those changes are fundamental to aggregate planning.

7.8. Linking and short term and Long term Planning

Decisions involving design and mix of products, the location and capacity of facilities and design of production process are long term decision and they decide the environment within which the production system must operate.

On the other hand Aggregate planning is the process of determining the company's production, inventory and personnel levels etc. for three to twelve month ahead.

Aggregate plans act as interface (Fig-1) between strategic decision, which fix the operating environment, and short term scheduling and control decisions, which guide the company's day-to-day operations.

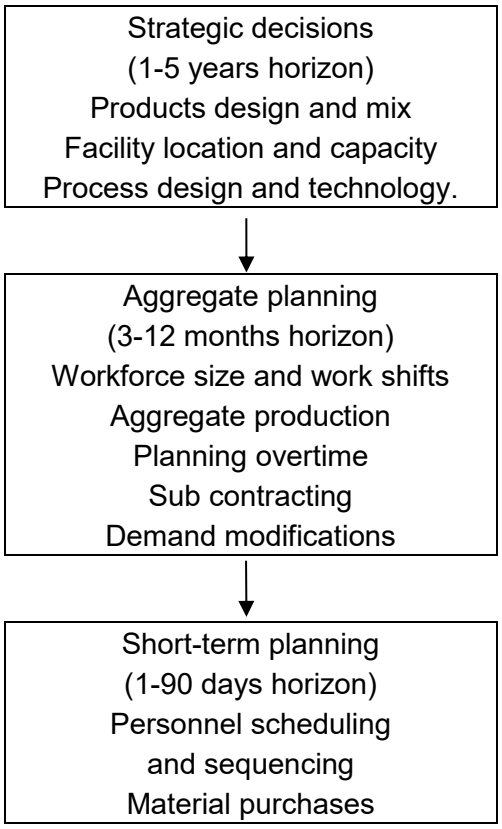
Aggregate planning typically focuses on manufacturing several aspects of operations-aggregate production, inventory, and personnel levels-to minimize costs over some planning horizon while satisfying demand and policy requirements.

Intermediate term planning is normally performed in terms of aggregate production units and resources (hence the term aggregate planning) rather than for individual products.

Although in the intermediate term major facility and process changes usually be expanded by using overtime - work, subcontracting production, hiring addition workers, or even adding entire work shifts. This approach takes the demand pattern as forecasted and focuses on minimizing the costs.

7.9. Purpose of Aggregate Planning

In this section we explain why companies need aggregate plans and how they use them to take a macro view of their business. We also discuss how the aggregate plan relates to a company's long-term and short-term plans. Only qualitative aspect of the aggregate planning in discussed.



Aggregation The aggregate plan is useful because it focuses on a general course of action, consistent with the company's strategic goals and objectives, without getting bogged down in detail's, for example, itallows managers to determine whether they can satisfy budgetary goals without having to schedule each of the company's thousands of products and employees.

Even, if a planner could prepare such a detailed plan, the time and effort required to update it would make it uneconomical. For this reason, production and stiffing plans are prepared by grouping together, or aggregating, similar products, services, units of labour, or units of time. For instance, a manufacturer of bicycles that products 12 different models of bikes might divide them into two groups, mountain bikes and road bikes, for the purpose of preparing the aggregate plan, it might also consider its work-force needs in the terms of unit of labour needed per month. In general, company's aggregate products or services, labour, and time.

7.10. Steps in aggregate Planning

i. Begin with a sales forecast for each product that indicates the quantities to be sold in eachtime period (usually weeks, months, or quarters) over the planning horizon (usually 3 months to 12 months).

ii. Total all the individual product or service forecasts into one aggregate demand. If the products are not additive because of heterogeneous

units, a homogeneous unit of measure must be selected that both allows the forecasts to be added and links aggregate outputs to production capacity.

iii. Transform the aggregate demand for each time period into workers, materials machines, and other elements of production capacity required to satisfy aggregate demand.

iv. Develop alternative resource schemes for supplying the necessary production capacity to, support the cumulative aggregate demand.

v. Select the capacity plan from among the alternatives considered that statistics aggregate demand and best meets the objective of the organization.

Let us Sum Up

It is clear from foregoing discussions that the success of any organization very much depends on how its long range planning is converted into reality. Aggregate planning plays pivotal role is achieving this goal. Any mistake in medium range planning leads to wastage/improper use of resources, excess/shortage of inventory etc. The success of organization is directly linked with how efficiently the medium range planning is done. Despite the number of models available and the favorable results in a few cases aggregate planning models have not gained widespread acceptance in industry. A more. Concerted implementation effort may be needed which includes careful definition of the decision problem in each case, tailor-made models, and demonstration ofimproved planning results

Check your Progress

1. The concept of supply chain is originated in the context of _____.
2. The purpose of supply chain management is_____.
3. Logistics is the part of supply chain involved with the forward and reverse flow of _____.

Glossary

Pure Chase Strategy: The purpose of the pure chase strategy is to match or chase demands by minimizing final inventory. It absorbs demand fluctuations effectively for successful aggregate planning. Organizations can either maintain workforce level or output rate to match demand.

Pure Level Strategy: Pure level strategies are concerned with maintaining workforce or output rates at all times. Production will be consistent within the same period of time for which aggregate planning was done. Inventory and backorders help manage demand fluctuations and market changes. Organizations may even employ different ways to put inventory to good use especially if there'sa change in demand.

Hybrid or Mixed Strategy: A hybrid or mixed strategy combines both inventory and workforce/output rate. It can include maintaining additional inventory ahead of time to match demands or even use backorders to keepup. Organizations can hire temporary workers if needed or they may even furlough or lay off workers temporarily in case of low demand. Job rotations may form a part of mixed strategies to make sure that workers' skills are being fully-applied.

Smoothing: Smoothing refers to the cost of changing inventory, relying on backorders and hiring or laying off workers temporarily. Anything that stands outside the norm of day-to-day business has certain costs associated with it. Aggregate planning may be an additional cost to the organization.

Planning Horizon: Aggregate planning is associated with a particular period of 3-12 months. So, it's important to specify the exact period beforehand or well in advance to keep track of what needs to be done. Interms of workforce and inventory, organizations have to determine the levels at which they need to be maintained. This may require extensive planning on their part.

Bottleneck: When it comes to fluctuating demand, it's not always black and white. Even if organizations ascertain demand at a certain level, it may not be accurate. So, bottleneck planning has to do withan inability to match demand due to capacity limitations.

What is the actual

Capacity: Actual capacity of the supply chain is the greatest throughput rate that can be achieved with the existing configuration of resources and the accepted product or service mix plans. Altering the product or service mix can change actual realizable capacity. Modifying the existing configuration of resources, equipment, and people in the supply chain workforce alters real capacity.

Backorder augment

service capacity : If the customer is willing to wait, backorders can be used to satisfy demand on the books. There is no real inventory available until later when supply catches up with demand. This applies to services that cannot be stored. It applies as well to the manufacturer who is out of stock. The overloaded system does not have to turn away orders if the customer agrees to wait until other customers' jobs are finished.

Model questions

1. Aggregate planning is sometimes confused with scheduling. What is thedifference?
2. The XYZ Company manufactures a seasonal product. At the present, they use a level labor force a matter of company policy. The company is afraid that, if theylay off workers they will not be able to rehire them or to find qualifies replacements. Does this company have a aggregate planning problem? Discuss.
3. It has been said that aggregate planning is related to personnel planning budgeting, and marketing planning. Describe the nature of the relationship between these types of planning.
4. What factors are important in choosing the length of the planning horizon for aggregate strategy?
5. What assumption are used in deriving the LDR model?

Answers to Check Your Progress

1. Marketing
2. Improve quality of a product
3. Goods and Services

Suggested Readings

1. Ravi Anupindi, Sunil Chopra et al (2013) Managing Business Process Flows: Principles of Operations Management, Pearson
2. Edward Pound, Jeffrey Bell, Mark Spearman(2014) Factory Physics for Managers_ How Leaders Improve Performance in a Post-Lean Six Sigma World-McGraw-Hill Education
3. Russell & Taylor (2010), Operations Management along Supply Chain, Wiley .

Unit-8

Disaggregation: Master Production Scheduling and Material Requirement Planning

STRUCTURE

Overview

In this Unit the Master Production Scheduling (MPS), Data sources for MPS, From Production Plan to Master Production Schedule, Importance of Master Production Schedule (MPS), Benefits of Master Production Schedule, Functions of Master Production Scheduling, Material Requirement Planning, Manufacturing Resources Planning Enterprise Resources Planning are been explained in detail.

Objectives

After reading this lesson, you will be able to:

- Understand the business process and analyze the operations
- Acquire knowledge of production planning and resource management
- Understand the concept of Corporate Vision - Mission and Objectives
- Understand the concept of SWOT and Portfolio Analysis
- Understand the different stages in strategy formulation process
- Understand the concept of Strategic Business Unit and Business Process re-engineering

8.1. Master Production Scheduling (MPS)

So far, in discussing material requirement planning (MRP), we have assumed that master production schedule (MPS) is ready to be fed into MRP. In fact, human users involve in MPS procedure much more than in MRP. MPS drives all kinds of planning including MRP of an enterprise. MPS is so important that users involve intensively, while MRP is normally an automatic computer procedure.

MPS Objectives and Data Sources In this section, we discuss the importance of MPS and its input data. MPS itself is a major input to the MRP. Importance of MPS a production plan is anaggregate plan that schedules product families in relatively long time intervals. Master production schedule is used for individual end products and in shorter time intervals. MPS is important in the following aspects:

1. It is the link between what is expected (production planning) and what is actually to be built, i.e., material requirement planning and final assembly schedule (FAS, to be discussed).
2. It develops data to drive the detailed planning, MRP. MPS is a priority plan for manufacturing. It keeps priorities valid.
3. It is the basis for calculating the resources available (capacity) and the resources needed (load). It provides devices to reconcile the customers' demand and the plant's capability.
4. It makes possible reliable delivery promises. It provides sales people information on available- to-promise (ATP) indicating when end products are available. ATP will be discussed later.
6. It is a tool that can be used to evaluate the effects of schedule changes. It is a device for communication and a basis to make changes consistent with the demands of the marketplace and manufacturing capacity.

7. It is a contract between marketing and manufacturing departments. It is an agreed-upon plan. It coordinates plans and actions of all organizational functions and is a basis to measure the functions' performance.
8. It provides management with the means to authorize and control all resources needed to support integrated plans.
9. In the short horizon, MPS serve as the basis for planning material requirement, production of components, order priorities, and short-term capacity requirements.
10. In the long horizon, MPS serves as the basis for estimating long-term demands on the company resources such as people, equipment, warehousing, and capital.

8.2. MPS as a primary Input to MRP

MRP input data include MPS, external demand for components, forecasts of independent demand for components, BOM, and fundamental data in item master such as lead times, safety stocks, scrap allowances and lot-sizing rules. Among the above data, MPS is the primary input toMRP. It enables MRP to translate the end item schedules into individual component requirements. Therefore, MRP depends on the validity and realism of the MPS for its effectiveness. Suppose that there are 30 end products made from 5,000 components, parts, and raw materials.

MPS helps people to concentrate on the planning of the 30 independent end items, and leave the other 5,000 dependent items to be processed automatically by MRP. External demands for components include service-part orders, interplant orders, OEM orders, and components needed for sales promotion, R&D, destructive testing, etc. Forecasts of independent demand for components include service parts no longer used in regular production which are better planned by Time Phased Order Point (TPOP). After reviewing forecasts, the planners input the quantities they decide are reasonable for such items as added gross requirements. External demands and forecasts for independent components normally are not incorporated in the MPS but are instead fed directly into MRP as separate inputs.

8.3. Data sources for MPS

The data needed to develop an MPS include:

1. Customer orders.
2. Dealer orders.
3. Inventory replenishment orders.
4. Forecast for individual end products.

5. Interplant requirements.
6. Distribution center requirements.
7. Inventory levels for end products.
8 . Safety stock.
9. Released production orders for end products.
10. Capacity constraints

8.4. Time Phased Order Point

Time Phased Order Point (TPOP) is a technique similar to MRP logic. It is used to conduct planning for independent demand items, where gross requirements come from a forecast, not via explosion of the planned order releases of the parent items. TPOP can be used in planning service part requirements. This technique can also be used to plan distribution center inventories as well as plans for service parts. TPOP is an approach that uses time intervals thus allowing for time-phased lumpy demands instead of average demand as in ROP.

TPOP is a preferred alternative to reorder point Replenishment Techniques (ROP) for the following reasons:

1. TPOP allows planning for known lumps in future demand; ROP accepts average demand only.

2. TPOPprovides information on future planned orders, which is the data required in planning the needed resources. ROP only provides information for overall resources requirement.

3. TPOP permits re-planning for requirements; this keeps relative priorities valid for all shop orders. ROP does notconsider future requirements.

4. TPOP links planning for independent and dependent demands for items with both types.

Service part demand planning is an example. ROP is to be discussed in chapter seven. TPOP differs from MRP in that TPOP covers each individual item while MRP covers all the items in a product structure. The gross requirements in TPOP are drawn from independent sources while the gross requirements in MRP come from the explosion of higher level data. The planned order releases in TPOP are not further exploded, but the POR in MRP are exploded to next level items.

8.5. From Production Plan to Master Production Schedule

Production plans and master production schedules differ in their precision. Production plans are “macro” plans, while MPS are “micro” plans. Production

planning is for preparing resources to accomplish business objectives. Resource requirement planning is used to reconcile business objectives with the resources available. MPS is the schedule of end item production. It is a decision of manufacturing actions subject to the constraints of capacity. It is a set of decisions that determines manufacturing actions subject to capacity constraints. Rough-cut capacity planning is used to obtain a realistic MPS and therefore a realistic MRP. Suppose the following production plan is for a product family X of three end products A, B, and C: (The initial on-hand inventory for X is 500.)

MPS Techniques Master production scheduling is a Time-Phased Order Point (TPOP) procedure. The planned order releases (POR) in the TPOP are the master schedules fed into the MRP system. MPS are done for the MPS items (end products). In assemble-to-order (ATO) cases, a module is defined as an MPS item, and all its ancestors must also be MPS items. Two-level master production schedules are used in assemble-to-order cases. Related topics are discussed as follows.

Demand Time Fence (DTF): DTF is a point of time in MPS. The DTF is set between the current date and the Planning Time Fence (PTF). The region between the current date and the demand time fence contains actual orders that are frozen. Change of orders within DTF may cause unstable production problems. No unanalyzed and unapproved changes are allowed for the MPS in this region. DTF is the earliest due date for taking a customer order. Promising a customer order with a due date prior to DTF may cause late delivery. But it does not mean that it is impossible to take an order with a due date earlier than DTF. As long as there is enough Available-to-Promise (ATP) within the DTF, we can still promise a customer order delivering before DTF.

Planning Time Fence (PTF): PTF is the accumulated lead-time for the end products. Related purchase orders or manufacturing orders may have been released. Change of customer orders within PTF may bring the necessity of rescheduling purchase orders or manufacturing orders. A customer order with due date later than PTF can easily be changed for related activities have not started yet. MPS considers only the customer orders within DTF for it is not likely that any new orders will fall in this region. MPS considers the larger of the customer orders and the forecasts from DTF to PTF for new orders keep replacing the forecasts in this region. If customer orders exceed forecasts, it means that the demand is underestimated, and MPS considers customer orders. MPS considers only the forecasts for it is not likely that many customer orders are received that early.

Projected available balance is the projected inventory of the end items if the MPS quantities are completed. MPS quantity is the quantity of end items that

we planned to manufacture. It includesthe scheduled receipts and the Firm Planned Orders (FPO). Firm planned order is a common approach to describe MPS. Master schedulers are required to firm all the Planned Order Receipts (POR) before PTF. That is, master schedulers have to make a decision of what to produce from now to PTF.

1. MPS system considers as independent demand only the customer orders in region 1, the larger of forecast and customer orders in region 2 and the forecast orders only in region
2. **Available-To-Promise (ATP):** Available-to-Promise is the uncommitted portion of a company's inventory and planned production, maintained in the master schedule to support customer order promising. The ATP quantity is the uncommitted inventory balance in the first period and is normally calculated for each period in which an MPS receipt is scheduled. In the first period, ATP equals on-hand inventory plus MPS (if it is positive) less customer orders that are due and overdue. In any period containing MPS schedule receipts, ATP equals the MPS less customer orders in this period and all subsequent periods before the next MPS schedule receipt. A negative ATP takes over prior periods' ATP until it turns from negativeto zero or the prior periods' ATP becomes zero.
3. **Two-Level Master Production Schedule:** It is a master scheduling approach where a planning bill of material is used to master schedule end items or product families. Key features such as options and accessories are frequently used in thetwo-level MPS procedure. For forecast demand, product families are master scheduled and the usage ratio in the "quantity-per" of planning BOM is used to calculate the gross requirement of the modules. For customer orders, options and accessories are defined before the master production scheduling. In this case, end items instead of families are master scheduled.

8.6. Importance of Master Production Schedule (MPS)

MPS is an integral part of an Enterprise Resource Planning system. It provides the most effective planning functionality by extracting the actual demand and supply data to deliver precise production plans. These plans assist manufacturers in quickly achieving their production goals and minimize the cost incurred on the procurement. While performing calculations of operating expenses, it pays special heed to the manufacturing capacity of the production plant. Automatic initiation of Material Resource Planning management process and generation of the purchase order takes place soon after the analysis and the approval of the production orders. Aside from all these implications, it acts as a protective barrier against shortages,

unexpected scheduling snafus, and inefficient allocation of resources.

8.7. Benefits of Master Production Schedule

- It provides an effective and most reliable communication conduit with the sales team to facilitate the planning process.
- Effectively reduce the time incurred in the manufacturing process throughout the year.
- It acts as an effective barrier against the shortage of raw material and any unexpected mishap.
- Make necessary adjustments to address the fluctuation in demands while reducing the waste properly.
- It smartly managed the cost incurred on manufacturing on behalf of the business owner and made the most precise calculation about the raw material requirements.
- It enhances the overall efficiency in the location of production resources.
- It acts as a foundation to construct, improve, and track the sales forecast.
- It helps the organization's account department reach income and expenses by providing account statements like profit & loss statements and the balance sheets.
- It helps in the calculation of inventory levels.

8.8. Functions of Master Production Scheduling (MPS)

The software system of Master Production Scheduling possesses too many attributes. Before implementing the system of Master Production Scheduling, it is generally regarded as a good practice to analyze the critical aspects of this computerized system that facilitate production. Here are the critical functionalities of the Master Production Scheduling software system. Transforming Plans This specific portion of the software speculates the amount of material, labor, and specialized equipment required to meet the manufacturing goal. Provide Alternative Production Routes.

The Master Production Scheduling system produces a trial and error schedule that gives an alternative route to accomplish the production. That would tackle any unexpected mishap that would arise within the completion of production. Utilization of Available Resources Master Production Scheduling solution establishes the relationship between the load and utilization for the machinery and equipment deployed in the manufacturing process. That allows for the

best utilization of all the available resources and a more efficient production flow. Establish Capacity Requirement.

The Master Production Scheduling facilitates capacity planning by establishing proper capacity requirements. Master Production Scheduling facilitates the manufacturers to obtain the proper knowledge about the requirement of capacity. Aid in Information Processing MPS determines the best appropriate time for delivery. It consistently coordinates with the various management information systems. Master Production Schedule Example Master Production Schedule (MPS) transforms the business plans into the intelligent management of the impact of seasonality, promotion, and fluctuating demand. Here is a typical real-life example, a pump manufacturer sells ready-to-made products. To successfully manage the sales, the pump manufacturer needs to assemble these products before shipping them within 48 hours after taking orders.

The time required for the completion of the production process is one day. Although numerous components and subassemblies are still necessary for the successfulmanufacturing of the pump, these subassemblies and internal components enhance the production time from 2 days to 2 months. To successfully manufacture a pump within 48 hours, the pump manufacturer must access all the components required to manufacture finishing products.

8.9. Seven proven steps for creating great MPS

Step One: Define your product lines and families. Product lines represent different categories of products, while product families represent similar products within a line. You'll need to define both to create an accurate MPS.

Step Two: Assign lead times to each product line/family. Lead times are the time it takes from when you place an order until you receive the product. You'll need to know this information to calculate your required throughputs (more on that later).

Step Three: Calculate the required throughput for each product line/family. The required throughput isthe number of products you need to produce each day to meet customer demand. This figure can vary depending on your business and production needs, so it's important to calculate it accurately.

Step Four: Allocate resources to meet the required throughputs. Once you know the throughputs needed for each product line/family, you'll need to allocate the necessary resources (staff, equipment, etc.) to meet those demands.

Step Five: Identify bottleneck operations and determine the required capacity for each. A bottleneck operation is an area of your production process that's

unable to meet customer demand. You'll need to identify these areas and determine how much additional capacity you need to meet demand.

Step Six: Create a master schedule. This is where the real work of creating an MPS begins. Using steps one through five information, create a master schedule that shows when the company will produce each product line/family.

Step Seven: Monitor and adjust as needed. As with any plan, your MPS will require regular monitoring and adjustment to ensure that it's meeting your business needs. Make sure to revisit step six regularly to ensure that your master schedule is up-to-date.

8.10. Material Requirement Planning (MRP)

Material requirement planning (MRP) refers to the basic calculations used to determine component requirements from end item requirements. It also refers to a broader information system that uses the dependence relationship to plan and control manufacturing operations. MRP is a technique of working backward from the scheduled quantities and needs dates for end items specified in a master production schedule to determine the requirements for components needed to meet the master production schedule.

The technique determines what components are needed, how many are needed, when they are needed and when they should be ordered so that they are likely to be available as needed. The MRP logic serves as the key component in an information system for planning and controlling production operations and purchasing. The information provided by MRP is highly useful in scheduling because it indicates the relative priorities of shop orders and purchase orders.

"Materials Requirement Planning (MRP) is a technique for determining the quantity and timing for the acquisition of dependent demand items needed to satisfy master production schedule requirements." MRP is one of the powerful tools that, when applied properly, helps the managersin achieving effective manufacturing control.

8.11. MRP Objectives

1. **Inventory reduction:** MRP determines how many components are required, when they are required in order to meet the master schedule. It helps to procure the materials/components as and when needed and thus avoid excessive buildup of inventory.
2. **Reduction in the manufacturing and delivery lead times:** MRP identifies materials and component quantities, timings when they are needed, availabilities and procurements and actions required to meet delivery deadlines. MRP helps to avoid delays in production and priorities

production activities by putting due dates on customer job orders.

3. **Realistic delivery commitments:** By using MRP, production can give marketing timely information about likely delivery times to prospective customers.
4. **Increased efficiency**: MRP provides a close coordination among various work centers and hence helps to achieve uninterrupted flow of materials through the production line. This increases the efficiency of production system.

8.12. Functions served by MRP

1. Order planning and control: When to release orders and for what quantities of materials.
2. Priority planning and control: How the expected date of availability is compared to the need date for each component.
3. Provision of a basis for planning capacity requirements and developing a broad business plans.Advantages and Disadvantages of MRP

Advantages:

(i) Reduced inventory,

(ii) Reduced idle time,

(iii) Reduced set up time,

(iv) Ability to change the master production schedule,

(v) Ability to price more competitively,

(vi) Better customer service,

(vii) Better response to market demands,

(viii) Reduced sales price.

In addition the MRP system enables the following:

(i) Aids capacity planning,

(ii) Helps managers to use the planned schedule before actual release orders,

(iii) Tells when to expedite or deexpedite,

(iv) Delays or cancels orders,

(v) Changes order quantities,

(vi) Advances or delays order due dates.

Disadvantages:

Even though MRP system has many advantages, there are some problems with MRP systems which make them fail in many firms. Three major causes for failures of an MRP system are:

i. Lack of top management commitment. MRP must be accepted by top management as a planning tool with specific reference to profit results. All executives concerned with the implementation of the MRP system must be educated emphasizing the importance of MRP as a closed-loop, integrated strategic planning tool.

ii. MRP was presented and perceived as a complete and stand-alone system to run a firm, rather than as part of the total system.

iii. The issue of how MRP can be made to function with just-in-time production system.

MRP also needs a high degree of accuracy for operation, which often requires (i) changing how the firm operates and (ii) updating files.

The major complaint by users of MRP is that MRP is too rigid because when MRP develops a schedule, it is quite difficult to deviate from the schedule if need arises.

8.13. Manufacturing Resources Planning

Manufacturing Resource Planning (MRP II) has been developed to facilitate manufacturing managers address the planning and controlling of a manufacturing process and all of its related support functions. It encompasses logically correct planning and control activities related to materials, capacity, finance, engineering, sales and marketing.

MRP II is universally applicable to any manufacturing organization regardless of its size, location, product or process. MRP II is a management process for taking the business plan and breaking it down into specific, detailed tasks that people evaluate, agree upon and are held accountable for. It involves all departments viz., materials department, engineering department that must maintain bill of materials, sales/marketing department that must keep sales plan upto date, purchasing and manufacturing departments that must meet due dates for bought out items and in-house manufactured items respectively.

From MRP I to MRP II

Manufacturing resource planning (MRP II) is a natural outgrowth of Materials Requirement Planning (MRP I) whereas MRP I focuses upon priorities of materials, CRP is concerned with time. Both material and time requirement are integrated within the MRP system [i.e., MRP I). Beyond this, MRP II has

been coined to ‘close the loop’ by integrating financial, accounting, personnel, engineering and marketing information along with the production planning and control activities of basic MRP systems. MRP II is the heart of corporate management information system for many manufacturing firms.

Evolution of MRP II

The earlier resource requirement planning systems were quite simple and unsophisticated. The MRP technique was used for its most limited capability to determine what materials and components are needed, how many are needed and when they are needed and when they should be ordered so that they are likely to be available when needed. In other words, MRP simply exploded the MPS into the required materials and was conceived as an inventory control tool or a requirements calculator. Later the logic of MRP technique was extended to serve as the key component in an information system for planning and controlling production operation and purchasing. It was helpful to production and operations managers to determine the relative priorities of shop orders and purchase orders. As a manufacturing planning and control system,

MRP laid the basic foundation for production activity control or shop-floor control.

8.14. Enterprise Resources Planning

Enterprise resource planning, popularly known as ERP, is today’s buzz-word in the corporate world. Company’s world-wide use ERP to integrate business processes and thereby reduce costs and increase productivity. It has established its base as a global phenomenon. Traditionally, companies developed isolated computer applications to suit and satisfy each of their functional segments such as sales, purchase, production, inventory, personnel and accounts. Materials Requirement Planning (MRP I) and Manufacturing Resource Planning re (MRP II) were developed basically to address the requirements of the manufacturing set-up. But the information available in various functional segments was so scattered that it was almost impossible to consolidate the information and provide the same to the people in the top management to enable them to take vital business decisions. Hence, the companies, whether in the manufacturing or the service sector have been searching for the ‘total solution’ on an integrated system which could provide for the information needs of the entire enterprise? ERP software was developed to provide such a ‘total solution’ to the business enterprise.

To be highly successful in today’s global competitive market, it is necessary that business enterprises continuously strive for developing a high level of

interaction and co-ordination along the supply chain and improve in the area of quality, time to reach the market, customer satisfaction, performance and profitability. The ERP software fulfils this need.

What is ERP?

ERP is a business process management software package developed for optimum use of resources of an enterprise in a planned manner. ERP integrates the entire enterprise starting from the supplier to the customer, covering logistics, financial and human resources. This will enable the enterprise to increase productivity by reducing costs. ERP is a package for cost saving. Once the ERP is implemented, a single solution addresses the information needs of the whole organisation.

Let Us Sum Up

In this unit, you have learned abou the following:

- Master Production Schedule is generally regarded as the heart of manufacturing Enterprise Resource Planning because it correlates manufacturing and planning.
- The MPS management system has been extensively used as a helpful tool for the most precise calculation of resources required to fulfill production plans. https://www.erp-information.com/master-production- schedule.html. It helps to identify production bottlenecks and potential problems. -MPS can help with forecasting, capacity planning, inventory management, order fulfillment/production schedule.
- With the MPS in place, it is easier for a company to predict demand more accurately, which will reduce on-hand inventories.
- This also improves customer service since customers are not waiting on products that may be out of stock or unavailable at any given moment.

Check Your Progress

1. Which of the following functions of Production Planning and Control is related to the timetable of activities _____.
2. _____ following processes is not a part of the Production Planning and Control system?
3. The objectives of Production Planning and Control are _____.

Glossary

Production Planning and Control : This involves deciding the course of action for actual production after the receipt of orders. Usually, Sales or Marketing Department receives or books orders from the customers and send their requisitions for manufacturing to Production Planning and Control Department and progress the job to ensure the execution of orders of meeting the customers' satisfaction. Effective production planning and control, therefore, ensure meeting the prime objectives of production, i.e., to manufacture and to deliver, meeting customers' requirements.

Production: After production planning and control, the next important function of a production manager is to ensure manufacturing or the production of finished goods in conformity with the plans.

Inspection: After production process is over, inspection or quality checking is necessary. This type of inspection is known as final inspection. However, for the increased emphasis on quality control, many organizations now also carry out in-process inspection. This minimizes the problem of rejection. In addition, inward inspection is also carried out for controlling the quality of rawmaterials and components.

Engineering: Manufacturing or production activities are also needed to be supported by design and development, which not only include designing tools, jigs and fixtures (this is done by independent Tool Room Department in large organizations) but also involves R&D activities for innovative product design and changes.

Industrial Engineering: A production manager is also required to carry out periodic work study, following method study or work measurement technique for systematic investigation of activities in order to ensure effective use of human and material resources.

(While method study helps in finding the best way of doing a work, work measurement helps in assessing the time required for doing a job).

Maintenance: Production manager is also responsible for time-to-time maintenance of plant and machineries to minimize machine downtime and consequent loss of production. While traditional concept is breakdown maintenance, i.e., to attend plant and machineries only, when they become dysfunctional, modern concept is Total Productive Maintenance, which also calls for preventive maintenance action to minimize machine downtim.

Interdepartmental Coordination: A production manager is also required to maintain contacts with other departments, like, Sales Department with regard to production plan, Personnel Department for manpower availability and training and Materials Department for procurement of raw materials and other components.

Model Questions

1. Describe the production planning based on the time horizon.
2. Illustrate the capacity plan with the examples.
3. Explain about the aggregate production plan with the examples.
4. Describe about the Master Production Schedule with the examples.
5. Explain about the Material Requirement Planning (MRP) with the examples.
6. Illustrate the production planning with the examples.
7. Illustrate the production control with the examples.
8. Explain the stages of production planning and control
9. Explain the difference between production planning and control.
10. Discuss the functions of production planning and control with the examples.

Answers to Check Your Progress

1. Scheduling
2. Integration of processes
3. All of the above

Suggested Readings

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Unit-9

Production Planning and Control

STRUCTURE

Overview

In this Unit Production Planning and Control (PPC) Functions of Production control, Product Design, Types of Production, Scope of Production Planning and Control, Production Planning and Control in Different Production System are been explained in detail.

Objectives

After reading this lesson, you will be able to:

- explain the idea of production planning and production control
- introduce the term ‘production planning

- enlist the functions of production planning and control

9.1. Introduction to Production Planning and Control (PPC)

Production Planning is a managerial function which is mainly concerned with the following important issues: What production facilities are required? How these production facilities should be laid down in the space available for production? And how they should be used to produce the desired products at the desired rate of production? Broadly speaking, production planning is concerned with two main aspects:

i. routing or planning work tasks

ii. Layout or spatial relationship between the resources. Production planning is dynamic in nature and always remains in fluid state as plans may have to be changed according to the changes in circumstances. Production control is a mechanism to monitor the execution of the plans. It has several important functions:

- Making sure that production operations are started at planned places and planned times.
- Observing progress of the operations and recording it properly.
- Analyzing the recorded data with the plans and measuring the deviations.
- Taking immediate corrective actions to minimize the negative impact of deviations from the plans.
- Feeding back the recorded information to the planning section in order to improve future plans.

9.2. Objectives and Benefits

The Objectives and Benefits are as follows:

- Minimize costs / maximize profits
- Maximize customer service
- Minimize inventory investment
- Minimize changes in production rates
- Minimize changes in work-force levels
- Maximize the utilization of plant and equipment

9.3. Functions of Production Control

Production function encompasses the activities of procurement, allocation and utilization of resources.

- The main objective of production function is to produce the goods and services demanded by the customers in the most efficient and economical way.
- Therefore efficient management of the production function is of utmost importance in order to achieve this objective.

9.4. Types of Production Systems

A production system can be defined as a transformation system in which a saleable product or service is created by working upon a set of inputs. Inputs are usually in the form of men, machine, money, materials etc. Production systems are usually classified on the basis of the following:

- Type of product,
- Type of production line, Rate of production, Equipment's used etc.
- They are broadly classified into three categories: Job shop production
- Batch production Mass production

Job shop Production: In this system products are made to satisfy a specific order. However that order may be produced only once or at irregular time intervals as and when new order arrives or at regular time intervals to satisfy a continuous demand the following are the important characteristics of job shop type production system: Machines and methods employed should be general purpose as product changes are quite frequent. Planning and control system should be flexible enough to deal with the frequent changes in product requirements.

Man power should be skilled enough to deal with changing work conditions. Schedules are actually nonexistent in this system as no definite data is available on the product. In process inventory will usually be high as accurate plans and schedules do not exist. Product cost is normally high because of high material and labor costs. Grouping of machines is done on functional basis (i.e. as lathe section, milling section etc.) This system is very flexible as management has to manufacture varying product types. Material handling systems are also flexible to meet changing product requirements.

Batch Production: Batch production is the manufacture of a number of identical articles either to meet a specific order or to meet a continuous demand. Batch can be manufactured either only once or repeatedly at irregular time intervals as and when demand arise or repeatedly at regular time intervals to satisfy a continuous demand the following are the important characteristics of batch type production system: As final product

is somewhat standard and manufactured in batches, economy of scale can be availed to some extent. Machines are grouped on functional basis similar to the job shop manufacturing. Semi-automatic, special purpose automatic machines are generally used to take advantage of the similarity among the products. Labor should be skilled enough to work upon different product batches. In process inventory is usually high owing to the type of layout and material handling policies adopted. Semi-automatic material handling systems are most appropriate in conjunction with the semi-automatic machines.

Mass Production: In mass production, same type of product is manufactured to meet the continuous demand of the product. Usually demand of the product is very high and market is going to sustain same demand for sufficiently long time. The following are the important characteristics of mass production system: As same product is manufactured for sufficiently long time; machines can be laid down in order of processing sequence.

Product type layout is most appropriate for mass production system. Standard methods and machines are used during part manufacture. Most of the Equipment's are semi-automatic or automatic in nature. Material handling is also automatic (such as conveyors). Semi-skilled workers are normally employed as most of the facilities are automatic. As product flows along a pre-defined line, planning and control of the system is much easier. Cost of production is low owing to the high rate of production. In process inventories are low as production scheduling is simple and can be implemented with ease.

9.5. Product Design

Product design is a strategic decision as the image and profit earning capacity of a small firm depends largely on product design. Once the product to be produced is decided by the entrepreneur the next step is to prepare its design. Product design consists of form and function. The form designing includes decisions regarding its shape, size, color and appearance of the product. The functional design involves the working conditions of the product. Once a product is designed, it prevails for a long time therefore various factors are to be considered before designing it. These factors are listed below: -

a. Standardization

b. Reliability

c. Maintainability

d. Servicing

e. Reproducibility

f. Sustainability

g. Product simplification

h. Quality Commensuration with cost

i. Product value

j. Consumer quality

k. Needs and tastes of consumers.

Above all, the product design should be dictated by the market demand. It is an important decision and therefore the entrepreneur should pay due effort, time, energy and attention in order to get the best results.

9.6. Types of Production

Broadly one can think of three types of production systems which are mentioned here under: -

(a) Continuous production

(b) Job or unit production

(c) Intermittent production

(a) Continuous production: - It refers to the production of standardized products with a standard set of process and operation sequence in anticipation of demand. It is also known as mass flow production or assembly line production. This system ensures less work in process inventory and high product quality but involves large investment in machinery and equipment. The system is suitable in 117plants involving large volume and small variety of output e.g., oil refineries reform cement manufacturing etc.

(b) Job or Unit production: - It involves production as per customer's specification each batch or order consists of a small lot of identical products and is different from other batches. The system requires comparatively smaller investment in machines and equipment. It is flexible and can be adapted to changes in product design and order size without much inconvenience. This system is most suitable where heterogeneous products are produced against specific orders.

(c) Intermittent Production: Under this system the goods are produced partly for inventory and partly for customer's orders. E.g. components are made for inventory but they are combined differently for different

customers. . Automobile plants, printing presses, electrical goods plant are examples of this type of manufacturing. 8 Intermittent productions

- Under this system the goods are produced partly for inventory and partly for customer's orders.
- E.g. components are made for inventory but they are combined differently for different customers. .
- Automobile plants, printing presses, electrical goods plant

9.7. Marketing Aspect

- Sales and Marketing is a key function whose participation is often hard to enlist.
- Sales and Marketing are critical functions in this process, since they provide the starting point of the planning and scheduling process -- the forecasts and customer order demands
- They are also vital from the viewpoint of providing the proper customer perspective whenever changes need to be made to plans and schedules based on mismatches of resources to customer demands.
- Only with a proper level of participation in Planning and Scheduling, can Sales and Marketing optimally leverage its performance and create a trusting and consensus based working relationship with Manufacturing, Purchasing, Planning, Engineering and all other functions in the company.

Standardization

- Sizes for screws, nuts bolts and other threaded fasteners were first standardized based on work of by Joseph Whit worth.
- Pipe sizes
- Shoe size standardization
- The screw base size and thread dimensions of electric lamp bulbs was standardized by Thomas Edison.
- Electrical voltage and frequency
- Electrical wiring and device standards.

9.8. Scope of Production Planning and Control

Production Planning and Control encompasses the following areas:

Materials: Planning for procurement of raw materials, components and spare parts in the right quantities and specifications at the right time from the right time form the right source at the right price. Purchasing, storage, inventory control, standardization, variety reduction, value analysis and inspection are the other activities associated with materials.

- **Methods:** It helps choosing the best method of processing from several alternatives. It also includes determining the best sequence of operations and planning for tooling, jigs and fixtures etc.
- **Machines and Equipment's:** Manufacturing methods are related to production facilities available in the production system. It involves facilities planning, capacity planning allocation and utilization of plant and Equipment's, machines etc.
- **Manpower:** Planning for man power (labor, supervisory and managerial levels) having appropriate skills and expertise.
- **Routing:** Determining flow of work material handling in the part, and sequence of operation or processing steps: This is related to consideration of appropriate shop layout and plant layout, temporary storage locations for raw materials, components and semi-finished goods and of materials handling system.
- **Estimating:** It is the process of establishing operations time leading to fixation of performance standards both for workers and machines.
- **Loading and Scheduling:** Machine loading is allocation of jobs to machines in conjunction with routing and with due consideration for capacity of machines and priority for jobs in order to utilize the machines to the maximum possible extent.
- **Scheduling** ensures that parts, sub-assemblies and finished.
- **Products** are completed as per required delivery dates. It provides a time table of manufacturing activities. It ensures balanced load on all work centers and ensures even flow of work through the manufacturing facilities.
- **Dispatching:** This is concerned with the execution of the planning functions. It gives necessary authority to start a particular work which has already been planned under routing and scheduling functions. Dispatching is release of orders and instructions for the starting of production in accordance with the route sheets and

schedule charts.

- **Expediting:** It means chasing, follow up or progressing which is down after dispatching function. It keeps a close liaison with scheduling in order to provide an efficient feedback and prompt review of targets and schedules.
- **Inspection:** This function is related to maintenance of quality in production and of evaluating the efficiency of the processes, methods and labor so that improvements can be made to achieve the quality standards set by product design.
- **Evaluating:** The objective of evaluation is to improve performance. Performance of machines, processes and labor is evaluated to improve the same.
- **Cost Control:** Manufacturing cost is controlled by wastage reduction, value analysis, inventory control and efficient utilization of all resources.

9.9. Principles of Production Planning and Control

Following are the principles of production planning and control

Type of production determines the kind of production planning and control the system needed. The number of parts involved in the product affects expenses of operating PPC department.

Complexity of PPC function varies with the number of assemblies involved. Time is a common denominator for all scheduling activities.

Size of the plant has relatively little to do with the type of the PPC system needed.

- PPC permits‘ management by exception’
- Cost control should be a byproduct of PPC function.

The highest efficiency in production is obtained by manufacturing the required quantity of a product of the required quality, at the required time by the best and cheapest method. PPC is a tool to coordinate all manufacturing activities in a production/operating system.

9.10. Limitations of Production Planning and Control Function

Following are the limitations of production planning and control function.

- PPC function is based on certain assumptions or force acts of Customers’ demand plant capacity, availability materials, Power etc. if these assumptions go wrong, PPC becomes in effective.

- Employees may resist changes is production levels set as per production plans if such plans are rigid.
- The production planning process is time consuming when it is necessary to carry out routing and scheduling functions for large and complex products consisting of a large no of parts going into the product.
- PPC, function becomes extremely, difficult, when the,
- Environmental, factors change very rapidly such as, technology, customers, taste regarding fashion or style of products needed, government policy and controls change frequently, stoppages of power supply by electricity boards due to power cuts, break in supply chain due to natural calamities such as floods, earthquakes, war etc.

9.11. Production Planning and Control in Different Production System

The manufacturing processes classified into four types.

Job production: Here in one of few units of the products are produced, as, per, the, requirement and, specification, of, the customer. Production is to mee the delivery schedule, and, costs are fixed prior to the contract.

Batch production: In this, limited quantities of each of the different types of products are manufactured on same set of machines. Different products are produced separately one after the other.

Mass or flow production: Under this, the production run is conducted, on a set of machines, arranged, according, to, the sequence of operations. A huge quantity of same product is manufactured at a time and is stocked for sale. Different product will require different manufacturing lines. Since one line can produce only one type of product, this process is also called as line flow.

Process production: Under this, the production run is conducted for an indefinite period.

PPC in job production: Job production involves manufacture of products to meet specific customer requirements of special orders. The quantity involved is usually small. Example: Manufacture of large turbo generators, boilers, steam engines, processing, equipment's, material handling equipment's, ship building etc.

Under Job production we have three types according to the regularity of

manufacturing namely,

- A small number of products produced only once a small number of products produced intermittently when the need arises A small number of products produced periodically at known interval of time
- PPC function is relatively difficult In Job production because of the following reasons:
- Every job order is of different nature and has different sequence of operation. There is no standardized routing for job orders.
- Specific, job, orders are, assigned to, different, work stations as, per, availability, of capacity.

Production schedules drawn depend on the relative priority assigned to various job orders.

Scheduling is dependent on assessment of production times and estimating is based on judgment. PPC in batch production or intermittent production

Batch production is the manufacture of a number of identical articles either to meet a specific order or to satisfy continuous demand. The decisions regard in tooling and jigs and fixtures are depended on the quantities involved in the production batch. In batch production too there can be three types namely;

- A batch produced only once
- A batch produced repeatedly at regular intervals, when the need arises
- A batch produced periodically at known intervals, to satisfy continuous demand

PPC in continuous production

Continuous production is normally associated with large quantities of production and with high rate of demand. Continuous production is justified when the rate of production can be sustained by the market. Two types of continuous production can be Mass production and Flow production. In Mass production, a large number of identical articles is produced, but in spite of advanced mechanization and tooling, the equipment need not be specially designed for the component to be manufactured.

In Flow production, the plant and equipment and layout have been primarily designed to manufacture a particular product.

A decision to switch over to a different kind of product needs basic changes in the equipment's and the layout, especially when special purpose machines and complex material handling systems are used. PPC in continuous production is usually simpler than in job or batch production. The output is either limited by available capacity or regulated within given limits to conform to production targets based on periodic sales forecasts.

9.12. PPC in process industry

PPC in process industry is relatively simple. Routing is automatic and uniform. Standard processes and specialized equipment's are used. As the products are standardized and goods are produced to stock and sell, scheduling is easy. Departmental schedules are derived from master production schedules. Dispatching involves issue of repetitive orders to ensure a steady flow of materials throughout the plant. The main task of PPC in process industry is to maintain a continuous and uniform flow of work at the predetermined rate in order to utilize the plant and equipment fully and to complete the production in time.

9.13. Factors Affecting the Choice of Manufacturing Process

Following factors need to be considered before making a choice of manufacturing process.

Effect of volume/variety: this is one of the major considerations in selection of manufacturing process. When the volume is low and variety is high, intermittent process is most suitable and with increase in volume and reduction in variety continuous process become suitable. The following figure indicates the choice of process as a function of repetitiveness. Degree of repetitiveness is determined by dividing volume of goods by variety.

Capacity of the plant: Projected sales volume is the key factor to make a choice between batch and line process. In case of line process, fixed costs are substantially higher than variable costs. The reverse is true for batch process thus at low volume it would be cheaper to install and maintain a batch process and line process becomes economical at higher volumes.

Lead time: The continuous process normally yields faster deliveries as compared to batch process. Therefore lead- time and level of competition certainly influence the choice of production process.

Flexibility and efficiency: The manufacturing process needs to be flexible enough to adapt contemplated changes and volume of production should be large enough to lower costs.

Let Us Sum Up

In this unit you have learned about the following:

Production, Planning and Control (PPC) is referred to as operations planning and control because the production planning and control techniques used in production systems manufacturing tangible goods can also be employed in operations or services systems providing services.

- Three stages in production planning and control functions are:
- Planning: Choosing the best course of action among several alternatives.
- Operations: Execution as per plan.
- Control: Maintaining the performance by comparing the actual results with performance standards set and taking appropriate corrective action if necessary to reduce variance.
- There are 3 phases of PPC that is Planning, Action and Control.
- The control functions are Dispatch and Follow up.

Check Your Progress

1. The correct sequence of operations in the Production Planning and Control process is _____.
2. Production Planning and Control function is crucial for ensuring cost savings and efficiency in _____.
3. The control activity in Production Planning and Control is performed _____ of the plan.

Glossary

Planning: The evaluation of the range, mix, specification and pricing of existing and new products in relation to present and future market requirements and competition. Planning of product range, mix, specification and pricing to satisfy company object specifying the research, design and development support required.

Feasibility study in relation to product planning: The purpose of feasibility study is to extend the market analysis with the intent of arriving

at a preferred system configuration that the firm is willing to offer the product or product-mix in response to an identified need.

System operation concept: Identification of prime mission of the system Definition of operating characteristics of the system. Anticipated usage of the system and its elements. Identification of effectiveness factors

Value analysis: Value analysis is a disciplined approach that ensure the necessary functions at minimum cost without comprising on quality, reliability, performance and appearance.

Value of a product: The value of a product can be increased:

By reducing the costs, By improving function, By increasing function by increasing the costs disproportionately low.

Machine loading: Machine loading is the process of assigning specific jobs to machines, men or work centers based on relative priorities and capacity utilization.

Product planning: Factors to be considered in product planning, which includes marketing factor, product characteristics, economic analysis and the production factor. Problems in lack of product planning.

Process planning and Routing: Manual process planning and computer aided process planning, important consideration for process planning, which includes manufacturing specification, determination of raw material and selection of machine tool.

Machine capacity, balancing: Line balancing, Variation of time efficiency, balancing to meet demand, estimating capacity, modifying time efficiency, multi product analysis, graphical representation, analysis by linear programming.

Model Questions

1. Develop the production planning based on the time horizon.
2. Describe about capacity planning.
3. Explain about the aggregate planning.
4. Describe about the disaggregate planning.
5. Describe about the Master Production Schedule.
6. Describe about the Material Requirement Planning (MRP)
7. Describe about the production planning.
8. Describe about the production control.
9. Illustrate the stages of production planning and control.
10. Illustrate the functions of production planning.
11. Illustrate the functions of production control.
12. Illustrate the Routing
13. Illustrate the Estimating
14. Illustrate the Dispatching
15. Illustrate the Evaluating.

Answers to Check Your Progress

1. Routing – Scheduling – Dispatching – Follow up
2. Promotion
3. After Execution

Suggested Readings

1. Boyer et al. (2011) Operations Management: Strategy, Global Supply Chain and Service Operations 1st Edition, Cengage Learning
2. Gerard. C and Christian. T, (2018), Matching Supply with Demand: An Introduction to Operations Management, McGraw Hill
3. Roger Schroeder, Susan Goldstein, M. Johnny Rungtusanatham (2019). Operations Management, McGraw-Hill Education,

Block-4: Introduction

Block-4: Quality has been divided in to Three Units.

Unit-10: Evolution of Quality – Quality Definition and Contributions by W.Edwards Deming, Joseph M. Juran and Philip B. Crosby deals with Introduction, Quality and Reliability Defined, Quality Concepts, Historical Development, Quality Philosophies, W. Edwards Deming, Joseph M.Juran, Philip B. Crosby, Armand V. Feigenbaum and The 7 Deadly Diseases for Management.

Unit-11: Dimensions of Quality – Process Quality Vs. Product Quality explains about Introduction, TQM Basic Concepts, Barriers in TQM Implementation, Five Pillars of TQM, Dimensions of quality, Quality Policy, Cost Analysis, Quality costs, Process quality, The Gap Analysis Model of Service Quality, Benefits of Service Quality and Product.

Unit -12: Seven Basic Quality Tools – Plan-Do-Check-Act (PDCA) Cycle presents about Introduction, Quality Control Defined, Process Capability Defined, Advantages of Control Charts, Quality Control during Production, P D C A, Approach, Implementation, PDCA at a IT Company.

In all the units of Block -4 **Quality**, the Check your progress, Glossary, Answers to Check your progress and Suggested Reading has been provided and the Learners are expected to attempt all the Check your progress as part of study.

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Unit-10
Evolution of Quality

STRUCTURE

Overview

In this Unit the Quality, Quality Concepts & Quality Philosophies are been explained in detail. The overall purpose of the course is to provide an understanding of the process of managing quality and managing services.

Objectives

After reading this lesson, you will be able to:

- Explain the principles of Quality, Quality Assurance, and Total Quality Management will provide an insight into the concepts of Excellence and Best Value and the contribution of quality to strategicmanagement.
- Show how all the fundamental disciplines of business are intrinsically linked with the concepts of service excellence and quality. Because these concepts are so interrelated they can be

shown to have a strategic importance to the culture and success of any organization.

- Learn about many tools and doctrines that can be used for assessing product/service quality and selection of these tools can help in the pursuit of excellence. This course is designed to provide a valuable perspective for future business managers

10.1. Introduction

Before the concepts and ideas of Total Quality Management (TQM) were formalized, much work had taken place over the centuries to reach this stage. This section charts the evolution, from inspection through to the present-day concepts of total quality. From inspection to total quality during the early days of manufacturing, an operative's work was inspected and a decision made whether to accept or reject it. As businesses became larger, so too did this role, and full time inspection jobs were created. Accompanying the creation of inspection functions, other problems arose:

- More technical problems occurred, requiring specialised skills, often not possessed by production workers
- The inspectors lacked training
- Inspectors were ordered to accept defective goods, to increase output

Skilled workers were promoted into other roles, leaving less skilled workers to perform the operational jobs, such as manufacturing these changes led to the birth of the separate inspection department with a "chief inspector", reporting to either the person in chargeof manufacturing or the works manager. With the creation of this new department, there came new services and issues, e.g, standards, training, recording of data and the accuracy of measuringequipment.

It became clear that the responsibilities of the "chief inspector" were more than just product acceptance, and a need to address defect prevention emerged. Hence the quality control department evolved, in charge of which was a "quality control manager", with responsibility for the inspection services and quality control engineering. In the 1920's statistical theory began to be applied effectively to quality control, and in 1924 She whart made the first sketch of a modern control chart. His work was later developed by Deming and the early work of She whart, Deming, Dodge and Romig constitutes much of what today comprises the theory of Statistical Process Control (SPC). However, there was little use of these techniques in manufacturing companies until the late 1940's. At that time,

Japan's industrial system was virtually destroyed, and it had a reputation for cheap imitation products and an illiterate workforce. The Japanese recognised these problems and set about solving them with the help of some notable quality gurus – Juran, Deming and Feigenbaum.

In the early 1950's, quality management practices developed rapidly in Japanese plants, and become a major theme in Japanese management philosophy, such that, by 1960, quality control and management had become a national preoccupation.

By the late 1960's/early 1970's Japan's imports into the USA and Europe increased significantly, due to its cheaper, higher quality products, compared to the Western counterparts.

10.2. Quality and reliability Defined

There are many definitions of quality available in the literature. A definition attributed to quality guru Crosby states the following: Quality is conformance to requirements. The preceding definition assumes that the specifications and requirements have already been developed.

The next thing to look for is conformance to these requirements. Another frequently used definition comes from Juran: Quality is fitness for use.

10.3. Quality Concepts

This definition stresses the importance of the customer who will use the product. W. Edwards Deming defined quality as follows: Good quality means a predictable degree of uniformity and dependability with a quality standard suited to the customer. The underlying philosophy of all definitions is the same – consistency of conformance and performance, and keeping the customerin mind.

Another definition that is widely accepted is Quality is the degree to which performance meets expectations. This definition provides a means to assess quality using a relative measure. We provide here the definition adopted by the American Society for Quality (ASQ): Quality denotes an excellence in goods and services, especially to the degree they conform to requirements and satisfy customers.

This definition assimilates the previous ones and is our definition of choice. Reliability implies dependability – reliability introduces the concept of failure and time to failure: Reliability is the probability that a system or component can perform its intended function for a specified interval under stated conditions. Quality and reliability go hand in hand. The customer expects a product of good quality that performs reliably.

10.4. Historical Development

The history of quality is as old as civilization. The Harappa's of the ancient Indus Valley civilization (3000 BC) achieved high precision in the measurement of length, mass, and time. Thesmallest division, which is marked on an ivory scale from Lothal, was approximately 1.704 millimeters, recorded in the Bronze Age. The dimensions of the pyramids, built around 2500 BC, show a high degree of accuracy. However, the use of tolerancing systems for the specification of quality and statistical principles to monitor quality are of recent origin.

The quality movement may be traced back to medieval Europe. Craftsmen began organizing into unions called guilds in the late thirteenth century. Manufacturing in the industrialized world followed the craftsmanship model throughout the eighteenth century. The factory system, with its emphasis on product inspection, started in Great Britain in the mid1750s and grew into the Industrial Revolution in theearly nineteenth century. In 1798 Eli Whitney introduced the concept of producing interchangeable parts to simplify assembly.

10.5. Quality Philosophies

Objective methods of measuring and ensuring dimensional consistency evolved in the mid-1800swith the introduction of go gages. A go gage for a hole checks for its lower limit (maximum material condition). No-go gages, which are used to check the upper limit for a hole, were introduced much later. Frederick W. Taylor introduced the principles of scientific management around 1900 and emphasized the division of labor with a focus on productivity. There was a significant rise in productivity but it had a negative effect on quality.

Henry Ford's moving automobile assembly line was introduced in 1913. This required that consistently good-quality parts were available so that the production assembly line would not be forced to slow down. In 1924 Walter A. Shewhart introduced the basic ideas of the statistical process control chart, whichsignaled the beginning of the era of statistical quality control. By the mid-1930s, statistical quality control methods were widely used at Western Electric, a manufacturing arm of the Bell system.

World War II brought increased recognition of quality in manufacturing industries and military applications. The American Society for Quality Control was formed in 1946. (Eventually it shortened its name to ASQ in 1997.) A quality revolution in Japan followed WorldWar II: the Japanese began applying the lessons learned in producing military goods produced for export. Quality stalwarts W. Edwards Deming and Joseph M. Juran

lectured extensively in Japan. As a result, the Japanese became leaders in quality by the 1970s. Japanese manufacturers began increasing their share in American markets, resulting in widespread economic effects in the United States. The U.S. response emphasized not only statistics but approaches that embraced the entire organization – a movement that became known as Total Quality Management.

Several other quality initiatives followed. The ISO 9000 quality system standards were published in 1987. The Baldrige National Quality Program and the Malcolm Baldrige National Quality Award were established by the U.S. Congress in the same year. The quality philosophies that introduced the modern concepts of quality are presented in the next section. Several individuals made significant contributions to quality control and improvement. We takea closer look at the approach and philosophies of W. Edwards Deming, Joseph M. Juran, Philip B. Crosby, and Armand V. Feigenbaum.

10.6. W. Edwards Deming

W. Edwards Deming is perhaps the best-known quality expert in the world. He was instrumental in the post-war industrial revival of Japan. Subsequently his ideas were increasingly adopted in industry in the United States and other countries. Deming received his electrical engineering degree from the University of Wyoming and his Ph.D. in mathematical physics. He worked for the Western Electric Company with Walter A. Shewhart, the developer of the control chart. Deming then worked with the U.S. Department of Agriculture and the U.S. Census Bureau.

Starting in 1950 he delivered a series of lectures to top management in Japan on statistical process control. Japanese industry adopted his methods which resulted in a significant improvement in quality. Deming firmly believed that quality is the responsibility of the management.

The Deming philosophy is summarized in the following fourteen points,1 which were included in his monumental work Out of the Crisis. The fourteen points apply to both smalland large organizations, to the service industry as well as to manufacturing.

They also apply to a division within a company. The fourteen points are presented here.

1. Create constancy of purpose for improvement of product and service. The point stresses the need for a mission statement which must be understood by all employees, suppliers, and customers. The strategic plan should look for the long term payback.

2. Adopt the new philosophy. Management must learn the responsibilities and take on leadership for change. Poor workmanship, defective products, or bad service are not acceptable.
3. Cease dependence on mass inspection. Eliminate the need for inspection on a mass basis by building quality into the product in the first place. Statistical methods of quality control are more efficient.
4. End the practice of awarding business on the basis of price tag alone. Instead, minimize the total cost. The aim in the purchase of new tools and other equipment should be to minimize the net cost per hour of operation or per piece produced. Move toward a single supplier for any one item, on a long-term relationship of loyalty and trust.
5. Improve constantly and forever the system of production and service. The improvement of product and service is an ongoing process. The Deming cycle involves the four-step process of plan, do, check, and act. At the plan stage, the opportunities for improvement are identified. The theory is tested on a small scale at the do stage, the results of the test are analyzed at the check stage, and the results are implemented in the act stage.
6. Institute training. On-the-job training must be provided for all employees. Employees must be encouraged to implement the knowledge developed through training.
7. Adopt and institute leadership. The aim of supervision should be to help people to do a better job using machines. Supervision must create an environment where the workers take leadership roles in accomplishing their work.
8. Drive out fear. Management must create an environment where workers are encouraged to askquestions and make suggestions. A climate of innovation leads to progress.
9. Break down barriers between departments. People in research, design, material procurement, sales, and production must work as a team. They must understand the requirements and specifications. Teamwork leads to improvements in quality and productivity.
10. Eliminate slogans, exhortations, and targets for the work force. Exhortations such as asking for zero defects and new levels of

productivity only create adversarial relationships. The bulk of the causes of low quality and low productivity belong to the system and thus lie beyond the power of the work force.

11. Eliminate numerical quotas for the work force and eliminate numerical goals for people in management. Quotas lead to the deterioration of quality. Learn the capabilities of processes and methods to improve them.
12. Remove barriers that rob people of pride of workmanship. Quality is achieved in the company when all employees are satisfied and motivated. Management must create an environment where the workers take pride in their job.
13. Encourage education and self-improvement for everyone. An organization needs people thatare improving with education.
14. Take action to accomplish the transformation. The transformation is everybody's job

10.7. Joseph M. Juran

Joseph M. Juran is the founder of the Juran Institute, which offers consulting and management training in quality. Juran obtained his degree in electrical engineering from the University of Minnesota in 1924 and then worked with Shewhart at Western Electric. He worked with a team from Bell Laboratories in 1926 to set up the first statistical process control techniques for factories. He published his Quality Control Handbook in 1951. In 1954 he was invited to Japan, where he conducted training courses in quality management.

Juran contributed to quality throughhis original ideas and the vast amount of literature he developed on quality. He defined quality asfitness for use. Juran proposed the quality trilogy: quality planning, quality control, and quality improvement to develop a universal thought process for quality. Quality planning is the process for preparing to meet the company's goals. Both internal and external customers are identified and their needs are determined. Products and services are developed to fulfill these needs. Quality control is the process for meeting company goals during operations, and statistical process control techniques are the primary tools of control. Quality improvement is the process for breaking through to superior, unprecedented levels of performance. Juran stated categorically that waste must be identified and eliminated. Juran conceptualized the Pareto principle, which helps in identifying the vital few out of the trivial many. This is commonly referred to as the 80– 20 principle – 80% of the problems are created by 20% of the causes.

10.8. Philip B. Crosby

Philip B. Crosby is a businessman and author who influenced quality improvement through his writings and lectures. He started the Crosby Associates, which provides consulting and training in quality management. In his book Quality Is Free, Crosby provides a detailed quality management grid which provides various stages of management understanding and attitude, quality organization status, problem handling, cost of quality in relation to sales, quality improvement actions, and company quality posture. Crosby's response to the quality crisis was the principle of "doing it right the first time." He also included four major principles:

(1) Quality is "conformance to requirements,"

(2) The management system is prevention,

(3) The performancestandard is zero defects, and

(4) The measurement system is the cost of nonconformance. The concept of zero defects was ahead of its time. More recently the concept of zero defects has led to the creation and development of Six Sigma, pioneered by Motorola, which has since been adopted worldwide by many other organizations.

10.9. Armand V. Feigenbaum

Armand V. Feigenbaum is a pivotal figure in the history of quality. He received his Ph.D. from MIT. In 1951 he published his book Quality Control: Principles, Practice and Administration, which was later published under the title Total Quality Control in 1961. Feigenbaum broadened adiscipline that had relied primarily on production employees to a new stage in which everyone in an organization participates in the process of quality improvement.

His book influenced much of the early philosophy of quality management in Japan in the early 1950s. He proposed a three- step process for quality improvement: quality leadership, quality technology, and organizational commitment. Total quality control is an effective system for integrating the quality development,quality maintenance, and quality improvement efforts of the various groups in an organization, enabling production and service to operate at the most economical level to achieve full customer satisfaction. We have briefly described the philosophies of Deming, Juran, Crosby, and Feigenbaum. Each of them stressed the importance of quality and the pivotal role management must play in the implementation of quality improvement.

10.10. The 7 Deadly Diseases for Management

The 7 Deadly Diseases for Management defined by Deming are the most serious and fatal barriers that managements face, in attempting to increase effectiveness and institute continual improvement.

1. The inadequacy of the constancy of purpose factor, to plan a product or service.
2. Organizations giving importance to short term profits.
3. Employing personal review systems to evaluate performance, merit ratings, and annual reviews for employees.
4. Constant Job Hopping
5. Use of visible figures only for management, with little or no consideration of figures that areunknown or unknowable.
6. An overload of Medical Costs
7. Excessive costs of liability.

Let Us Sum Up

In this unit, you have learned about the following:

- Brief description of quality history and the philosophies that influenced the quality movement.
- Readers are encouraged to study current trends such as the Six Sigma approach and ISO 9000 certification. Quality improvement is an ongoing process, and the implementation of quality principles is not limited to industry – these principles are for all businesses, offices, services, education, healthcare, and other organizations.

Check Your Progress

1. QIP stands for_____

2. Quality management is a method for _____

3. QMS, TQM, and QIP all corresponds to _____

Glossary

Quality:	Quality = Performance x Expectations
Dimensions of Quality:	Features, Conformance, Reliability, Durability, Service, Response, Aesthetics, Reputation
Concepts of TQM:	A committed and involved management to

	provide long-term, top-to- bottom organizational support. An unwavering focuses on the customer, both internally and externally. Effective involvement and utilization of the entire work force.
Quality Costs:	Quality Costs are defined as those costs associated with the non-achievement of product or service quality as defined by the requirements established by the organization and its contracts with customers and society.

Model Questions

1. The chapter discussed four quality gurus. Who are the other major contributors to quality improvement?
2. What is the Malcolm Bald ridge National Quality Award? What are the criteria for this award? Which organizations are the past recipients?
3. What is the underlying philosophy of Six Sigma? Which companies spearheaded this movement?
4. Who proposed the “zero defects” concept? Why did this philosophy lose its appeal?
5. How does improvement in quality benefit a manufacturing company?
6. Why do quality and reliability go hand in hand?
7. Define Total Quality?
8. What are the six basic concepts that a successful TQM programmer requires?
9. Explain Deming’s philosophy.
10. Elaborateon Juran’s principles of quality improvement.

Answers to Check Your Progress

1. Quality improvement program

2. Design

3. Quality abbreviations

Suggested Readings

1. Roger Schroeder, Susan Goldstein, M. Johnny Rungtusanatham (2019). Operations Management, McGraw-Hill Education.

2. Ajay Garg (2020). Production and Operations Management, Tata McGraw-Hill Education,

3. Stevenson J. William (2007), Operations Management, 6th Edition, TMH.

4. Lee J. krajewski and Larry P.Ritzman, (2007), Operations Management strategy and analysis, th Edition,Pearson Education / Prenctice Hall of India,

Unit-11
Dimensions of Quality

STRUC TURE

Overview

In this Unit the TQM Basic Concepts , Dimensions of quality , Quality Policy, Quality Cost Analysis, Five Pillars of TQM ,are been explained in detail.

Objectives

After reading this Unit, you will be able to:

- Organize an internal team to lead the quality improvement efforts and to create awareness about the philosophy of Total Quality Management.

- To identify the problems relating to quality through Customer Satisfaction, Employee Involvement, Failure mode and Effect Analysis, etc. Students would be designing and installing best practices for quality improvement through Benchmarking, Process Improvement and adherence to International Quality Standards.

11.1. Introduction

Historical Review of TQM Industrialization led to mass production in which it led to the conceptof one product at a time to the assembly line of production. Though workmanship was affected but mass production led to more job and reduction in cost of the product and increase in quality, reduction of defects etc. 1924 – After WWI, W.A. Sherwat of Bell Telephone statistical chart for the control of various. Concept of sample tests was followed. It was a failure in the initial stages. 1946 – ASQC American Society for Quality Control, now ASQ. Frequent meetings, conferences and publications were made to public.

1950 – W.Edwards Demings his guidance and lecture to Japan engineers transformed quality concepts in the organisation. His cycle PLAN-DOCHECK - ACT 1954 – Joseph M.Juran Concept of efficient and productive. Juran Trilogy Quality planning – Quality Control – Quality Improvement 1960 – Quality control circles was formed. Zero defects concepts 1970 – Reactive approach to proactive approach. Shift from Japan to USA 1980 – SPC – Statistical Process Control. Concepts of parameter and tolerance. Experiments 1990 – Concepts of certification of ISO, CMM etc 2000 – six sigma concept - Six Sigma stands for Six Standard Deviations (Sigma is the Greek letter used to represent standard deviation in statistics) from mean. Six Sigma methodology provides the techniques and tools to improve the capability and reduce the defects in any process.

11.2. TQM Basic Concepts

1. Management Involvement – Participate in quality program, develop quality council, direct participation
2. Focus on customer – who is the customer – internal and external, voice of the customer, do it right first time and every time.
3. Involvement and utilisation of entire work force all levels of management
4. Continuous improvement Quality never stops, placing orders, bill errors, delivery, minimise wastage and scrap etc.

5. Treating suppliers as partners no business exists without suppliers.
6. Performance measures reating accountability in all levels

11.3. Barriers in TQM Implementation

1. Lack of commitment from top management – avoiding training for self and employees, meetings
2. Lack of employee involvement – particularly at managerial level, supportive attitude, trust
3. Lack of teamwork – Co-operation and co-ordination within workers.
4. Lack of customer oriented approach – Know the customer need, demand, taste, shortcomings
5. Lack of attention to feedback and complaints –
6. Supplier control – in terms of materials, cost, quality, delivery etc
7. Review quality procedures – up gradation, correct past errors. Learn from experience

11.4. Five Pillars of TQM

Product ·

Process ·

System ·

People ·

Leadership

11.5. Dimensions of quality

1. Performance - Fulfilment of primary requirement
2. Features - Additional things that enhance performance
3. Conformance - Meeting specific standards set by the industry
4. Reliability - Consistence performance over a period of time
5. Durability - Long life and less maintenance
6. Service - Ease of repair, guarantee, and warranty
7. Response - Dealer customer relationship, human interface
8. Aesthetics - exteriors, packages
9. Reputation - Past performance, ranking, branding

11.6. Quality Policy

The Quality Policy is a guide for everyone in the organization as to how they should provide products and service to the customers. The common characteristics are :

- Quality is first among equals.
- Meet the needs of the internal and external customers.
- Equal or exceed the competition. Continually improve the quality.
- Include business and production practices. Utilize the entire work force

11.7. Quality Cost Analysis

The main language of corporate management is money, so the concept of studying quality-related costs is essential. The quality guru, Joseph Juran has been advocating the analysis of quality-related costs since 1951. He give his theory of quality improvement which is commonly known as Juran Trilogy.

11.8. Quality costs

The costs that are associated with preventing, finding, and correcting defective work are Quality Costs. Normally, these costs are running at 20% – 30% of sales. Many of these costs can be significantly reduced or completely avoided. One of the key functions of a Quality Analysis / Engineer is the reduction of the total cost of quality associated with a product / service. Below are the main Quality Costs:

- Prevention Costs Appraisal Costs
- Failure Costs
- Internal Failure Costs

External Failure Costs Total Cost of Quality can be calculated as the sum of costs: Prevention + Appraisal + Internal Failure + External Failure Prevention Costs: Costs of activities that are specifically designed to prevent poor quality which include

- Coding errors
- Design errors

Mistakes in the user manuals

Deadly documented or unmaintainable complex code Most of the prevention costs don’t fit within the Testing Group’s budget. This money is spent by the programming, design, and marketing staffs. Appraisal

Costs: Costs of activities designed to find quality problems, such as code inspections and any type of testing. Design reviews are part of prevention and part appraisal. Please note the following two points:

1. To the degree that you're looking for errors in the proposed design itself when you do the review, you're doing an appraisal.
2. To the degree that you are looking for ways to strengthen the design, you are doing prevention.

Failure Costs: Costs that result from poor quality, such as the cost of fixing bugs and the cost of dealing with customer complaints.

Internal Failure Costs: Failure costs that arise before your company supplies its product to the customer. Along with costs of finding and fixing bugs are many internal failure costs borne by groups outside of Product Development. If a bug blocks someone in your company from doing his or her job, the costs of the wasted time the missed milestones and the overtime to get back onto schedule are all internal failure costs. The UI issues / bugs / defects –the ones that will be fixed later – can make it hard for these staff members to take accurate screen shots. Delays caused by these minor design flaws, or by bugs that block a packaging staff member from creating or printing special reports, can cause the company to miss its printer deadline.

External Failure Costs: External failure costs are much higher. The costs that arise after your company supplies the product to the customer such as - Customer service costs - Cost of patching a released product distributing the patch. It is much cheaper to fix problems before shipping the defective product to customers.

Examples of Prevention Costs: - Fault-tolerant design - Defensive programming - Usability analysis - Clear specification - Staff training - Requirements analysis - Early prototyping - Accurate internal documentation - Evaluation of the reliability of development tools

Examples of Appraisal Costs: - Training testers - Beta testing - Test automation - Usability testing - Design review - Code inspection - Glass box testing - Black box testing Examples of Internal Failure Costs: - Training testers - Beta testing - Test automation - Usability testing - Design review - Code inspection - Glass box testing - Black box testing

Examples of External Failure: - Lost sales - Lost customer goodwill - Discounts to resellers to encourage them to keep selling the product - Warranty costs - Liability costs - Penalties - Technical support calls - Preparation of support answer books.

11.9. Process quality

Process quality refers to the degree to which an acceptable process, including measurements and criteria for quality, has been implemented and adhered to in order to produce the artifacts. Software development requires a complex web of sequential and parallel steps.

As the scale of the project increases, more steps must be included to manage the complexity of the project. All processes consist of product activities and overhead activities. Product activities result in tangible progress toward the end product. Overhead activities have an intangible impact on the end product, and are required for the many planning, management, and assessment tasks.

The objectives of measuring and assessing process quality are to:

- Manage profitability and resources
- Manage and resolve risk
- Manage and maintain budgets, schedules, and quality
- Capture data for process improvement

To some degree, adhering to a process and achieving high process quality overlaps somewhat with the quality of the artifacts. That is, if the process is adhered to (high quality), the risk of producing poor quality artifacts is reduced.

However, the opposite is not always true generating high quality artifacts is not necessarily an indication that the process has been adhered to. Therefore, process quality is measured not only to the degree to which the process was adhered to, but also to the degree of quality achieved in the products produced by the process.

To aid in your evaluation of the process and product quality, the Rational Unified Process (RUP)has included pages such as:

- **Activity**: a description of the activity to be performed and the steps required toperform the activity.
- **Work Guideline**: techniques and practical advice useful for performing the activity.
- **Artifact Guidelines and Checkpoints**: information on how to develop, evaluate, anduse the artifact.
- **Templates**: models or prototypes of the artifact that provide structure and guidancefor content.

11.10. The Gap Analysis Model of Service Quality

Gap 1: Consumer Expectations vs. Management Perceptions

Often hospitality managers fail to understand what customers expect in the offered product/service. And, this includes understanding which features (of the product) are necessary to deliver high-quality service. **Gap 1** occurs when this breakdown of understanding occurs. For example, a manager might develop a system to ensure that all guests wait no longer than 15 minutes to check in. If the hotel guest gets upset after a 10 minute wait, then Gap 1 exists.

Often, hospitality firms initially survey customers to understand their expectations. However, over time these customer expectations change (change is constantly happening). If the product/service does not adapt to these changes, then Gap 1 widens.

Ongoing research is essential to stay apprised of the changing customer expectations. Formal research plus informal research (managers walking around and talking to hospitality guests, for example) is one source of information. The salesforce, especially, for complex group business, is a vital source of changing customer expectations.

Gap 2: Management Perception vs. Service Quality Specifications

When hospitality managers know what customers expect, BUT cannot or will not develop products/services and systems to deliver it, then **Gap 2** occurs. Several reasons for Gap 2 are:

1. Inadequate commitment to service quality,
2. Lack of perception of the feasibility of addressing customer expectations
3. Inadequate task standardization (within the hospitality organization)
4. Absence of goal-setting by management and inability to get employee "buy-in." The hospitality industry has been accused of being short-term oriented. Short-term profits and unwillingness to invest in human resources and technological tools and equipment almost always causes service quality delivery problems.

Gap 3: Service Quality Specifications vs. Service Delivery

When hospitality managers know what customers expect AND have developed products/services, systems, and specifications to deliver it BUT employees are unable or unwilling to deliver the service, then Gap 3 occurs. Several reasons for Gap 3 are:

1. Employees are not given the tools and working conditions to do the job.
2. Employees are not correctly selected, trained, and motivated.
3. Employees are not properly **"led"** by managers (Are managers really "leaders?")

Gap 4: Service Delivery vs. External Communications

When hospitality management (represented by marketing and sales executives) promises more in its external communications than it can deliver (operations) then **Gap 4** occurs. External communications includes, but is not limited to, advertising, public relations, pricing messages, and personal selling.

Hospitality marketers must ensure that operations can deliver what marketing (external communications) promises. General Managers must fully understand the marketing/selling process as well as operational processes. Why? Because it is obvious that the two areas must "seamlessly" work together to meet customer expectations.

Gap 5: Expected Service vs. Perceived Service

Gap 5 is where the "rubber-meets-the-road." The size of Gap 5 is dependent on all ofthe other gaps.

1. **Expected Service** is what the customer expects to receive from the hospitalityorganization
2. **Perceived Service** is what the customer believes or perceives that he or she has actually received from the hospitality organization (after the service experience
3. **Gap 5 is the Difference** between the above. Customer satisfaction and quality is dependent upon this gap being reduced or eliminated. Hospitality management is responsible for managing the absence or presence of this gap.

11.11. Benefits of Service Quality

The hospitality industry has a reputation for being short-term oriented. Often, in this fast moving industry, there is a large amount of "fire-fighting" that occurs. When problems arise seem to completely surround the hospitality manager, survival is key. Thus, simply handling the problem and moving to next is the pattern of activity. Long-term planning and serious thought seems to be often overlooked.

Ancient wisdom continuously reminds the human being that, "if you don't

know where you are going, any road will take you there" (said the Cheshire Cat to Alice in Through the Looking-glass by Lewis Carroll written in the 1800s). The same can be said for effective planning and implementation by circumspect hospitality leadership. The hospitality industry offers products and services that are often "me-toos" and similar to undifferentiated commodities such as salt or gasoline. Anybody can spend the money to build a beautiful hotel, but not everybody can produce superior service quality. And, meeting customers' expectations, as we have seen above, translates into service quality.

Those hospitality organizations that deliver service quality escape the "commoditization" of the hospitality industry: they "stand-out" from their competitors. This differentiation leads to competitive advantage as well as other benefits. Some major benefits of delivering service quality are:

1. **Retaining Customers** – This means "repeat business."
2. **Referrals** – Satisfied customers are happy to generate positive word-of-mouth.
3. **Avoidance of "Price" Competition** – If your organization is seen by customers as the same as others, then your product/service is essentially undifferentiated or like a commodity. As mentioned above, Differentiation is a strategy upon which to effectively compete. Price strategy is another way to compete, however this may not always be possible or desirable. Attaining service quality allows competition based on a differentiation strategy.
4. **Retention of Good Employees** – Employees like to work for a "quality" organization.
5. **Reduction of Costs** – When quality is achieved, costs of correcting problems (after they have occurred) is reduced. Since a focus on quality stresses preventative maintenance, then these costs are reduced. Of course, many other costs are reduced such as lowing employee turnover and the cost of having to motivate uninspired employees (Kotler, Bowen, and Makens, 1996, pp. 362 - 364).

11.12. Product

Products and Services that meet or exceed customer expectations result in *customer satisfaction.* Quality is the *expected* product/service being realized. Before a customer makes a purchase (exchanges money for a product/service) he or she does a mental calculation: "Is the worth of the product/service (as I perceive and expect) equal to the money that I am

about to exchange?”

Products/services that are produced and manufactured to specifications that are appropriate to the price (money to be given in exchange by the customer) of the product/serviceis an operational or manufacturing view of quality. Here, the customer receives the value that he or she expects since operations has built quality standards into the product. An operations view of quality is a common view of the concept of quality.

However, quality is a function of how the customer views the product/service that he or she receives. The customer view always compares what they expect with what they actually receive regardless of how operations conceives quality. How do customers arrive at their expectations?

Marketing, especially sales, has a major effect on how the customer views quality. As mentioned earlier, customer satisfaction is based on receiving the actual product/service as expected. When marketing and sales enthusiastically promises a product/service that manufacturing or operations (in the case of a hospitality service) cannot deliver, then expectations are not met, the customer is dissatisfied, and quality (in the customers’ eyes) is not realized.

Quality is not an absolute to be determined by *operations* or manufacturing. Variables that affect quality are: (a) customer expectations (obtained from marketing and sales, as well as word of mouth and previous experience), (b) actual product/service received (how a service is performed by operational people and actual tangibles received (cold food for example). The following models explain these basic concepts.

Let Us Sum Up

In this Unit, you have learned about the following:

Services are unique in the since that they are intangible and, thus, customers must have trust before they purchase. In predominantly selling services, as in the hospitality industry, quality and perception of quality is essential. Service quality has many benefits including the ability for the organization to compete with a “differentiation” strategy in a world of “look-alike”hospitality products/services.

The good news is that thinking hospitality managers have service quality models that canguide them in planning and implementing service quality systems. And, these systems are almost guaranteed to deliver “competitive advantage.”

The two above quality models significantly affect the service industry. These models offer ways for management to think about the way that they manage service quality. Instead of the ineffective bandages of exhortations to employees to “smile,” managers have these models to guide real structural changes that, if implemented, will be both effective and efficient.

Check Your Progress

1. _____ is not a process tools for TQM systems.
2. Inspection, scrap, and repair are examples of _____
3. _____ are used in six sigma.

Glossary

Quality statements: Vision Statement, Mission Statement, Quality Policy Statement

Strategic quality planning: Customer needs,Customer positioning, Predict the future, Gap analysis, Closing the gap, Alignment, VII. Implementation

Quality policy: The Quality Policy is a guide for everyone in the organization as to how they should provide products and service to the customers. The common characteristics are Quality is first among equals. Meet the needs of the internal and external customers. Equal or exceed the competition. Continually improve the quality. Include business and production practices. Utilize the entire workforce.

Factors that influenced Purchases: Performance, Features, Service Warranty, Price, and Reputation

Juran Trilogy: Planning, Control and Improvement

Process Improvement Cycle: Identify the opportunity, Analyze the process, Develop the optimal solutions, Implement, Study the results, and standardize the solution and Plan for the future.

Model Questions

1. Give the Basic Concepts of TQM?
2. What are the Dimensions of Quality?
3. Give the Principles of TQM?
4. Give the Analysis Techniques for Quality Costs?
5. Give the primary categories of Quality cost?
6. What are the six basic concepts that a successful TQM programme requires?
7. Give the Objectives of TQM?
8. Characteristics of Quality
9. List the dimensions of Service quality.
10. Tabulate the tangible and intangible benefits of TQM.
11. Explain the Evolution of TQM?

Answers to Check Your Progress

1. Plier
2. Internal costs
3. Both black belt and green belt

Suggested Readings

1. Stevenson J. William (2007), Operations Management, 6th Edition, TMH.
2. Lee J. krajewski and Larry P.Ritzman, (2007), Operations Management strategy and analysis, th Edition,Pearson Education / Prenctice Hall of India.
3. Chase, R.B., Ravi Shankar & Jacobs, F.R. (2018), Operations & Supply Management. 15th Edition.
4. Ravi Anupindi, Sunil Chopra et al (2013) Managing Business Process Flows: Principles of Operations Management, Pearson.

Unit – 12

Seven Basic Quality Tools and Plan-Do-Check-Act (PDCA) Cycle

STRUCTURE

Overview

In this Unit the Quality Control, Process Capability, Advantages of Control Charts & P D C A are been explained in detail.

Objectives

After reading this lesson, you will be able to:

- Discuss quality control and process capability Explain statistical techniques for quality control
- Describe modern concepts like TQM, quality circles, PDCA etc.
- Explain the shift of emphasis from quality control to quality assurance

12.1. Introduction

Quality, as it is said, is not by chance but by intention. All successful

companies value quality as a system in their manufacturing systems. It is on account of high quality that German cars, Swisswatches, Japanese electronics etc. have established global acceptance. Thus, it is imperative for all organizations to make systems for quality management and control. Let us now study the techniques and standards for quality control accepted globally.

12.2. Quality Control Defined

Quality Control implies working to a set standard of quality which is achievable and which has a ready market. Thus, Quality Control means adherence to a standard or prevention of a change from the set standard. In general, this is essential because when there is acceptable quality, a manager must ensure that there is no deterioration from the standard. However, in a changing world one is often faced with the fact that the quality which is acceptable today by the customer may not be acceptable to him a year later. Therefore, there is need for a breakthrough, (creation of change) for improving existing standards. Thus preventing change (control) and creating change (breakthrough) are two important functions of quality management. Unfortunately a largenumber of managers simply have no time for breakthrough because they are obsessed with day- to-day problems of keeping controls at the existing levels.

Many breakthrough programmes call for a change of the existing practices. There is always a resistance to change specifically if the objective is not properly understood. This is because the people likely to be affected by the change are not involved in breakthrough efforts. Many breakthrough programmes have failed to click because of this attitude. The training programme to suit the requirement of the organisation and person involves has been found to be helpful in ensuring breakthrough in attitude.

Quality control has the objective of coordinating the quality maintenance and improvement efforts of all groups in the organisation with a view to providing full consumer satisfaction. Statistical quality control enables these objectives to be attained most economically reducing scrap and rework, reducing machine downtime and minimising inspection. A successful statistical quality control programme should result in “better quality to the consumer at a lower cost”. One would instinctively recognise two aspects of quality, quality of design and quality of performance. The difference between an ambassador and a maruti is the quality of design. Once the quality of design has been established, quality of performance concerns itself with how well the target is hit. SQC is, in general, concerned with the quality of performance but it is also a factthat SQC

applications have occasionally resulted in the improvement of the design as well.

12.3. Process Capability Defined

The Process Capability may be defined as the capability of a process. This can be evaluated fromthe data which is free from assignable causes and hence the extent of variation exhibited by it is only under the influence of the chance causes alone. In case it is not possible to remove the assignable causes of, at least, we should get these (assignable) causes segregated through 'Tests of Significance' the difference between the reference value and the measured value of samples. The number of units in each sample is called 'Sample Size'.

12.4. Advantages of Control Charts

There are numerous advantages of the Control charts.

- The alphabets of the 'Control Charts'itself can be used to highlight the advantages of Control Charts:
- Controls the process (at desired Economic levels).
- Optimises technical resources (as it provides the information) as to take remedial action).
- Narrows the heterogenecity (among units of a product).
- Traces differences among Operators, Supervisors, Machines etc.
- Reduces cost of Inspection.
- Overhauling and maintenance of machines, indicated whenever necessary.
- Leads to the detection of inspection errors.
- Creates quality consciousness. Histories the process at a glance.
- Acceptability of the product by consumer is enhanced. Reduces waste of materials.
- Trains the Operator and improves his skill.
- Standardizes the stage processes.

12.5. Quality Control during Production

The Standard Quality is determined through careful research & investigation. It is quite impracticle to adhere strictly to the standards of precision, especially in cases where human factor dominates over the machine factor. Some deviation is therefore, allowed or tolerated. They

are referred to as tolerances. Within the limits, set by these tolerances, the product is considered to be of standard quality. SQC brings to light the deviations outside these limits, i.e. the purpose of Statistical Quality Control is to discover and correct only those forces which are also responsible for variations outside the suitable pattern through SQC techniques.

While acceptance through sampling is used for controlling the materials input to the process, the process itself may be controlled by Statistical Sampling procedures i.e. by taking samples from the output of the process. The samples may be checked for:

1. Their measurable characteristics such as length, diameter, hardness, tensile strength etc.
2. 'Fraction Defectives' "p", when the characteristics cannot or need not to be measured.
3. Number of defects in the sample (c).

The Process is said to be within control if the sample points fall within the pre-established control limits. The crux of the Process Control lies in establishing the appropriate control limits. The charts showing these control limits are called 'Process Control Charts'.

12.6. P D C A

Plan

Establish the objectives and processes necessary to deliver results in accordance with the expected output (the target or goals). By making the expected output the focus, it differs from other techniques in that the completeness and accuracy of the specification is also part of the improvement.

Do

Implement the new processes, often on a small scale if possible, to test possible effects. It isimportant to collect data for charting and analysis for the following "CHECK" step.

Check

Measure the new processes and compare the results (collected in "DO" above) against the expected results (targets or goals from the "PLAN") to ascertain any differences. Charting data can make this much easier to see trends in order to convert the collected data into information. Information is what you need for the next step "ACT".

Act

Analyze the differences to determine their cause. Each will be part of either one or more of the PD-C-A steps. Determine where to apply changes that will include improvement. When a pass through these four steps does not result in the need to improve, refine the scope to which PDCA is applied until there is a plan that involves improvement.

12.7. Approach

A fundamental principle of the PDCA is iteration once a hypothesis is confirmed (or negated), executing the cycle again will extend the knowledge further. Repeating the PDCA cycle can bring us closer to the goal, usually a perfect operation and output

12.8. Implementation

PDCA should be repeatedly implemented in spirals of increasing knowledge of the system that converge on the ultimate goal, each cycle closer than the previous. One can envision an open coilspring, with each loop being one cycle of the scientific method - PDCA, and each complete cycleindicating an increase in our knowledge of the system under study.

This approach is based on thebelief that our knowledge and skills are limited, but improving. Especially at the start of a project, key information may not be known; the PDCA scientific method provides feedback to justify our guesses (hypotheses) and increase our knowledge. Rather than enter "analysis paralysis" to get it perfect the first time, it is better to be approximately right than exactly wrong. With the improved knowledge, we may choose to refine or alter the goal (ideal state). Certainly, the PDCA approach can bring us closer to whatever goal we choose Rate of change, that is, rate of improvement, is a key competitive factor in today's world. PDCA allows for major 'jumps' in performance ('breakthroughs' often desired in a Western approach), as well as Kaizen (frequent small improvements).

In the United States a PDCA approach is usually associated with a sizable project involving numerous people's time, and thus managers want to see large 'breakthrough' improvements to justify the effort expended. However, the scientific method and PDCA apply to all sorts of projects and improvement activities.

12.9. PDCA at a IT Company

Global IT companies use several process, methods and techniques which are adopted and implemented to come up with a high level quality product which meets and exceeds customer expectations. PDCA approach at

global IT compaines at a higher level can be adopted and applied at 4 different levels as classified below

a) **Individual level -** Each associate can incorporate PDCA to complete daily activities

b) **Program level -** Each program can adopt PDCAfor every scrum and non-scrum based programs.

c) **Product line level -** Each product line can analyze its goals by periodic use of PDCA concept

d) **Organization level -** The Company as a whole can review its overall performance from time to time. The idea is to first successfully adopt the PDCA concept at the first two levels to begin with, that is, at the Individual Level and Program Level. Based on the successful implementation at these two levels, the implementation can later be applied at the Product line level and Organization level to ensure that we achieve a wholistic improvement from the base to the top ultimately making a difference to the company's overall yearly objectives, targets, financial goals and also the meet and exceed customer expecations. "Quality is King", this is the mantra of success at Tektornix moving forward and PDCA method would definitely help in a great way in successful implementation of this mantra

Let Us Sum Up

In this unit, you have studied about the following:

Quality Control implies working to a set standard of quality which is achievable and which has aready market. Thus Quality Control means adherence to a standard or prevention of a change from the set standard.

Quality control has the objective of coordinating the quality maintenance and improvement efforts of all groups in the organisation with a view to providing full consumer satisfaction. Statistical quality control enables these objectives to be attained most economically reducing scrap and rework, reducing machine downtime and minimising inspection. Objective decisions in quality management can be built only on facts. The decisions naturally would be as good or asbad as the data on which they are based. Thus, it is important to build that base of sound lines.

When data are examined, it will normally be found that a few values will be extremely high or extremely low and most of the values tend to be concentrated within a region which is somewhere between the two extremes. This phenomenon is known as central tendency.

The Process Capability may be defined as the capability of a process. This can be evaluated fromthe data which is free from assignable causes and hence the extent of variation exhibited by it is only under the influence of the chance causes alone.

Check Your Progress

1. PDCA cycle is used for _____.
2. The _____ Capability may be defined as the capability of a process.
3. The crux of the Process Control lies in establishing the appropriate _____limits.

Glossary

Dispersion: The extent to which the data are scattered about the zone of central tendency. Measure of Central Tendency: A parameter in a series of statistical data which reflects a central value of the same series.

Quality Circles: Voluntary groups engaged in managing quality. Quality Function Deployment: represents a comprehensive analytic schema or framework for quality.

Quality Control: Working to a set standard of quality which is achievable and which has a ready market.

Statistical Quality Control: The application of statistical techniques to determine how far the product confers to the standards of quality and precision and to what extent its quality deviates from the standard quality.

Taguchi Methods: They provide a powerful means for isolating critical product design parameters that need to be controlled in the manufacturing process.

Total Quality Management: A quality focused customer oriented integrative management method that emphasizes continuing and cumulative gains in quality, productivity and cost reducti

Model Questions

1. What are chance and assignable causes of variations?
2. (a) What is the objective of inspection in a manufacturing industry? Write its uses at variousstages and the errors associated with inspection.
   (b) Differentiate between hundred percent inspection and sampling inspection.
3. Discuss process capability and write procedure for its evaluation.
4. What do you mean by Control Charts in Process Control? Write the maintenance and usage ofControl Chart.
5. What do you understand by 'Quality'? How the emphasis is shifting from Quality Assurance?
6. Define Statistical Quality Control. Describe briefly the techniques of SQC used in:
   (a) Inspection of Incoming Materials
   (b) Inspection during Process Control
7. Explain how the same is used for Inspection of Incoming Materials.
8. Explain the importance and Benefits of SQC techniques.
9. Explain the role of human behaviour in managing quality and also explain the followingconcepts:
   (a) Quality Circles
   (b) JIT Concept
10. Describe 'Use of Gauges and Fixtures' in Controlling Production Quality duringManufacturing.

Answers to Check Your Progress

1. Continuous improvement.
2. Process.
3. Control.

Suggested Readings

1. Chase, R.B., Ravi Shankar & Jacobs, F.R. (2018), Operations & Supply Management. 15th Edition,
2. Ravi Anupindi, Sunil Chopra et al (2013) Managing Business Process Flows: Principles of Operations Management, Pearson
3. Edward Pound, Jeffrey Bell, Mark Spearman (2014) Factory Physics for Managers. How Leaders Improve Performance in a Post-Lean Six Sigma World-McGraw-Hill Education.

Block-5: Introduction

Block-5: Inventory Management - has been divided in to Three Units.

Unit-13: Inventory Management – Types of Inventory Models – Independent Demand Vs. Dependent Demand describes about Introduction, Defining Inventory, Types of Inventory, Need for I M, Finished good Inventory, Independent and Dependent demand Inventories, Inventory Costs, Factors effecting Inventory Operations, Inventory turnover as indicator for health of Business and Good Inventory Management Practice.

Unit-14: Basic Economic Order Quantity (EOQ) Model – Analysis: ABC and VED deals with the Introduction and Graphical Representation of E.O.Q., EOQ Model, A.B.C. Analysis (Always Better Control) – Introduction and Classification of items Under A.B.C.

Unit-15: Push Vs. Pull system – Just-In-Time (JIT) Vs. Material Requirement Planning(MRP) explains about the Difference between Push and Pull Strategy, Definition of Push Strategy, Definition of Pull Strategy, Key Differences Between Push and Pull Strategy, Operations Introduction, JIT-Introduction, Characteristics, Total Quality Management (TQM), Benefits of JIT Manufacturing, JIT Purchasing, JIT in Seasonal Demand Industry, Use of Kanban in a Job Environment, Material Requirement Plnning, MRP Computations, The Level of an Item, An Outline of the MRP Process, Computing Direct and Indirect Requirements, Expediting and Deferring Scheduled Receipts, Lot Sizing Rules, Dealing with Uncertainty in MRP, Shortcomings of MRP, MRP II and ERP Systems and Bolt-Ons.

In all the units of Block -5 **Inventory Management**, the Check your progress, Glossary, Answers to Check your progress and Suggested Reading has been provided and the Learners are expected to attempt all the Check your progress as part of study.

Unit-13

Inventory Management and Independent Demand vs Dependent Demand

STRUCTURE

Overview

In this Unit the Inventory, Types of Inventory, Need for I M, Finished good Inventory, Inventory Costs & Factors effecting Inventory Operations are been explained in detail.

Objectives

After reading this lesson, you will be able to:

- Explain Inventory Management
- Identify the functions of MRP and
- Understand the meaning of Independent Demand

13.1. Introduction

Inventory management is a very important function that determines the health of the supply chain as well as the impacts the financial health of

the balance sheet. Every organization constantly strives to maintain optimum inventory to be able to meet its requirements and avoid over or under inventory that can impact the financial figures. Inventory is always dynamic. Inventory management requires constant and careful evaluation of external and internal factors and control through planning and review.

Most of the organizations have a separate department or job function called inventory planners who continuously monitor, control and review inventory and interface with production, procurement and finance departments. Inventory management is a very important function that determines the health of the supply chain as well as the impacts the financial health of the balance sheet.

Every organization constantly strives to maintain optimum inventory to be able to meet its requirements and avoid over or under inventory that can impact the financial figures. Inventory is always dynamic. Inventory management requires constant and careful evaluation of external and internal factors and control through planning and review. Most of the organizations have a separate department or job function called inventory planners who continuously monitor, control and review inventory and interface with production, procurement and finance departments.

13.2. Defining Inventory

Inventory is an idle stock of physical goods that contain economic value, and are held in various forms by an organization in its custody awaiting packing, processing, transformation, use or sale in a future point of time. Any organization which is into production, trading, sale and service of a product will necessarily hold stock of various physical resources to aid in future consumption and sale. While inventory is a necessary evil of any such business, it may be noted that the organizations hold inventories for various reasons, which include speculative purposes, functional purposes, physical necessities etc. The term inventory has been defined by several authors. The popular among them are :-“the term inventory includes materials-raw, in process, finished packaging, spares and others stocked in order to meet an unexpected demand or distribution in the future.” – B.D. Khare, Inventory Control,

From the above definition the following points stand out with reference to inventory:

- All organizations engaged in production or sale of products hold inventory in one form orother.
- Inventory can be in complete state or incomplete state.

All inventoried resources have economic value and can be considered as assets of theorganization.

13.3. Types of Inventories

Inventory of materials occurs at various stages and departments of an organization. A manufacturing organization holds inventory of raw materials and consumables required forproduction. It also holds inventory of semi-finished goods at various stages in the plant with various departments. Finished goods inventory is held at plant, FG Stores, distributioncenters etc.

Further both raw materials and finished goods those that are in transit atvarious locations also form a part of inventory depending upon who owns the inventory at the particular juncture.

Finished goods inventory is held by the organization at variousstocking points or with dealers and stockiest until it reaches the market and end customers. Besides Raw materials and finished goods, organizations also hold inventories of spareparts to service the products. Defective products, defective parts and scrap also forms a partof inventory as long as these items are inventoried in the books of the company and have economic value.

13.4. Need for IM

Most of the organizations have raw material inventory warehouses attached to the production facilities where raw materials, consumables and packing materials are stored and issue for production on JIT basis. The reasons for holding inventories can vary from case-to-case basis.

1. **Meet variation in Production Demand:** Production plan changes in response to the sales, estimates, orders and stocking patterns. Accordingly the demand for raw material supply for production varies with the product plan in terms of specific SKU as well as batch quantities.Holding inventories at a nearby warehouse helps issue the required quantity and item to production just in time.
2. **Cater to Cyclical and Seasonal Demand:** Market demd and supplies are seasonal depending upon various factors like seasons; festivals etc and past sales data help companies to anticipate a huge surge of demand in the market well in advance. Accordingly they stock up raw materials and hold inventories to be able to increase production and rush supplies to the market to meet the increased demand.
3. **Economies of Scale in Procurement:** Buying raw materials in

larger lot and holding inventory is found to be cheaper for the company than buying frequent small lots. In such cases one buys in bulk and holds inventories at the plant warehouse.

4. **Take advantage of Price Increase and Quantity Discounts:** If there is a price increase expected few months down the line due to changes in demand and supply in the national or international market, impact of taxes and budgets etc, the company's tend to buy raw materials in advance and hold stocks as a hedge against increased costs. Companies resortto buying in bulk and holding raw material inventories to take advantage of the quantity discounts offered by the supplier. In such cases the savings on account of the discount enjoyed would be substantially higher that of inventory carrying cost.
5. **Reduce Transit Cost and Transit Times:** In case of raw materials being imported from a foreign country or from a far away vendor within the country, one can save a lot in terms of transportation cost buy buying in bulk and transporting as a container load or a full truck load. Part shipments can be costlier. In terms of transit time too, transit time for full container shipment or a full truck load is direct and faster unlike part shipment load where the freight forwarder waits for other loads to fill the container which can take several weeks. There could be a lot of factors resulting in shipping delays and transportation too, which can hamper the supply chain forcing companies to hold safety stock of raw material inventories.
6. **Long Lead and High demand items need to be held in Inventory:** Often raw material supplies from vendors have long lead running into several months. Coupled with this if the particular item is in high demand and short supply one can expect disruption of supplies. In such cases it is safer to hold inventories and have control.

13.5. Finished good Inventory

Production Strategy necessitates Inventory holding: The blue print of the entire Production strategy is dependent upon the marketing strategy. Accordingly, organizations produce based on marketing orders. The production is planned based on Build to stock or Build to Order strategies.

While Build to Order strategy is manufactured against specific orders and does not warrant holding of stocks other than in transit stocking, Build to Stock production gets inventoried at various central and forward locations

to be able to cater to the market demands.

Market penetration: Marketing departments of companies frequently run branding and sales promotion campaigns to increase brand awareness and demand generation. Aggressive market penetration strategy depends upon ready availability of inventory of all

products at nearest warehousing location so that product can be made available at short notice - in terms of number of hours lead time, at all sales locations throughout the state and city. Any non-availability of stock at the point of sale counter will lead to dip in market demand and sales. Hence holding inventories becomes a necessity.

Market Size, location and supply design: Supply chain design takes into account the location of market, market size, demand pattern and the transit lead time required to reach stocks to the market and determine optimum inventory holding locations and network to be able to hold inventories at national, regional and local levels and achieve two major objectives. The first objective would be to ensure correct product stock is available to service the market. Secondly stocks are held in places where it is required and avoid unwanted stock build up.

Transportation and Physical Barriers: Market location and the physical terrain of the market coupled with the local trucking and transportation network often demand inventory holding at nearest locations. Hilly regions for example may require longer lead-time to service. All kinds of vehicles may not be available and one may have to hire dedicated containerized vehicles of huge capacities. In such cases they will have to have an inventory holding plan for such markets. Far away market locations means longer lead times and transportation delays. Inventory holding policy will take into account these factors to work out the plan.

Local tax and other Govt. Rules: In many countries where GST is not implemented, regional state tax rules apply and vary from state to state. Accordingly while one state may offer a tax rebate for a particular set of product category, another state may charge higher local taxes and lower interstate taxes. In such cases the demand for product from the neighboring state may increase than from the local state. Accordingly inventory holding would have to be planned to cater to the market fluctuation.

While in case of exports from the country of origin into another market situated in another country, one needs to take into account the rules regarding import and customs duties to decide optimum inventories to be held en route or at destination.

Production lead times: FG inventory holding becomes necessary incases where the lead- time for production is long. Sudden market demand or opportunities in such cases require FG inventories to be built up and supplies to be affected.

Speculative gain: Companies always keep a watch on the economy, annual state budget, financial environment and international environment and are able to foresee and estimate situations, which can have an impact on their business and sales.

In cases where they are able to estimate an increase in industry prices, taxes or other levies which will result in an overall price increase, they tend to buy and hold huge stocks of raw materials at current prices. They also hold up finished stock in warehouses in anticipation of an impending sale price increase. All such moves cause companies to hold inventories at various stages.

Avoid Certain Costs: Finally, organizations hold FG inventories to satisfy customer demand, Notes to reduce sales management and ordering costs, stock out costs and reduce transportation costs and lead times.

Markets and Supply Chain Design: Organizations carry out detailed analysis of the markets both at national as well as international / global levels and work out the Supply Chain strategy with the help of SCM strategists as to the ideal location for setting up production facilities, the network of and number of warehouses required to reach products to the markets within and outside the country as well as the mode or transportation, inventory holding plan, transit times and order management lead times etc, keeping in mind the most important parameter being, to achieve Customer Satisfaction and Demand Fulfillment.

13.6. Independent and dependent demand Inventories

Inventory Management deals essentially with balancing the inventory levels. Inventory is categorized into two types based on the demand pattern, which creates the need for inventory. The two types of demand are Independent Demand and Dependent Demand for inventories.

Independent Demand

An inventory of an item is said to be falling into the category of independent demand when the demand for such an item is not dependent upon the demand for another item. Finished goods Items, which are ordered by External Customers or manufactured for stock and sale, are called independent demand items. Independent demands for inventories

are based on confirmed Customer orders, forecasts, estimates and past historical data.

Dependent Demand

If the demand for inventory of an item is dependent upon another item, such demands are categorized as dependent demand. Raw materials and component inventories are dependent upon the demand for Finished Goods and hence can be called as Dependent demand inventories. Take the example of a Car. The car as finished goods is a held produced and held in inventory as independent demand item, while the raw materials and components used in the manufacture of the Finished Goods - Car derives its demand from the demand for the Car and hence is characterized as dependent demand inventory.

This differentiation is necessary because the inventory management systems and process are different for both categories. While Finished Goods inventories which is characterized by independent demand, are managed with sales order process and supply chain management processes and are based on sales forecasts, the dependent demand for raw materials and components to manufacture the finished goods is managed through MRP -Material Resources Planning or ERP – Enterprise Resource Planning using models such as Just In Time, Kanban and other concepts. MRP as well as ERP planning depends upon the sales forecast released for finished goods as the starting point for further action.

Managing Raw Material Inventories is far more complicated than managing Finished Goods Inventory. This involves analyzing and co-coordinating delivery capacity, lead times and delivery schedules of all raw material suppliers, coupled with the logistical processes and transit timelines involved in transportation and warehousing of raw materials before they are ready to be supplied to the production shop floor. Raw material management also involves periodic review of the inventory holding, inventory counting and audits, followed by detailed analysis of the reports leading to financial and management decisions.

13.7. Inventory Costs

Inventory costs are basically categorized into three headings:

1. Ordering Cost
2. Carrying Cost
3. Shortage or stock out Cost & Cost of Replenishment
    a) Cost of Loss, pilferage, shrinkage and obsolescence etc.

b) Cost of Logistics

c) Sales Discounts, Volume discounts and other related costs.

4. Ordering Cost: Cost of procurement and inbound logistics costs form a part of Ordering Cost. Ordering Cost is dependent and varies based on two factors - The cost of ordering excess and the Cost of ordering too less.

   Both these factors move in opposite directions to each other. Ordering excess quantity will result in carrying cost of inventory. Whereas ordering less will result in increase of replenishment cost and ordering costs.

   These two above costs together are called Total Stocking Cost. If you plot the order quantity vs the TSC, you will see the graph declining gradually until a certain point after which with every increase in quantity the TSC will proportionately show an increase.

   This functional analysis and cost implications form the basis of determining the Inventory Procurement decision by answering the two basic fundamental questions - How Much to Order and When to Order. How much to order is determined by arriving at the Economic Order Quantity or EOQ.

5. Carrying Cost: Inventory storage and maintenance involves various types of costsnamely:

   a. Inventory Storage Cost

   b. Cost of Capital

Inventory carrying involves Inventory storage and management either using in house facilities or external warehouses owned and managed by third party vendors. In both cases, inventory management and process involves extensive use of Building, Material Handling Equipments, IT Software applications and Hardware Equipments coupled managed by Operations and Management Staff resources.

a. **Inventory Storage Cost**: Inventory storage costs typically include Cost of Building Rentaland facility maintenance and related costs. Cost of Material Handling Equipments, IT Hardware and applications, including cost of purchase, depreciation or rental or lease as the case may be. Further costs include operational costs, consumables, communication costs and utilities, besides the cost of human resources employed in operations as well as management.

b. **Cost of Capital:** Includes the costs of investments, interest on

working capital, taxes on inventory paid, insurance costs and other costs associate with legal liabilities.

The inventory storage costs as well as cost of capital is dependent upon and varies with the decision of the management to manage inventory in house or through outsourced vendors and third-party service providers.

Current times, the trend is increasingly in favor of outsourcing the inventory management tothird party service provides. For one thing the organizations find that managing inventory operations requires certain core competencies, which may not be in line with their business competencies. They would rather outsource to a supplier who has the required competency than build them in house.

13.8. Factors effecting Inventory operations

Inventory management entails study of data on movement of inventory, its demand pattern, supply cycles, sales cycles etc. Active management calls for continuous analysis and management of inventory items to target at lean m inventory Management. Inventory Management function is carried out by the inventory planners in the company in close Notes coordination with procurement, supply chain logistics and finance, besides marketing departments. The efficiencies of inventory management are largely dependent upon the skills and knowledge of the inventory planners, the focus and involvement of management and the management policies coupled with the inventory management system. However inventory operations management is not under the control of the inventory management team but rests with the third party service providers. In this section of the article we aim to uncover few of the critical areas and action points on the part of operations that can impact the inventory of the company.

(1).Unskilled Labour and Staff: Inventory operations management is a process-oriented operation. Every task and action required to be carried out by the operatives will impact the inventory as well as the delivery lead times and other parameters. Therefore knowledge of what one is required to do and the effect of the action should be known to the operatives who are on the shop floor.

For Example: If an operative is given a put away task, he should know how and where he should put away the pallet, how to scan the pallet ID and confirm it back to the system. Besides he should also know the impact of not completing any of these actions or doing something wrong. The impact his action will have on the system as well as physical inventory

should be clear to the operative. Secondly different inventory items would have to be handled differently. Operatives who are carrying out the task should know why and what is required to be done. They should also know the consequences of not following the process. A pallet might have to be scanned for the pallet id and put away on a floor location, while a carton might have to be opened and scanned for individual boxes inside and put away into a bin.

The operatives should be trained on the entire process and understand why and what he is doing. The WMS systems are quite operational and task intensive. Where the warehouses are being managed on RF based systems, the operatives should be able to manage the RF readers, understand how to access and complete transactions through the RF Guns. Often it is noticed that when the warehouseoperations are being managed by a third party service provider and the principle customer is not present at the location, the quality of staff and operatives is compromised and people arenot given adequate training before being allocated their responsibility. Such situations can lead to inventory discrepancies.

(2).In adequate SOP, Training and emphasis on processes compliance: When a inventory management project kicks off at a third party warehouse location, both the principle customer as well as the third party service provider work on the project and setup basic processes, document them in Standard Operating Procedures and conduct training as a part of the project management methodology.

However, over a period of time, the nature of business requirements changes, resulting in change in the operating processes. These do not get documented in terms of amendments and the SOPs become outdated. Thereafter one finds that the new comers who are introduced on the shop floor are required to learn the processes by working along with others where as no training or SOP document is provided to him for reference. With the result they often have half-baked knowledge of the processes and carry on tasks not knowing why they are doing and what they are required to do.

This situation is very dangerous for the health of the inventory and it shows slackness in the attitude of the third party service provider. Continuation of such a situation will lead to bad housekeeping, inventory mismatches, and discrepancies and also affect the service delivery. If left unchecked can lead to theft, pilferage and misuse of inventory. In any third party owned inventory operations warehouse, the principle client should ensure that periodic review and training is conducted for all staff. Inventory

operations should be periodically reviewed and inventory counts and audits carried out regularly.

13.9. Inventory turnover as indicator for health of business

Inventory management as well as Supply chain operations are often overlapping and hold the key to the success of sales operations. In all of the businesses be in automobile, manufacturing, pharma or retail industry, status of inventory reflects the health of the business. Inventory operations have two key elements namely Inventory System and Physical operations. Today inventory systems have replaced the book keeping and financial accounting that was being practiced earlier. Current inventory systems not only do the book keeping but are linked to upstream as well as downstream activities including procurement, sales processing, and financial accounting. In terms of measuring a sales performance in relation to Inventory, we often use the term Inventory Turnover. Inventory turnover simply refers to the number of times the inventory is sold or used in a period of one year.

Inventory turnover is also termed as stock turn, or stock turnover. Inventory Turnover is calculated by taking the Total Cost of Goods Sold, divided by Average Inventory. Adding together opening inventory and closing inventory and dividing the figure by 2 which in turn gives average Inventory. The inventory turnover as a measure of health of sales and business is used extensively in Retail, textile as well as FMCG segments. A higher inventory turnover does indicate a healthy trend of increased sales and indicates the need to maintain adequate inventory levels to avoid stock outs. In adequate stocks can result in loss of business opportunities and is something that the management needs to keep watching closely. On the other hand a lower inventory turnover shows that either the sales of the said inventory is slowing down or that the unused inventory is building up clogging the system somewhere.

A slow inventory turn can help the inventory manager focus on finding non-moving, obsolete and slow moving inventory items and thereby steps can be taken to deal with them appropriately. When the inventory turnover is higher, the inventory operations efficiency will also be high to meet with the increased operational requirements thereby good housekeeping and increased responsiveness to market requirements. Inventory turn in some cases or some systems is also calculated based on the numbers sold rather than the average value of inventory. In such a system the Inventory turn is calculated by dividing the Number of Units Sold divided by the Average number of Units inventory held in a given period of time. Over a number of years, each industry has developed methods to check

inventory turnover and industry standards have been standardized. So whenever a new business venture is set up, they are able to have the industry standard as benchmark to be achieved and use it as a guide to streamline operations.

13.10. Good Inventory Management Practice

Good inventory Management practices in the company help by adding value in terms of having control over and maintaining lean inventory. Inventory should not be too much or too less. Both the situations are bad for the company. However often we see that inventory is not focused upon by the management and hence lot of inefficiencies build up over a period of time without the knowledge of the management.

It is only when we start a cost reduction drive that the inventory goof ups and skeletons come out of the cupboard and results in revamping the entire operations. However those companies, which have always focused on inventory as a principle function and recognized that the inventory effects their sales, as well as the books of accounts and profits, have managed to introduce and improve inventory management processes. Many business models work on lean inventory principle or JIT inventory along with other models like VMI etc.

Inventory management to a large extent is dependent upon the supply chain efficiency as well as operations. Inventory management is a management cum operations function. It requires operational processes to be followed and maintained on the floor and in inventory management systems. Coupled with operations, it entails continuous study; analysis and decision making to control and manage inventory levels. We have covered below briefly few of the points which when followed, can go a long way in ensuring that the inventory is lean and clean.

(1).Review Inventory periodically and revise stocking patterns and norms: Inventory is dependent upon the demand as well as the supply chain delivery time. Often companies follow one stocking policy for all items. For example, all A, B & C categories may be stocking inventory of 15 days, which may not be the right thing that is required. While some items may have a longer lead-time thus affecting the inventory holding, the demand pattern and the hit frequency in terms of past data may show up differently for each of the inventory items. Therefore, one standard norm does not suit all and can lead to over stocking of inventory as well as in efficiencies in the system.

(2).Get into detailed inventory planning - One size does not fit all: Understand the inventory types and the specific characteristics of the

items you are carrying. Then build the inventory stocking parameters taking into account the unique characteristics of the particular inventory. From amongst your inventory list, you will find that all types of materials are notof the same value. Some might be very expensive and need to be carried in stock for a longer period, while another item might have a shorter lead-time and may be fast moving. Quite a few items often have shelf life and hence require separate norms and focus to manage such items.

Getting into the detailed understanding will help you identify the inventory-stocking norm required to manage these characteristics to ensure optimum efficiency. The solution quite often may not be to carry stocks; rather it may involve setting up the customer service standard for such items and specifying a delivery time depending upon the frequency of demand. Quite a few items often have shelf life and hence require separate norms and focus to manage such items.

(3).Study demand pattern, movement patterns and cycles to build suitable inventory norms for different categories of inventory: Companies which are into retail segments and dealing with huge inventories in terms of number of parts as well as value will necessarily need to ensure they practice review of inventory list and clean up operations on ongoing basis. Popularly known as catalogue management, inventory norms review should be carried out based on detailed study of the sales data, demand pattern, sales cycles etc.

Understanding ofthe business and sales cycles specific to the product category helps one manage inventories better. For example, in case of retail garments, with every season certain skus become redundant no matter how their demand was in the previous months. This helps identify those stocks which are required to be managed at a micro level and identify the high value and fast-moving items that need to be always on the radar to avoid stock outs.

It does not help for example to carry standard stocks of all items including low value items as Notes well as high value items. If the low value items are locally available and the lead-time is less, one can cut down on the inventory and change the buying pattern. Similarly high valueitems too can be managed by cutting down the delivery lead times and in turn reducing inventory. It helps to periodically study the past data and extrapolate the same to identify slow moving and obsolete items. The dead stocks should be flushed out and active catalogue items should be made available.

Why Inventory Management Is Important

Holding inventory ties up a lot of cash. That's why good inventory management is crucial for growing a company. Just like cash flow, it can make or break your business. Good inventory management saves you money in a few critical ways:

Avoid Spoilage

If you're selling a product that has an expiry date (like food or makeup), there's a very real chance it will go bad if you don't sell it in time. Solid inventory management helps you avoid unnecessary spoilage.

Avoid Dead Stock

Dead stock is stock that can no longer be sold, but not necessarily because it expired. It could have gone out of season, out of style, or otherwise become irrelevant. By managing your inventory better, you can avoid dead stock.

Save on Storage Costs

Warehousing is often a variable cost, meaning it fluctuates based on how much product you're storing. When you store too much product at once or end up with a product that's difficult to sell, your storage costs will go up.

Inventory Management Improves Cash Flow

Not only does good inventory management save you money, it also improves cash flow in other ways. Remember, inventory is product that you've likely already paid for with cash (checks and electronic transfers count as cash too), and you're going to sell it for cash, but while it's sitting in your warehouse it is definitively not cash. Just try paying your landlord with 500 iPhone cases.

This is why it's important to factor inventory into your cash flow management. It affects both sales (by dictating how much you can sell), and expenses (by dictating what you have to buy). Both of these things factor heavily into how much cash you have on hand. Better inventory management leads to better cash flow management.

When you have a solid inventory system, you'll know exactly how much product you have, and based on sales, you can project when you'll run out and make sure you replace it on time. Not only does this make sure you don't lose sales (critical for cash flow), but it also helps you plan ahead for buying more so you can ensure you have enough cash set aside.

Let Us Sum Up

In this unit, you have learned about the following:

- Inventory management is a very important function that determines the health of the supply chain as well as the impacts the financial health of the balance sheet.
- Every organization constantly strives to maintain optimum inventory to be able to meet its requirements and avoid over or under inventory that can impact the financial figures. Inventory management requires constant and careful evaluation of external and internal factors and control through planning and review.
- Good inventory Management practices in the company help by adding value in terms of having control over and maintaining lean inventory.
- Inventory should not be too much or too less. Both the situations are bad for the company. However often we see that inventory is not focused upon by the management and hence lot of inefficiencies build up over a period of time without the knowledge of the management. It is only when we start a cost reduction drive that the inventory goof ups and skeletons come out of the cupboard and results in revamping the entire operations.
- Inventory operations have two key elements namely Inventory System and Physical operations.
- Today inventory systems have replaced the book keeping and financial accounting that was being practiced earlier. Current inventory systems not only do the book keeping but are linked to upstream as well as down stream activities including procurement, sales processing, financial accounting.
- Inventory management entails study of data on movement of inventory, its demand pattern, supply cycles, sales cycles etc. Active management calls for continuous analysis and management of inventory items to target at lean m inventory Management.
- Inventory Management function is carried out by the inventory planners in the company in close coordination with procurement, supply chain logistics and finance, besides marketing departments.

Check Your Progress

1. Effective inventory management minimizes the investment in inventory by effectively meeting the_____.
2. To achieve_____ in purchasing and transportation, goods may be Dpurchased in larger quantities than the actual demand.
3. The type of inventory method that comprises more number of accounting transactions is known as_____.

Glossary

Inventory: Inventory is the goods that your company handles with the intention of selling.It might be raw materials that you buy and turn into something entirely new, or it might be abulk product that you break down into its constituent parts and sell separately. It could even be something completely intangible: software, for instance.

Nature of business: The level of inventory will depend upon the nature of business whether it is a retail business, wholesale business, manufacturing business or trading business.

Inventory turnover: Inventory turnover refers to the amount of inventory which gets sold and the frequency of its sale. It has a direct impact on the amount of inventory held by a business concern. 3. Nature of type of product: The product sold by the business may be a perishable product or a durable product. Accordingly, the inventory has to be maintained.

Economies of production: The scale on which the production is done also affects the amount of inventory held. A business may work on large scale in order to get the economiesof production.

Inventory costs: More the amount of inventory is held by the business, more will be the operating cost of holding inventory. There has to be a trade-off between the inventory held and the total cost of inventory which comprises of

purchase cost, ordering cost and holding cost.

Financial position: Sometimes, the credit terms of the supplier are rigid and credit period is very short. Then, according the financial situation of the business the inventory has to be held.

Model Questions

1. Define inventory.
2. What is finished goods inventory?
3. What do you mean by inventory costs?
4. Justify the concept of inventory turnover.
5. Explain the benefits of inventory turnover.
6. Explain the need for inventory management
7. Define inventory. Explain various types of inventories.
8. Describe the advantages and disadvantages of inventory management.
9. What do you mean by inventory turnover? Discuss different types of inventory costs.
10. Narrate the different types of inventory management techniques.

Answers to Check Your Progress

1. Functional requirement.
2. Cost efficiency
3. Perpetual inventory system

Suggested Readings

1. Russell & Taylor (2010), Operations Management along Supply Chain, Wiley.
2. Slack N, Chambers S, Johnston R(2010), Operations management 6th edition Prentice Hall.
3. Krajewski, Lee J and Ritzman, Larry P (2015), Operations Management: Processes and Value Chains, Pearson.

Unit-14

Basic Economic Order Quantity (EOQ) Model

STRUCTURE

Overview

In this Unit the Introduction & Graphical Representation of E.O.Q , EOQ Model & A.B.C. Analysis (Always Better Control) are been explained in detail.

Objectives

After reading this lesson, you will be able to:

- Explain the term “Economic Order Quantity.
- Demonstrate “Economic Order Quantity” with the help of graph.
- Explain the A.B.C. Analysis
- Discuss the importance of A.B.C. Analysis
- Define A.B.C. Analysis

14.1. Introduction & Graphical Representation of E.O.Q.

Definition: Economic Order Quantity (EOQ) is a production formula used to determine themost efficient amount of goods that should be purchased based on ordering and carrying costs. In other words, it represents the optimal quantity of inventory, a company should order each time in order to minimize the costs associated with ordering and holding inventory. 1.1 Introduction to E.O.Q. This model is known as Economic Order Quantity

(EOQ) model, because it established the most economic size of order to place. It is one of the oldest classical production scheduling models. In 1913, Ford W. Harris developed this formula whereas R. H. Wilson is given credit for the application and in-depth analysis on this model.By using this model, the companies can minimize the costs associated with the ordering and inventory holding.It can be a valuable tool for small business owners who need to make decisions about how much inventory to keep on hand, how many items to order each time, and how often to reorder to incur the lowest possible costs. There are two most important categories of inventory costs are ordering costs and carrying costs.

Ordering costs: It is the costs that are incurred on obtaining additional inventories. They include costs incurred on communicating the order, traveling allowance and daily allowanceto purchase officers, printing and stationary, salary of purchase department, cost of inspection, cost of receiving the material, transportation cost etc. all above cost, other than transport costs remain unchanged per order irrespective of the order size. Therefore, it is assumed that ordering cost per order remain constant. The more frequently orders are placed, and fewer the quantities purchased on each order, the grater will be ordering cost and vice versa

Carrying cost: It is the cost incurred for holding inventory in hand. They include interest on the money locked up in stocks, storage costs, deterioration spoilage costs, insurance, evaporation, godown rent, pilferage, shrinkage, obsolescence, other overhead of stores department etc. They are assumed to be constant per unit of inventory. The large the volume of inventory, the higher will be the inventory carrying cost and vice versa.

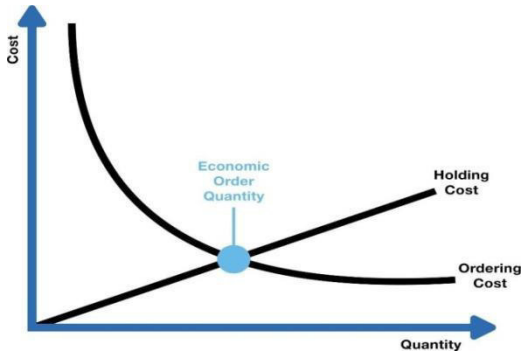
14.2. EOQ Model

Economic Order Quantity (EOQ) Model From the above discussion it is clear that ordering costs and carrying costs are quite opposite to each other. If we need to minimize carrying costs, we have to place small order which increases the ordering costs. If we want minimizeour ordering costs we have to place few orders in a year and this requires placing large orders which in turn increases the total carrying costs for the period. We need to minimize the total inventory costs, Thus, E.O.Q. is determine by the intersection of ordering cost curve and carrying cost line. At this point total ordering cost is equal to total carrying cost, and the total of the two costs is the least which has been demonstrated in the figure.

Assumptions in EOQ Model

The model is based on the following assumption: 1. Demand is known

with certainty and is constant over time. 2. There is no time gap between placing an order and receiving its supply i.e. lead time for the receipt of order is constant. 3. Ordering cost vary directly with the number of orders. 4. Carrying cost vary directly with the average inventory. 5. There is no quantity discount.



Economic Order Quantity

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

D = Annual demand (units)

S = Cost per order ($)

C = Cost per Unit ($)

I = Holding cost (%)

H = Holding cost ($) = I × C

Application

Calculating TC with these values, we get a total inventory cost of $18,175 for the year. Notice that the main variable in this equation is the quantity ordered, Q. The painter might decide to purchase a smaller quantity. If he or she does so, more orders will mean more fixed order expenses (represented by S) because more orders are handles but lower holding charges (represented by H): less room will be required to hold the paint and less money tied up in the paint. Assuming the painter buys 200 gallons at a time instead of 350, the TC will drop to $18,063 a year for a savings of $112 a year. Encouraged by this, the painter lowers his/her purchases to 150 at a time. But now the results are unfavorable. Total costs are now $18,075. Where is the optimal purchase quantity to be found? The EOQ formula produces the answer. The ideal order quantity comes about when the two parts of the main relationship (shown above) "HQ/2" and the "SD/Q" are equal. We can calculate the order quantity as follows: Multiply total units by the fixed ordering costs (3,500 Ã- $15) and

get 52,500; multiply that number by 2 and get 105,000. Divide that number by the holding cost ($3) and get 35,000. Take the square root of that and get 187. That number is then Q. In the next step, HQ/2 translates to 281, and SD/Q also comes to 281. Using 187 forQ in the main relationship, we get a total annual inventory cost of $18,061, the lowest cost possible with the unit and pricing factors shown in the example above. Thus EOQ is definedby the formula: EOQ = square root of 2DS/H. The number we get, 187 in this case, divided into 3,500 units, suggests that the painter should purchase paint 19 times in the year, buying 187 gallons at a time.

The EOQ will sometimes change as a result of quantity discounts offered by some suppliers as an incentive to customers who place larger orders. For example, a certain supplier may charge $20 per unit on orders of less than 100 units and only $18 per unit on orders over 100 units. To determine whether it makes sense to take advantage of a quantity discount when reordering inventory, a small business owner must compute the EOQ using the formula (Q = the square root of 2DS/H), compute the total cost of inventory for the EOQ and for all price break points above it, and then select the order quantity that provides the minimum total cost. For example, say that the painter can order

200 gallons or more for $4.75 per gallon, with all other factors in the computation remaining the same. He must compare the total costs of taking this approach to the total costs under the EOQ. Using the total cost formula outlined above, the painter would find TC = PD + HQ/2 + SD/Q = (5 Ã— 3,500) + (3 Ã— 187)/2 + (15 Ã— 3,500)/187 = $18,061 for the EOQ. Ordering the higher quantity and receiving the price discount would yield a total cost of (4.75 Ã— 3,500) + (3 Ã— 200)/2 + (15 Ã— 3,500)/200 = $17,187.

In other words, the painter can save $875 per year by taking advantage of the price break and making 17.5 orders per year of 200 units each. EOQ calculations are rarely as simple as this example shows. Here the intent is to explain the main principle of the formula.

The small business with a large and frequently turning inventory may be well served by looking around for inventory software that applies the EOQ concept more complexly to real-world situations to help to purchase decisions more dynamically.

14.3. A.B.C. Analysis (Always Better Control) – Introduction

ABC is a selective inventory control technique that stands for Always Better Control.

ABC analysis is a technique for prioritizing the management of inventory. Inventories are categorized into three classes - A, B, and C. Most management efforts and oversights are expended on managing A items. C items get the least attention and B items are in-between. Modern businesses may carry inventories of a large variety of items – finished goods, spare parts, and raw materials. Sometimes the numbers will run into the thousands. Managing these inventories involve answering, at a minimum, two questions - how much to order andwhen to order. Answers to these questions have to be based on an analysis of demand and lead time. Doing this one at a time for every item is neither efficient nor cost-effective, yet inventories have to be managed. They are often the biggest manageable costs of production and represent significant portions of a company's assets.

Traditionally, ABC analysis has been based on the criterion of dollar volume and on the principle that there are a relatively small number of items - category A - that account for the bulk of the dollar volume. At the other extreme, a large number of items - category C - account for a small share of the dollar volume. Category B items are between categories A and C, both in number and dollar volume. By this criterion, A items are those of both high-value and high-demand and C items are low-value and low-demand. However, over the last 30 years, there has been an accumulation of research questioning this focus on a single criterion – the dollar volume. It has been pointed out that other criteria can be important; among these are lead time, item criticality, durability, scarcity, reparability, stockability, commonality, substitutability, the number of suppliers, mode and cost of transportation, the likelihood of obsolescence or spoilage, and batch quantities imposed by suppliers.

Several methods have been developed to perform multi-criteria ABC analysis that can be quite easily implemented today. However, operations management textbooks still focus on the single criterion of dollar- volume. In this paper, it is argued that it is time to bring multi-criteria ABC analysis center- stage in the textbooks. Today's businesses and supply chains operate in a world where the ability to deliver the right products rapidly to very specific markets is key to survival. With suppliers, intermediaries, and customers all over the globe, and product lives decreasing rapidly, all the criteria listed above become much more important in deciding how inventory will be classified and how it will be managed.

Explanation of A.B.C.

This ABC analysis is based on economic principle of economist Vilfredo Pareto which statethat most of the economic productivity comes from only a small parts of the economy i.e. inany large group there are “significant few” and “insignificant many”. As I have discussed above, ABC analysis technique involves the classification of inventory items into three categories A, B & C.

14.4. Classification of items Under A.B.C.

Category ‘A’ . Most valuable and costly items are classified under ‘A’ category. Such items have large investment but not much in number. For example 10 percent of items account for70 percent of total invested in inventory. So, more careful and strict control is needed for such items. This category will be the smallest category in quantity but largest in monetary terms.

Category ‘B’ represents the middle parts of products between Category ‘A’ and Category ‘C’. They are larger in number than category ‘A’ but smaller in monetary term. These items having average consumption value. 20 percent of the item in an inventory account 20 percent for total investment. These ‘B’ items have less importance than ‘A’, so moderate control is needed for them.

Category ‘C’ . The items placed under category ‘C’ have the lowest consumption value. But, nearly 70 percent of inventory items account only for 10 percent of the total invested capital. So, these are “trivial many” items which do not catch much strict management attention i.e. loose control is needed for such items.

Why A.B.C. Analysis:

- Ensures control over the costly items.
- Reduction in the storage expenses.
- Resource allocation.
- Increased economy.

Limitation of A.B.C. Analysis:

- ABC Analysis does not permit precise consideration of all relevant problem of inventory control.
- If ABC Analysis is not updated and reviewed periodically the real purpose of control may be defeated. • Periodical consumption value is the basis for ABC classification not the unit value.

Application

ABC Analysis ABC analysis may be seen to share similar ideas as the Pareto principle, which states that 80% of overall consumption value comes from only 20% of items. Plainly,it means that 20% of your products will bring in 80% of your revenues. ABC analysis works by breaking it down in the following ways: A-items: 20% of all goods contribute to 70-80% of the annual consumption value of the items B-items: 30% of all goods contribute to 15-25% of the annual consumption value of the items

C-items: 50% of all goods contribute only 5% of the annual consumption value of the itemsIn order to calculate the annual consumption value of any item or items:

Value analysis is a problem-solving system implemented by the use of a specific set of techniques, a body of knowledge, and a group of learned skills. It is an organized creative approach whose purpose is the efficient identification of unnecessary costs, i.e. cost that provides neither quality nor use nor tool life nor appearance nor customer features." The term Value Analysis / Value Engineering originated in the early days of technique development and its first approach was to increase value, rather than to reduce costs.

Therefore there was a need to analyze value. "Value analysis approaches may assist all branches of an enterprise-engineering - manufacturing, procurement, marketing, and management by securing better answers to their specific problems in supplying what the customer wants at lower production costs. Quite commonly, 15 to 25 per cent and often more of manufacturing costs can be made unnecessary without any reduction in customer values by the use of this problem-solving system in significant decisional areas." VA/VE is an extremely powerful approach with over a century of worldwide application and it can be applied to any cost generating areas with equal success.

What is value

Different customers will answer to that question in different ways. The value of a product can be the performance of its functions or its aesthetic beauty, when applicable and needed. As a general statement high level performances, capabilities, emotional appeal, style, all compared to cost is commonly what we consider as value. Value Analysis is a standardized, multi-skilled team approach which aims at identifying the lowest cost way and ensuring the highest worth to accomplish the functions of a product, process or service. Value analysis means to assess product functions and value-to-cost ratios, and to find opportunities for costs reduction.

Classification and codification Classification and codification of materials are steps in maintaining stores in a systematic way. Materials are classified in such way that storing, issuing and identifying of materials become easy. Generally, materials are classified on the basis of their nature. Materials can also be classified on the basis of quality and utility. For example, materials may be classified as raw materials, consumable stores, components, spares and tools.

Thus classifying materials on different bases such as nature, quality and utility is called classification of materials. For the purpose of identification and conveniencein storage and issue of materials, each item of material is given a distinct name.

Such a process of giving distinct names and symbols to different items of materials is called codification of materials. Good store-keeping requires proper classification and codificationof various items of stores on stock. Stores are generally classified either by their nature or by their usage.

The former method of classification or classification by the nature of materials is most commonly used. Under this method of classification, the various items of stores are divided into specific groups like construction materials, belting materials, consumable stores, spare parts and so on. All the items are grouped, so that each item of stores will be conveniently codified on alphabetical, numerical or alpha-numerical basis concept and given a distinctive store code number.

In numerical codification, each item is allotted a number, the numbering may be straight orin groups or blocks. This method is very suitable for those companies where the number of items are very large.In alphabetical codification, each item is denoted by a combination of the alphabets, for example, A for nut, B for screw and so on.

This system is not suitable if there are large number of store items. In alpha-numeric codification, alphabets along with numbers are used for coding. The decimal codification system is more commonly used. The number of digits in the code will depend upon the extent of classification required.

The greater the number of details to be covered, the greater will be the number of digits. Following are the advantages of classification and codification of materials Quick and easy identification of materials. Helps ensure a proper material control. Secrecy of materials. Saving of time in material handling. Eliminating the chances of wrong issue.

Let Us Sum Up

In this unit, you have learned about the following:

- During this session, we have discussed about the Economic Order Quantity (EOQ) which is very useful tool for inventory control. It may be applied to finished goods inventories, workin-progress inventories and raw material inventories.
- It regulate of purchase and storage of inventory in such a way so as to maintain an even flow of production at the same time avoiding excessive investment in inventories.
- During this session, we have discussed about ABC analysis and learned that ABC analysis is a great way to inform your data into well interpreted segments that you can use to reduce overhead costs and drive profit.
- Traditionally, ABC analysis has been used to classify various inventory items into three categories - A, B, and C. This has been done based on the criterion of dollar volume. In the current globalized hyper-responsive business environment, a single criterion is no longer an adequate guide to the management of inventories and multiple criteria have to be considered.
- Researchers in operations and inventory management recognized this fact in the early 1980s and since then have proposed numerous approaches to multi-criteria ABC classification. However, textbooks of operations management and supply chain management have not followed their lead but continue to discuss ABC analysis based on the idea of annual dollar volume.

  In this paper, the authors review the literature to date and argue that multi-criteria ABC analysis is a mature concept that needs to make its way into textbooks. Authors should revise their coverage to include a detailed coverage of the concept and methodology of multi-criteria ABC analysis.

  Such a revision will make their textbooks more relevant to the current business environment and provide students with the skills they need to function and contribute in the workplace.
- As a result, companies will be able to manage their inventories better and be more competitive in the marketplace.

Check Your Progress

1. ABC Analysis is used in _____.
2. ABC analysis is _____.
3. Always better Control _____.

Glossary

Economic Order Quantity (EOQ): is the order quantity that minimizes total inventorycosts.

Order Quantity: is the number of units added to inventory each time an order is placed.

Total Inventory Costs: is the sum of inventory acquisition cost, ordering cost, and holding cost. Ordering Cost is the cost incurred in ordering inventory from suppliers excluding thecost of purchase such as delivery costs and order processing costs.

Carrying cost: also known as Holding Cost, is the total cost of holding inventory such as warehousing cost and obsolescence cost.

ABC Analysis Relates to the Pareto Principle: The Pareto Principle says that most results come from only 20% of efforts or causes in any system. Based on Pareto's 80/20 rule, ABC analysis identifies the 20% of goods that deliver about 80% of the value. Therefore, most businesses have a small number of "A" items, a slightly larger group of B products and a big group of C goods, a category that that defines the majority of items.

Model Questions

1. Explain the term "Economic Order Quantity".
2. Demonstrate "Economic Order Quantity with the help of graph.
3. Write the Assumption Economic Order Quantity.
4. What is Ordering? Explain it.
5. Explain the term "carrying cost"

6. Describe the A.B.C.
7. Define A.B.C
8. Explain A.B.C. Analysis with the help of graph.

Answers to Check Your Progress

1. Inventory Management
2. Always Better Control
3. Controlling the Inventory Costs Money.

Suggested Readings

1. Edward Pound, Jeffrey Bell, Mark Spearman (2014), Factory Physics for Managers, How Leaders Improve Performance in a Post-Lean Six Sigma World-McGraw-Hill Education.
2. Russell & Taylor (2010), Operations Management along Supply Chain, Wiley.
3. Slack. N, Chambers.S, Johnston.R(2010) Operations Management 6th edition, Prentice Hall.

Unit-15

Push vs Pull system and Just-In-Time vs Material Requirement Planning

STRUCTURE

Overview

In this Unit the Push and Pull Strategy, Operations Introduction, JIT & Material Requirement Planning are been explained in detail.

Objectives

After reading this lesson, you will be able to explain:

- The Characteristics of just-in-time system
- The Pull method versus push method of operation
- The Prerequisite for J3T manufacturing Benefits of ET manufacturing.
- The Kanban system of manufacturing.

15.1. Difference between Push and Pull Strategy

The two promotional strategies which is applied to get the product to the target market is Push and Pull Strategy. While in the **Push strategy**, the idea is to push the company's product onto customers by making them aware of it, at the point of purchase. **Pull strategy** relies on the notion, "to get the customers to come to you". The two types of strategies differ, in the way consumers are approached.

The term is derived from logistics and supply chain management, however, their use in marketing is not less. The movement of a product or information is the essence of push and pull strategy. This article excerpt may help you in understanding the difference between push and pull strategy.

15.2. Definition of Push Strategy

The strategy wherein marketing channels are used to push the product or service to sales channel is called push strategy. It explains the movement of products & services and information through intermediaries to the final consumer. In this strategy, the company takes their product to the customers, who are neither aware of it nor seeking it but the product is introduced to them, through various promotional activities.

The strategy uses trade show promotion, the point of sale display, direct selling, advertisement on radio, television, emails etc. to make an impact on consumers' mind and reducing the time between the discovery of a product and purchasing it.

15.3. Definition of Pull Strategy

The business strategy which aims at generating interest or demand for a particular product or service of the target audience, in a way that they

demand the product or service from the channel partners, is called pull strategy. In this strategy, the consumer demands are intensified by directing marketing strategies on them, which results in the 'pulling' of Products. Pull strategy uses methods like social networking, blogging, word of mouth, strategic placement of a product, media coverage, and so on, for reaching a large audience.

In finer terms, any method which is used for creating consumer demand for the product is called the Pull strategy. It is one such strategy, in which customers actively seek products ofa particular brand, due to its goodwill, quality, reliability, and reputation.

15.4. Key Differences between Push and Pull Strategy

The differences between push and pull strategy, is provided in the points given below:

1. The type of marketing strategy which involves direction of marketing efforts to intermediaries is called push strategy. On the other hand, the marketing strategy involving the promotion of marketing efforts to the end user is called pull strategy.
2. In pull strategy, communication of products or information is demanded by the buyer, while in push strategy, no such communication is demanded.
3. Push strategy aims at making customer aware of the product or brand. As against this, pull strategy encourages the customer to seek the product or brand.
4. Push strategy uses sales force, trade promotion, money, etc. to induce channel partners, to promote and distribute the product to the final customer. Conversely, pull strategy uses advertising, promotion and any other form of communication to instigate customer to demand product from channel partners.
5. Push strategy focuses on resource allocation whereas pull strategy is concerned withresponsiveness.
6. There is a long lead time in push strategy. However, it is just opposite in the case of pull strategy.
7. Push strategy is best suited when there is low brand loyalty in a category. Unlike pull strategy, is appropriate for the products with high brand loyalty, where the consumers are well known about the differences in various brands, and they opt for a particular brand before they go shopping.

15.5. Operations Introduction

In financial parlance, inventory is defined as the sum of the value of raw materials, fuels and lubricants, spare parts, maintenance consumables, semi-processed materialsand finishedgoods stock at any given point of time. The operational definition of inventory would be: the amount of raw materials, fuel and lubricants, spare parts andsemi-processed material to be stocked for the smooth running of the plant. Since theseresources are idle when kept in the stores, inventory is defined as an idle resource or any kind having an economic value.

Inventories are maintained basically for the operational smoothness which they can effect by uncoupling successive stages of production, whereas the monetary value of inventory serves as a guide to indicate the size of the investment made to achieve this operational convenience. The materials management department is expected to provide this operational convenience with a minimum possible investment in inventories. The objectives of inventory, operational and financial, needless to say, are conflicting. The materials department is accused of both stock outs as well as large investment in inventories. The solution lies in exercising a selective inventory controland application of inventory control techniques.

Inventory control has been attracting the attention of managers in India for a long time. Forcontrol purposes, it is very essential to study the inventory in detail- raw materials, production components, work-in-progress and finished goods inventories should be segregated as the reasons for their existence and the causes for their size are different.

Raw materials and production components are purchased from outside suppliers and the reason for their existence is to uncouple the purchasing function from the production function. The size of this inventory is depend upon factors such as internal lead time for purchase, supplier lead time, vendor relations availability of the material government import policy, in the case of imported material, the annual consumption of the materials (ABC classification) and the relative criticality of the material (VED classification).

Work-in progress inventory might exist merely because of the production cycle time or could also be maintained for decoupling successive manufacturing operations. The decoupling could be employed either for implementing an incentive scheme or to enable each of the production departments to plan independently. The size of this inventory is dependent on the production cycle time, the percentage of machine utilization, the make/ buy policies of the company, and the management

policy for decoupling the various stages of manufacturing.

The finished goods inventory is maintained to assure a free-flowing supply to the customers and for this the marketing department insists on substantial finished goods inventory. The size also depends on the ability of the marketing department to push the products, the, company's ability to stick to the delivery schedule of the client, the shelf life and the warehousing capacity.

Two factors which influence the inventories of all types are: the accuracy and details of the final forecast-all the inventories are geared for future requirements and are therefore sensitive to this factor-and the available storage space-the logical sequence to this factor isthe shelf life of the items stored, a factor for consideration in the case of perishable goods.

15.6. Just-in-Time (JIT) Introduction

Just in Time (JIT) is a Japanese innovation, and key features of this were perfected by Toyota. Some facets of the management practices Toyota developed are ideologically related to Japan's unique customs, culture, and labour - management relations.

However there is nothing uniquely Japanese about JIT production and it is usable anywhere.The concepts have been applied successfully in many companies throughout the world. JIT production means producing and buying in very small quantities just in time for use.

It is simple hand to mouth mode of industrial operations that directly cuts inventories and also reduces the need for storage space, racks, conveyors, forklifts, computer terminals for inventory control and of course material control personnel. Products are assembled just before they are sold, subassemblies are made just before the products are assembled, and components are fabricated just before the subassemblies are made - so work-in-process (WIP) inventory is low and production lead times are short. To operate with these low inventories, the companies must be excellent in other areas. They must have consistently high quality throughout the organizations.

To achieve this quality and coordination, they must have the participation and cooperation of all employees. So TIT manufacturing or manufacturing excellence is a broad philosophy of continuous improvement. More important, the absence of continuous improvement. More important, the absence of extra inventories creates an imperative to run an error free operation because there is no cushionof excess parts to keep production going when problems crop up, causes of error are rooted out, never to occur again.

The JIT transformation begins with inventory removal. Fewer materials are bought, and parts and products are made in smaller numbers; that is the lot size inventories thereby decrease. This immediately results in work stoppages. Production comes to standstill because feeder processes breakdown or produce too many detectives and d-there are no buffer stock to keep things going on. Once this happens, analysts and engineers try to solve the problems and keep things going on. Each round of problem exposure and solution increases productivity and quality too.

Just-in-time (JIT) is a philosophy of improvement through aggressively discovering and resolving any problems or weaknesses that impede the organization's effectiveness and efficiency. Basically, it seeks to eliminate all waste within the organisation, including the waste of underutilizing the talents, skills, and potential of its employees. Anything that does not contribute to add in value for an internal or external customer is considered waste. The philosophy originated in manufacturing operations, but its concepts have been applied in other area such as a means of work, service and distribution. JIT can be very effective and powerful as a means of improvement.

15.7. Characteristics

Just-in-time systems focus on reducing inefficiency and unproductive time in the production process to improve continuously the process and the quality *of* the produce or service. Employee involvement and inventory reduction are essential to JIT operations. Just-in-time systems are known by many different names, including zero inventory synchronous manufacturing , lean production, stock less production (Hewlett- Packard), material as needed (Harley - Davidson), and continuous flow manufacturing (IBM). In this section we discuss the following characteristics of JIT systems : People involvement, Team Work, Discipline, Total quality management, pull method of material flow, small lot sizes, short setup times, uniform workstation loads, standardized components and work methods, close supplier ties, flexible work force, product focus, automated production, and preventivemaintenance.

People Involvement

Probability all management efforts have some behavioural aspects, because management is working through other people to accomplish the organization's objectives. Management plans and decisions only lay the groundwork. This is the resulting human behaviour that determines a company's success or failure. Such terms as zero inventory and stock less production have given some people the impression that JIT is only an

inventory program. JIT has a strong human resources management components that must be recognized if the technical component is to be fully successful. Much of the success of JIT can be traced to the fact that companies that use it train their employees to have the appropriate skill, give them responsibility, and coordinate and motivate them.

The JIT philosophy of continuous improvement and minimization of waste considers waste to be any activity that does not add value to the product or serve the customer insome way. One form of waste that is inconspicuous and difficult to combat is the underutilization of human talent. JIT seeks to utilize more fully the creative talents of employees, suppliers, subcontractors, and others who may contribute to the company'simprovement.

Businesses ultimately succeed or fail because of their people. JIT is no exception to this rule. Because JIT is a system of enforced problem solving, having a dedicated work force committed to working together to solve production problem, is essential. JIT manufacturing, therefore, has a strong element of training and involvement of workers in all phases of manufacturing.

Teamwork

First, and foremost, a culture of mutual trust and teamwork must be developed in an organization. Managers and workers must see each other as co-workers committed to the company's success.

Successful people involvement steams from a culture of open trust and teamwork in which people interact to recognize, define, and solve problems. Sometimes it is mistakenly assumed that this component is just another program, such as a suggestion program or a quality circle program.

People involvement can include these programs and others, such as adhoc project teams that focus on specific improvement targets andsemi-autonomous work teams whose membership seldom changes. The involvement components of JIT is much broader than a program or two: it is a management style and a permanent company-wide attitude of teamwork. So that each person works to improve the company. People are encouraged to suggest ways to improve methods which are quickly and fairly considered, improvement.

Another important factor that is crucial to JIT is the empowerment of workers. This means that workers are given the authority to take the initiative in solving production problems. Rather than waiting for guidance from above, workers have the authority to stop production at any time for

such things as quality problems machine malfunctions or safety concerns. Groups of workers are then encouraged to work together to quickly get production going again. Once workers have identified problems. They are encouraged to meet during breaks before work or after work to discuss the problems. Having workers actively involved in problem solving is the objective of worker empowerment. People, suppliers, workers, managers and customers must all be motivated and committed to teamwork for JIT manufacturing to be effective.

Discipline

This open, improvement - driven atmosphere does not mean, however, that any employee is free **to** work by any method he or she choose to try. Usually there is a standard way each job is to be done. If an improvement is suggested and approved, a new standard procedure will be adopted. This standardization prevents variations in products or services which can cause defects. Defects occur- because some variationhas been introduced into a material or procedure that normally products good result. When an efficient procedure that results **in** good quality is established, it is to be followed until a better way is tested and approved. You can see that creativity and openness to change are needed, but it is creativity in conjunction with teamwork anddiscipline that achieves consistent good quality and leads to improvements.

15.8. Total Quality Management (TQM)

JIT systems seek to eliminate scrap and rework in order to achieve a uniform flow of materials. Efficient JIT operations require conformance to product or service specifications. JIT systems control quality at the source, with workers acting as their own quality inspectors.

JIT manufacturing depends on a system of TQM being in place. Successful JIT manufacturing goes hand-in-hand with an organization-wide TQM culture. Just as everyonehas to be involved in JIT, so also must everyone be involved in TQM. Total commitment to producing products of perfect quality every time and total commitment to producing products for fast delivery to customers have one essential thing in common Both are finely focused on the overall goal of satisfied customers.

Pull Method of Material Flow

Just-in-time systems utilize the pull method of material flow. However, another popular method of material flow is the push method. To differentiate between these two systems, we consider the production system for a fast food dish at a restaurant. There are two workstations. The dish maker is the person responsible for producing; this dish: the

cutlets must be prepared; buns must be toasted and then dressed with ketchup, pickles, onions, lettuce, and cheese; and the cutlets must be inserted into buns and put on a tray. The final assembler takes the tray, wraps the buns in paper, and restocks the inventory. Inventories must be kept low because any buns left unsold after ten minutes must be destroyed.

The flow of materials is from the dish maker to the final assembler to the customer. Onewayto manage this flow is by using the push method, in which the production of the item begins **in** advance of customer needs. With this method, management schedules the receipt of all raw materials (e.g., vegetables, buns, and condiments) and authorizes the start of production, all in advance of the dish needs. The dish maker starts of production, no. of dish (the capacity of the griddle) and, when they are completed, pushes them along to the final assembler's station, where they might have to wait until he is ready forthem. The packaged dishes then wait on a warming tray until a customer purchases one.

The other way to manage the flow among the dish maker, the final assembler, and the customer is to use the pull method, in which customer demand activates production of the item. With the pull method, as customer purchase dish, the final assembler checks the inventory level of dish and, when they are almost depleted, orders six more. The dish maker produces the six dish and gives the tray to the final assembler, who completes the assembly and places the dish in the inventory for sale. The pull method is better for the inventory low, important because of the ten-minute time limit. The production of dishis a highly repetitive process, setup times and process times are low, and the flow of materials is well defined. There is no need to produceto anticipated needs more than afew minutes ahead.

Firms that tend to have highly repetitive manufacturing processes and well-defined material flows use just-in-time systems because the pull method allows closer controlof inventory and production at the workstations. Other firms, such as job shops, producing products in low volumes with low repeatability in the production process, tend to use a push method such as MRP. In this environment a customer order is promised for delivery on some future date. Production is started at the first workstation and pushed ahead to the next one. Inventory accumulates in anticipation of shipping the completed order on the promised date.

Small Lot Sizes

Rather than building up a cushion of inventory, users of JIT systems maintain inventory with lot sizes that are as small as possible. Small lot

size have three benefits. First, small lot sizes reduce cycle inventory, the inventory in excess of the safety stock carried between orders. The average cycle inventory equals one-half the lot size: As the lot size gets smaller,so does cycle inventory. Reducing cycle inventory reduces the time and space involved in manufacturing and holding inventory,

Second, small lot size help cut lead times. A decline in lead time in turn cuts pipeline (WIP)inventory because the total processing time at each workstation is greater for large lots than for small lots. Also, a large lot often has to wait longer to be processed atthe next workstation while that workstation finishes working on another large lot. In addition, if any defective items are discovered, large lots cause longer delays becausethe entire lot must be inspected to find all the items that need rework.

Finally, small lots help achieve a uniform operating system workload. Large lots consume large chunks of processing time on one workstation and therefore complicatescheduling.

Short Setup Times

Reduced lot sizes have the disadvantage of increased setup frequency. In operations where the setup times are normally low, small lots are feasible. However, in fabricationoperations with sizable setup times, increasing the frequency of setups may result in wasting employee and equipment time. Theses operations must reduce setup times to realize the benefits of small-lot production.

Uniform Workstation Loads

The JIT systems work best if the daily load on individual workstation is relatively uniform. Uniform loads can be achieved by assembling the same type and number ofunits each day, thus creating a uniform daily demand at all workstations. Capacity planning, which recognizes capacity constraints at critical workstations, and line balancing are used to develop the monthly master production schedule.

Standardized Components and Work Methods

The standardization of components, called part commonality or modularity, increases repeatability. For example, a firm producing 10 products from 1000 different components could redesign its products so that they consist of only 100 different components with large daily requirements. Because the requirements per components increase, so does repeatability; that is, each worker performs a standardized task or work method more often each day. Productivity tends to increase because workers learn to do the task more efficiently. Standardization of

components and work methods aids in achieving the high- productivity, low-inventory objectives of JIT systems.

Close Supplier Ties

The JIT philosophy may extend beyond the walls of the company applying JIT, to include, its suppliers. It has an impact on the entire logistics system, or "supply chain." Because JIT systems operate with very low levels of inventory, close relationships with supplier are necessary. Stock shipments must be frequent, have short lead times, arrive on schedule, and be of high quality. A contract might require a supplier to deliver goods to a factory as number of supplier, using local suppliers, and improving supplier relations.

Typically, one of the first actions undertaken when a JIT system is implemented is to pare the number of suppliers. Xerox, for example, reduced the number of its suppliersfor 5000 to just 300. This approach puts a lot of pressure on these suppliers to deliver high-quality components on time. By placing a bigger percentage of its business withits business with its best suppliers, the company can improve its quality and the reliability of receiving items. The partnership is a long term agreement so the companies can develop a smooth working relationship. The desire is for the supplier tobecome an extension of the company so that the supply chain is aseamless organization that works to serve the ultimate customer better than any competing supply chain could.

The JIT company can also benefit from the supplier's expertise by having supplier representatives participate in the design phase of few products and recommend improvements. They also work with their suppliers vendors, trying to achieve JIT inventory flows throughout the entire supplier chain.

It can be beneficial to a supplier to work in such a relationship, particularly with a high volume manufacturer. When a company reduces the number of suppliers for an item, the volume of purchase from the remaining supplier or supplier can increase dramatically.

Continuous improvement is central to the philosophy of JIT and is a key reason for its success.

Flexible Work Force

Workers in flexible work forces can perform more than one job. When the skill levels required to perform most tasks are low, a high degree of flexibility in the work force can be achieved with little training. In situations requiring higher skill levels, such as at the Hi-tech industries, shifting

workers to other jobs may require extensive, costly training. Flexibility can be very beneficial. Workers can be shifted among workstations to help relieve bottlenecks as they arise without resorting to inventory buffers. This is an important aspect to the uniform flow of JIT systems. They can also step in and do the job for those on vacation or out sick. Although assigning workers to tasks they don't usually perform may reduce efficiency, some rotation relieves boredom and refreshes workers.

Product Focus

A product focus can reduce the frequency of setups. If volumes of specific products arelarge enough, groups of machines and workers can be organized into a product layoutto eliminate setups entirely. It volume is insufficient to keep a line of similar products busy, group technology can be used to design small production lines that manufacture, volume, in families of components with common attributes. Changeovers from a component in one product family to the next component in the same family are minimal.

Automated Production

Automation plays a big role in JIT systems and is a key to low-cost production. Sakichi Toyota, the founder of Toyota, once said "whenever there is money, invest it into machinery". Money freed up because of JIT inventory reductions can be invested in automation to reduce costs. The benefits, of course, are greater profits, greater market share (because prices can be cut), or both. Automation should be planned carefully, however, many managers believe that if some automation is good, more is better. Thatisn't always the case.

Preventive Maintenance

Because JIT emphasizes finely tuned material flows and little buffer inventory between workstations, unplanned machine downtime can be disruptive. Preventive maintenance can reduce the frequency and duration of machine downtime. After the technician has performed routine maintenance activities, he/she can rest other parts that might need to be replaced. Replacement during regularly scheduled maintenanceperiods is easier and quickerthan dealing with machine failures during production.

Maintenance is done on a schedule that balances the cost of the preventive maintenance program against the risks and costs of machine failure. Another tactic is to make workers responsible for routinely maintaining their own equipment and develop employee pride in keeping their machines in top condition.

Production Methods

Processes are designed so that there is less specialization of workers. The physical layout isarranged so that a worker can operate two or three different machines, thus providing flexibility in processes that might precedes the assembly line. The benefitsthat result from this organisation of multi-function workers are:

- reduction of inventory between what would otherwise be separate processes
- decrease in the number of workers required, resulting in a direct increase inproductivity
- increased worker satisfaction because of more broadly defined jobs
- multi-functional workers can engage in teamwork

There are three elements of job standardization that are included on a standardoperationsheet stacked up for all workers to see: Cycle time, operations routing, and standard quantity of work in process.

Based on the computed cycle time that is derived from market demand, the aggregate number of workers required to produce one unit of output in the cycle time is determined. Rebalancing may then be necessary to schedule for minimum labour inputfor a given output objective. The standard quantity of work input for a given output objective. The standard quantity of work in process indicates the in-process inventoryrequired for smooth flow.

The smoothing of production is regarded as the most critical element in the Just-in-Time objective. As will be described in more detail under the heading Kanban which follows, workers go to the preceding process to withdraw the required parts andcomponents for their operations. If there are fluctuations in the rates at which these materials are withdrawn, then the preceding process must hold buffer in-process inventories to give off the-shelf service. The required in-process inventories would increase also for upstream processes. This results in the objective of minimizing production fluctuations in the final assembly line by scheduling small lots of individual models, and focusing "all out" efforts on minimizing setup times for all processes.

15.9. Benefits of JIT Manufacturing

Some of the benefits that a JIT system provides are:

- Inventory levels are drastically reduced.

- The time it takes for products to get through the factory is greatly reduced, thus enabling factories to engage in time based competition, using speed as a weapon tocapture share.
- Product quality is improved, and the cost of scrap is reduced. Product quality improves because of worker involvement in solving the causes of production problem and with smaller lots, defective parts are discovered earlier.
- With less in-process inventory, less space is taken up with inventory and materials handling equipment. Workers are closer together so that they can see each other, communicate more easily, work out problems more efficiently, learn each other'sjobs, and switch job as needed. This promotes teamwork an-tong workers and flexibility in work assignments.

  Because the focus in manufacturing is on finding and correcting the causes of production problems, manufacturing operations are streamlined and problem-fr

15.10. JIT JPurchasing

The same pull type approach in JIT is applied to purchasing shipments of parts from suppliers. In JIT purchasing, supplier use the replacement principle of Kanban by using small. Standardize containers and make several shipments daily to each customer. If Kanban is used by a supplier. Kanban cards authorize the movement of containers of parts ordinarily located near their customers. JIT therefore not only reduces in-processinventories by using Kanban, but raw-materials inventories are also reduced by applying the name principles to suppliers.

The essential elements of JIT purchasing are as follows:

1. Supplier development and supplier relations undergo fundamental changes. The nature of the relationships between customers and suppliers shifts from being adversarial to being cooperative. The Japanese call these relationships subcontractor networks and costs and improving quality, and even financing areoften shared by customers and suppliers.
2. Purchasing departments develop long-tern relationships with suppliers. The result is long- term supply contracts with a few suppliers rather than short-term supply contracts with many suppliers. Repeat business is awarded to the same suppliers, and competitive bidding is ordinarily limited to new parts.
3. Although price is important, delivery scheduled, product quality,

and mutual trust and cooperation become the primary basis for supplier selection.

4. Suppliers are encouraged to extend JIT methods to their own suppliers.
5. Suppliers are ordinarily located near the buying firm's factory, or if they are samedistance from the factory, they are usually clustered together. This causes lead times to be shorter and more reliable.
6. Shipments are delivered directly to the to the customer's production line. Because suppliers are encouraged to products and supply parts at a steady rate that matchesthe use rate of the buying firm. Company-owned hauling equipment tends to be preferred.
7. Parts delivered in small, standard-size containers with a minimum of paperwork and in exact quantities.
8. Delivered material is of near-perfect quality. Because suppliers have a long-term relationship with the buying firms and because parts are delivered in small lot sizes, the uality of purchased materials tends to be higher.

15.11. JIT in Seasonal Demand Industry

The fashion garment industry is example of a high seasonal industry. Fashion garments are highly style and fashion sensitive and get out-dated quickly. Thus, discount sales and financial losses are not uncommon. World Company is a leading producer of fashion garments in Japan. It is a member of NPSRA. Prior to JTT, world used mass production system, which made it suffer from over-production, and excessive inventory.

As part of its JIT strategy, world dispensed with the mass production machinery. It adopted "slow speed" machines to achieve balanced, synchronised garment production.

`Multitask' production was adopted, where in each worker operated not one but several machines which performed different tasks, in a well defined cycle. With transition to JIT, world reduced the lead time from one month to two hours, enabling it to produce to orders, eliminate inventories and discounting:

15.12. Use of Kanban in a Job Environment

A manufacturer in Canada operated a job shop to manufacture to orders, high quality outdoor clothing used for camping, hunting, canoeing, skiing and so on. Both summer and winter clothes were produced. The

manufacturer faced problems resulting in out of phase production. Traditionally the orders were grouped in to a production run that included all the sizes and colours required. This resulted in high WIP and long lead times.

After implementing KANBAN and JIT, following improvements were observered : improved quality due to small lots, less WIP, lower congestion in packing and shippingareas,increase in throughput capacity, quicker availability of finished products, and release of 40- 50% of space.

15.13. Material Requirement Planning

Material Requirements Planning (MRP) is a computer-based production planning and inventory control system. MRP is concerned with both production scheduling and inventory control. It is a material control system that attempts to keep adequate inventory levels to assure that required materials are available when needed. MRP is applicable in situations of multiple items with complex bills of materials. MRP is not useful for job shops or for continuous processes that are tightly linked.

The major objectives of an MRP system are to simultaneously:

1. Ensure the availability of materials, components, and products for plannedproduction and forcustomer delivery,
2. Maintain the lowest possible level of inventory,
3. Plan manufacturing activities, delivery schedules, and purchasing activities.

MRP is especially suited to manufacturing settings where the demand of many of the components and subassemblies depend on the demands of items that face external demands. Demand for end items are independent. In contrast, demand for componentsused to manufacture end items dependon the demands for the end items. The distinctions between independent and dependent demandsare important in classifying inventory itemsand in developing systems to manage items within each demand classification. MRP systems were developed to cope better with dependent demand items. The three majorinputs of an MRP system are the *master production schedule*, the *product structure records*, and the *inventory status records*. Without these basic inputs the MRP system cannot function.

The demand for end items is scheduled over a number of time periods and recorded on a **master production schedule** (MPS). The master production schedule expresses how much of each item is wanted and when it is wanted. The MPS is developed from forecasts and firm

customer orders for end items, safety stock requirements, and internal orders. MRP takes the master schedule for end items and translates it into individual time-phased component requirements.

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

The **inventory status records** contain the status of all items in inventory, including on hand inventory and scheduled receipts. These records must be kept up to date, with each receipt, dis- bursement, or withdrawal documented to maintain record integrity.

MRP will determine from the master production schedule and the product structure records the gross component requirements; the gross component requirements will be reduced by the available inventory as indicated in the inventory status records.

15.14. MRP Computations

We will illustrate MRP computations through examples.

Example 1 Suppose you need to produce 100 units of product A eight week from now, where product A requires one unit of product B and two units of product C, whileproduct C requires oneunit of product D and two units of product E. How many units of each type do you need? In this example it is easy to compute the requirements of each item to produce 100 units of product A: Req(B) = 100, Req(C) = 200, Req(D) = 200, Req(E) = 400.

Suppose further that the lead-times for the products are as follows: Product A, four weeks, product B three weeks, product C two weeks, products D and E one week each. Since the production lead-time for product A is four weeks, we must have products B and C available at the end of week four. Since product B has a lead time of three weeks, we need to release the production of product B by the end of the first week. Similarly, product C need to be released for production at the endof week two, while products D and E must be released for production at the end of week one.

A material requirements plan has been developed for product A based on the product structure of A and the lead-time needed to obtain each component. Planned order releases of a parent item are used to determine gross requirements for its component items. Planned order

release dates are simply obtained by offsetting the lead times. The computations and steps required in the MRP process are not complicated. They involve only simple arithmetic. However, the bill-of-materials explosion must be done with care. What may get complicated is the product structure, particularly when a given component is used in different stages of the production of a finished item.

15.15. The Level of an Item

To form a useful bill of material matrix it is convenient to order the items by levels. The level of anitem is the maximum number of stages of assembly required to get the item into an end product.

Example 2 Consider a system with two end items, item 1 and item

Item 1 requires two units of item A and one unit of item C.

Item 2 requires one unit of item B, one unit of item D and three units ofitem E. Item A requires one unit of item B and two units of item F.

Item B requires two units of item C and one unit of item E. Item C requires one unit of item F and threeunits of item G. Item D requires two units of item Band one unit of item C.

The levels of the items are:

Level 0: Items 1 and 2.Level 1: Items A and D.Level 2: Item B.

Level 3: Items Cand E.Level 4:

Items F and G.

15.16. An Outline of the MRP Process

Starting with end items the MRP process goes through the following steps Establish gross requirements. Determine net requirements by subtracting scheduled receipts and on hand inventory from the gross requirements, Time phase the net requirements. Determined the planned order releases

Table 1: MRP Table

Week	1	2	3	4	5	6	7
Gross requirements							
Scheduled receipts							
Net requirements							
Time-phased net req							
Planned order releases							

The planned order releases aggregated over all the end items will result in the gross requirementsfor level one items, the gross requirements for this items are then netted and time phased to deter- mined their own order releases. The process is continued until all the items have been exploded. Table 1 shows a typical MRP table.

Example 3 MRP computations are shown in Table 2 where the lead-time is two weeks. Here the planned releases were obtained by solving a Wagner-Whitin problem with time- varying demand. More often, however, MRP will plan releases in a lot-by-lot fashion.

Table 2: Standard MRP Table

Week	1	2	3	4	5	6	7
Gross requirements	10	15	25	30	45	20	30
Schedule receipts	10	25					
Net requirements			15	30	45	20	30
Time-phased net req	15	30	45	20	30		
Planned order releases	45	0	45	50			

15.17. Computing Direct and Indirect Requirements

Let B_{ij} denote the number of units of item j required to make directly one unit of item i, and let

R_{ij} denote the total number of units of item j, direct or indirect, required to produce one unit of

item i. Clearly $R_{ii} = 1$, while for j

In matrix notation, we havesoand

i we have

$$R_{ij} = B_{ik}R_{kj}\Sigma k$$

$$R = I + BR \quad (I - B)R = I \; R = (I -$$

$B)^{-1}$.Let d be a row vector of item requirements, then dB and dR represent respectively, the direct and total derived demand.

15.18. Expediting and Deferring Scheduled Receipts

The process of determining net requirements, as outlined above, is to subtract scheduled receipts and on hand inventory from the gross requirements. Occasionally, because of anticipated changes in the MPS, we will find that the scheduled receipts are not enough to cover the gross

requirements within a lead time. Consider, for example, Table 3, and assume that the lead time is three weeks.

Notice that the schedule has a net requirement of 15 units in period 2. An order placed for 15 units in period 1 will arrive in period 4, so it would need to be expedited to be ready by period 2. An easier alternative, is to issue an expedite notice to the schedule receipt of period 3, stating thatwe need 15 units by period 2. Suppose that it is only possible to have 10 units ready by period 2. Then we will have a shortfall of five units. When a shortage occurs, it is important to backtrack and identify the source of demand. It may be that 10 of the 15 units required in period 2 are for actual orders, while the other five are in anticipation of future demand. In this case, we will allocate the 10 units to the actual order and avoid a stockout. On the other hand, there may be changes in the MPS that make scheduled receipts unnecessary. In that case the schedule receipts can be deferredto a later period.

Table 3: Expediting in MRP

Week	1	2	3	4	5	6	7
Gross requirements	10	15	25	30	45	20	30
Schedule receipts	10		25				
Net requirements		15		30	45	20	30

15.19. Lot Sizing Rules

The problem of lot sizing is one of satisfying the requirements while trying to minimize holding and setup costs. A variety of lot-sizing rules have been proposed. The lot-for-lot (LFL) is the simplest approach, and it calls for producing in period *t* the net requirements for period *t*. The LFL approach minimizes the holding cost by producing just in time. This approach is optimal if setup costs and setup times have been reduced to negligible levels, butit may be expensive if setup costs are significant. A variety of lot-sizing algorithms have been developed to deal with case where setup costs are significant.

The Wagner-Whitin (WW) algorithm can be used to optimally select the lot sizes at one level. However, applying the Wagner-Whitin algorithm, or any other single-level approach, to different levels does not guarantee that the overall policy is optimal. An alternative to the Wagner-Within policy is the Silver-Meal (SM) heuristic. Starting from the first period with positive requirements, the SM heuristic attempts to cover more and more periods with one setup while the average cost of doing this is decreasing. Once it is determined that adding the requirements of the next period increases

the average cost, a new setup is incurred and the method is repeated until all the requirements are covered. Another approach, which is popular in practice, is the part period balancing (PPB) heuristic which attempts to select the number of periods covered by a setup by making the holding cost over the covered horizon as close as possible to the setupcost. The fixed order quantity (FOQ) heuristic is to order a predetermined quantity whenever an order is placed.

Finally, the fixed order period (FOP) heuristics calls for covering the demand of a fixed number of periods with one setup. Vollman et. al. [1] recommend the use of different lot-sizing rules for different levels in the BOM, with FOQ for end items, either FOQ or LFL for intermediate levels, and FOP for the lowest levels. The idea is to avoid the propagation of the bullwhip effect tothe lowest items.

15.20. Dealing with Uncertainty in MRP

There are several sources of uncertainty that we have ignored so far. These include uncertainty in the quantity demanded (forecast errors) and the quantity supplied (yield losses), and uncertainty in the timing of demand and the timing of supply (random lead times). Many MRP systems cope with uncertainty by inflating lead times (inducing safety time), by expediting orders, and by shifting priorities of shop and vendor orders. Another way of protecting against uncertainty is to carry safety stock for end items with random demand, and to carry safety stock of items produced at bottleneck operations.

15.21. Shortcomings of MRPCapacity

MRP expects the lead time to be constant regardless of how much work has been released into the production system, so it is implicitly assuming infinite capacity. This can create problems when production levels are at or near capacity. One way to address this problem is to make sure that the MPS is capacity feasible. Rough-cut capacity planning (RCCP) attempts to do this by checking the capacity of a few critical resources. RCCP makes use of the bill of resources (BOR) for each itemon the MPS.

The BOR specifies the number of hours required at each critical resource to build a particular end item and its components and then aggregates the number of hours required at each critical resource over the end items in the MPS. RCCP then checks whether the available resources are enough to cover the MPS on each time bucket. Notice that RCCP does not perform time offsets, so the calculation of the number of hours required has to be done with time buckets that are large enough so that parts and

their components can all be completed within a single time bucket. This usually makes RCCP an optimistic estimation of what can be done. Advanced MRP systems provide more detailed capacity analysis proposing alternative production schedules when the current plan is not feasible.

Long Lead Times

There are many pressures to increase planned lead times in an MRP system. MRP uses constantlead times when, in fact, actual lead times vary considerably. To compensate, plannerstypically choose pessimistic estimates. Long lead times lead to large work-in-process (WIP) inventories.

Nervousness

MRP is typically applied in a rolling horizon basis. As customer orders firm up, and forecasts become better, a new MPS is fed to MRP which produces updated planned order releases that may be very different form the original. Even small changes in the MPS can result in large changes in planned order releases. Vollman et. al. [1], give an example where a small decrease in demand causes a formerly feasible MRP plan to become infeasible.

15.22. MRP II

Manufacturing Resource Planning (MRP II) embeds additional procedures to address the shortcom- ings of MRP. In addition, MRP II attempts to be an integrated manufacturing system by bringing together other functional areas such as marketing and finance. The additional functions of MRP II include forecasting, demand management, rough-cut capacity planning (RCCP), capacity re- requirement planning (CRP), scheduling dispatching rules, and input/output control. MRP II works within a hierarchy that divides planning into long-range planning, medium-range planning, and short-term control.

15.23. ERP Systems and Bolt-Ons

Enterprise Resource Planning (ERP) systems are extensions of MRP systems that run on a single database in a client-server environment. ERP systems support the marketing and financedepartments in addition to the production department. Significant coordination advantages arise when all functions draw and add to the same data. SAP is currently the leading provider of ERP systems. Many companies such as *i*2 Technologies, and Manugistics have developed bolt-ons programs that run on top of ERP systems. These companies address specific problems

that are not solved by ERP. For example, a better forecasting system or a finite-capacity scheduler can be added to SAP. Lately, SAP has developed many of the capabilities that were formerly available only through bolt-ons.

Let Us Sum Up

In this unit, you have learned about the followings:

- Top multinational companies like Coca-Cola, Intel, Nike, and many others employ both push and
- Pull strategies effectively. When a push strategy is implemented with a well-designed and executed pull strategy, the result is phenomenal, as it generates consumer demand.
- JIT is a new approach to repetitive manufacturing, whereas MRP is suited to job shop or batch production. Wehave seen how parts should be produced just-in-time rather then Just-in-Case they are needed. This is accomplished by a simple visual system of production control and dedication toward constant reduction in inventories.
- The objective of JIT is to improve return on investment. This is done by increasing revenues, reducing costs, and reducing the investment required. It is based onphilosophy of eliminating the waste and utilizing the full capability of each worker.This system was originally developed in Japan and gradually picking up in Indian industries In Kanban system a faxed number of containers are provided for each plant required. When these containers full, no more parts are produced, thus limiting the inventory of each part.
- Improvement activities are encouraged by workers and management to reduce the number of containers, size of containers and inventory. Impleme4tation of JIT systems requires a staged progression of activities. Top management must provide leadership and support.

Check Your Progress

1. Material requirements plan specify
2. The full form of MRP is
3. MRP is different from JIT in terms of

Glossary

Kanban cards/tickets: In a kanban system, actions are driven through kanban cards, which are signals that supply of a certain resource needs to be replenished. If a factory needs to produce 25 Widgets, but lacks the 100 Part As needed to fabricate them, the assembly line takes the Part A kanban card and moves it up to the supply desk, communicating that Part A has to be restocked. This way, nothing along the entire production line is made or requisitioned unless there's an explicit demand for it.

Just-in-Time (JIT) Production: JIT is the philosophy of inventory and supply underpinning pull manufacturing and, by extension, Kanban. In JIT the tightening up of production efficiency is a continuous process. Surpluses of parts and product are inefficiencies to be avoided on account of the cost of storing and maintaining them.

Model Questions

1. Demonstrate the Inventory management.
2. Explain about the different types of inventory.
3. Explain about the inventory management system.
4. Illustrate the safety stock.
5. Illustrate the buffer stock.
6. Illustrate the various costs associated with inventory.
7. Illustrate the Independent Demand
8. Illustrate the Dependent Demand
9. List out the Inventory models.
10. Explain Economic order quantity (EOQ).
11. List out the Inventory control techniques.
12. Demonstrate the ABC Analysis.

13. Explain the Vital Essential Desirable (VED) analysis.

14. Explain the Just-In-Time (JIT).

Answers to Check Your Progress

1. the quantity and timing of planned order releases

2. Materials Requirement planning

3. Inventory, Quality and human orientation

Suggested Readings

1. Lee J. krajewski and Larry P.Ritzman, (2007), Operations Management strategy and analysis, 9th Edition, Pearson Education / Prenctice Hall of India.
2. Chase, R.B., Ravi Shankar & Jacobs, F.R. (2018), Operations & Supply Management. 15th Edition.
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Annexure-Case studies

Case Study-1

The Detroit Automobile Company (DAC) was established by Detroit Mayor and Henry Ford with an initial investment of $150,000. Henry Ford came out with his new invention - a self-driven vehicle called 'Quadricycle.' He later sold the quadricycle for $200 and invested the amount in his future experiments to build another car. Henry's plan was very clever: since he personally knew many of the industrialists in Detroit. He would try to an automobile they could use in their businesses. He leased a factory and planned to hire a hundred workers to make his new "Delivery Wagon", as he called it. The vast majority of the parts used in the making of the delivery wagon were produced by other companies and every time a single delivery was late the entire factory would have no choice but to stop production. The first delivery wagon took six months to produce and no more than twenty were made in the first two years of the company's existence. DAC was not a successful venture, and in January 1901 it was closed down.

By the end of 1903, the Ford Co. had 125 employees and had sold 1,708 cars in three different models. Ford and his team of engineers developed 19 models during the period 1903-1908 and named them each after a letter of the alphabet from 'Model A' to 'Model S.' During the same period, Ford himself introduced five models – Models A, B, C, F and K. Instead of targeting businesses with expensive machines, Ford would design a vehicle to be used by the average man. He tried getting as many parts as possible from the same manufacturer, Dodge Brother Company, a machine shop.

Ford introduced the mass-production system in 1908 to produce Model T using vanadium steel (though much lighter than US steel). To enable the parts to be used interchangeably, Ford standardized the gauging system throughout the production process.

The idea of a 'moving assembly line' struck Ford when he was on a tour of Chicago. Describing the brainwave, Ford said, "The idea came in a general way from the overhead trolley (a device from which the meat was hung) that the Chicago packers use in dressing beef." Ford completely reversed the process, building up a completed automobile on a moving assembly line. In October 1913, Ford introduced the 'moving assembly line' concept in the Highland Park factory, bringing the car assembly line to the stationary worker. This innovation reduced the cycle time of the task from 2.3 minutes to 1.19 minutes. The assembly time for Model T chassis fell drastically from 12 hours 30 minutes to 5 hours 50 minutes.

Question:

(1).Discuss in detail about the production system and function.

Case Study-2

In June 1896, Henry Ford came out with his new invention - a self-driven vehicle called 'Quadricycle.' He later sold the quadricycle for $200 and invested the amount in his future experiments to build another car. On August 5, 1899, the Detroit Automobile Company (DAC) was established by Detroit Mayor and few of his friends with an initial investment of $150,000. Henry's plan was very clever: since he personally knew many of the industrialists in Detroit.

He would try to an automobile they could use in their businesses. He leased a factory and planned to hire a hundred workers to make his new "Delivery Wagon", as he called it. The vast majority of the parts used in the making of the delivery wagon were produced by other companies and every time a single delivery was late the entire factory would have no choice but to stop production. The first delivery wagon took six months to produce and no more than twenty were made in the first two years of the company's existence. DAC was not a successful venture, and in January 1901 it was closed down.

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to the stationary worker. This innovation reduced the cycle time of the task from 2.3 minutes to 1.19 minutes. The assembly time for Model T chassis fell drastically from 12 hours 30 minutes to 5 hours 50 minutes.

Question:

(1).Discuss in detail about the Operations Strategy based on the operations function.

Case Study-3

Although EasyJet only undertook its first flight in 1995, when it only operated two routes (London Luton to Glasgow and Edinburgh), ten years later the budget airline offered 212 routes to 64 European airports and transported over 29 million passengers in 2005. EasyJet now carries more passengers within Europe than British Airways. Analysts expect EasyJet and its Irish-based rival Ryanair, to both overtake all traditional airlines to become the largest short-haul operators in Europe by the end of the decade.

The Luton-based airline is continuing to expand, recently announcing the purchase of a further 20 Airbus A 319 planes to service the ever increasing number of routes it operates. In 2005 EasyJet carried nearly 30 million passengers, up from 25.7 million in 2004, making it a £1.3 billion business. Despite record high fuel costs, profits were up around 10 per cent to £68 million. Passenger numbers rose 21 per cent to 29.6 million and the load factor, indicating how many seats are filled, was 85.2 per cent, reflecting the airline's popularity.

The low cost lines like EasyJet have revolutionized the airline industry in Europe. Modelled on SouthWest Airlines in the USA, these airlines have not only helped create a whole new market of cost-conscious travelers but have taken market share from established operators like British Airways and become the most profitable airlines in Europe.

To be profitable, these airlines have to achieve low costs to match the low fares, which are the main attraction to their passengers. With its head office as a large tin shed adjacent to the main taxiway at unfashionable Luton Airport, all of EasyJet's operations are aimed at minimizing costs.

This is done in a number of ways:

*Use of the Internet to reduce distribution costs. EasyJet sells around 95 per cent of all seats over the Internet. Its online booking system uses a variable pricing system to try to maximize load factors. (Prices start very low – sometimes free, and rise as seats are filled.) The fuller the aircraft the lower the unit cost of travel.

*Ticketless travel. Passengers are emailed with their travel details and booking reference. This helps reduce significantly the cost of issuing, distributing, processing and reconciling millions of tickets each year. Neither does EasyJet pre-assign seats on-board. Passengers sit where they like. This eliminates an unnecessary complexity and speeds up passenger boarding.

*No free on-board catering. Eliminating free catering on-board reduces cost and unnecessary bureaucracy. Passengers can purchase food and refreshments on-board.

*Efficient use of airports. EasyJet flies to the less crowded airports of smaller European cities and prefers the secondary airports in the major cities. These also have lower landing charges and normally offer faster turnarounds as there are fewer air movements.

*Paperless operations. EasyJet has embraced the concept of the paperless office, with all its management and administration undertaken entirely on IT systems. These can be accessed through secure servers from anywhere in the world thereby enhancing flexibility in the running of the airline.

Question:

(1).Develop the framework for implementation of operations strategy.

Case Study-4

ABC Ltd. is the country's largest manufacturer of mobile with well-established market. ABC Ltd. has a good reputation for quality and service. Their marketing department identified that the potential for the global market is expanding rapidly and hence the company undertook an exercise for expansion of the capacity for export market. The company formed a team of Marketing and Materials department to study the store keeping possibilities. After extensive study, the team came up with a report on store keeping and submitted that store keeping is essentially same as domestic due to the information that is critical to effective provision of customer service, management of inventory, vendor product and cost control. The functional processes of inventory management, warehousing, order processing, carrier selection, procurement, and vendor payment are required for both.

Question:

(1).Design the Material Requirement Planning (MRP) for inventory management.

Case Study-5

The Pak Elektron Limited, PEL Appliances manufactures printed circuit boards to the specifications of its different customers, the electronic manufacturers. It employs new designs and prototype production techniques that enable the company to become more adept in anticipating and resolving the problems of its consumers, over its competitors.

However, despite the effective maintenance of the company's workers over its operations, several problems have been encountered in sustaining the operations of the company, which become the source of its loss of profit and sales. The problems identified and described by Mr. Mohsin Qayyum include problems related to operations, productivity, quality and delivery. Primarily, the operation of the company is declining, due to production bottleneck

The shifting of workload from one operation to another without pattern causes this bottleneck. The company is having a hard time anticipating the workload pile up in the shop daily because individual orders from clients impose varying workloads on each operation. The variation in the workload depends upon the differences in the size of the order that bypass some operations and from the differences in circuit designs. In addition, the company entertains four-day rush orders, which require rework at one or two operations, thus, delaying the process of delivering art work modifications of a client. This is because the company's workers are shifted from one work operation to another depending on the demand of the operation. In this sense, some workstations are left vacant, while some workstations are overloaded.

Moreover, disturbance in the operations of the company is may be attributed to telephone calls from the customer's engineers who had encountered a design problem. As a result, the customer would be requiring redesigning and rework on the products. Another problem of the company can be encountered in terms of its productivity, as some machines are left idle more often that expected.

Another source of this problem is that the standard labor hours do not include time spent in reworking parts that have failed inspection or have been returned by clients. In addition, the time used for moving from one station to another adds to the idle time used by workers, thus, further lessening their time for production. I also believe that the job strategies used in the company are far from ideal, thus, not reflecting improvements in its operations. This leads to the realization that operations and productivity method improvements are not being implemented due to the pressure for output, the constant shifting of workers from one job to the

next, and in inhibiting experimentation with new ideas. Furthermore, the introduction and implementation of new ideas and methods has led to further confusion, as the increase in the production of a particular station resulted to the piling up of work in another, thus, rescheduling orders and reassigning workers. This further impeded the productivity of the company. Aside from operations and productivity problems encountered, the company also encounters problems and failures in maintaining the quality standards of products and in meeting promised delivery dates.

The company's sales manager, reported that since August, the company has been receiving customer returns, which increased from under one percent to about 3%, and delay in product delivery, which averaged 9 days late. This would result to the continuous loss of sales, as the company's competitors are able to promise four -week deliveries on small orders. In addition, the company fails to inspect the quality of their products more effectively, thus, resulting to increase in returns and reprocessing.

The problem occurs as the president feels that a more strict inspection system would not be possible, as product standards vary from customer to another and from one order to another. In September, the company's reshipments reject rates increased, resulting to a 6% total loss due to incomplete operations and subsequent reworking and reprocessing of circuit boards. Moreover, due to the delay of production and the increase in the reworking of products, the company has fewer shipments, with actual deliveries delayed with an average of 9 days. This forced the company to hire an addition of eight employees assigned in the production force. However, it would still take some time before making the additional employees skilled in the business.

Question:

(1).Plan how to basic quality tools.

Case Study-6

General Motors (GM) was dropping Velcro from its highest supplier quality rating. GM allowed Velcro 90 days of time period to set up and start a program of total quality management (TQM) or else face the loss of not only an important customer (GM) but also Velcro's most promising growth market. At this time, Velcro had 23 Quality Control (QC) people at their plant. To the machine operators, quality was the responsibility of QC people. The QC people were stationed at certain points and they would inspect on a sample basis and say whether the particular product was good or bad. When the product was reworked and scrapped, nobody changed the process to improve quality. It is wrong to assume that the

production employees were causing the quality problems and to blame them for it without giving them the tools to deal with the quality problems. Under such conditions, production employees were afraid to report defects in the products produced and the scrap was being disposed off to scrap yard during the last shift.

The management felt that it was necessary to train the operators in TQM and more attention is given to operators and the pressure on production employees to reduce the quality problems. Velcro installed the QC system for implementation of TQM at the production process that went wrong and needed improvement. They wanted to improve quality by continuous process improvement (CPI) techniques with QC tools. The management felt that it was necessary to train the quality team in CPI techniques and QC tools for implementation of TQM and more attention given to operators and the pressure on production employees to reduce the quality problems with a quality team.

Question:

(1).Plan how to implement the TQM along with problem solving steps and basic quality tools.

Case Study-7

India has large call centre industries. Indian call center emerged in early twenty first century. Outsourcing to Company A straightaway reduces the costs by half and gives optimum quality service for an enterprise based in USA or UK. The two major types of call centres are outbound centres and inbound centres in Company A.

The main operations are inbound call center in Company A. For many customers call centres are the first point of contact with an organisation and their experiences can play a major role in their decision to stay or leave that organization. Outbound centres of Company A are used more in areas such as marketing and sales.

In those cases, operator of Company A makes contact with the customer. Company A puts a lot of emphasis on its level of customer service, an integral part of its mission, vision and values, as a differentiator from the competition; its strategic position was that of a quality service, intended to attract those customers who wanted to pay a bit more for a better service, in contrast with its low-cost competitors.

A consistent number of the calls of the 1,200,000 received annually at the inbound call centre couldn’t be solved at the first attempt, leading to customer dissatisfaction and unnecessary repetition of work in the Centre.

The objective of the project was to implement the total quality management (TQM).

Company A is the country's largest manufacturer of mobile with well-established market. It has a good reputation for quality and service. Their marketing department identified that the potential for the global market is expanding rapidly and hence the company undertook an exercise for expansion of the capacity for export market. The company formed a team of Marketing and Materials department to study the store keeping possibilities. After extensive study, the team came up with a report on store keeping and submitted that store keeping is essentially same as domestic due to the information that is critical to effective provision of customer service, management of inventory, vendor product and cost control. The functional processes of inventory management, warehousing, order processing, carrier selection, procurement, and vendor payment are required for both.

Question:

(1).Suggest the implementation phases of TQM to redesign the operations system of call centre.

Model End Semester Examination Question Paper

Master of Business Administration (MBA)

Course Code: **DCMBA-25**

Course Title: **Operations Management**

Max. Marks: 70 **Time: 3 hours**

PART – A (10x2 =20 Marks)

Answer any TEN questions out of TWELVE questions

[All questions carry equal marks]

(1). Define Production Management.

(2). What is Production Process?

(3). What is Operations Strategy?

(4). Define Delphi Methods

(5). What are the factors influencing plant location?

(6). What is Regression Analysis?

(7). Define Capacity Planning.

(8). List out the objectives production planning and control.

(9). Define Routing.

(10). What are the benefits of Service Quality?

(11). Define PDCA.

(12). List out the types of Inventory.

PART – B (5X8=40 Marks)

Answer any FIVE questions out of SEVEN questions

[All questions carry equal marks]

(13). Explain the types of various production systems.

(14). Discuss in details production functions.

(15). Describe the types of layout with examples

(16). Describe about the Master Production Schedule with the examples.

(17). Explain the stages of production planning and control

(18). Explain Deming's philosophy

(19). Discuss in details Five Pillars of TQM.

PART - C (1x10=10 Marks)

CASE STUDY (Covering the Whole Course)

(20). General Motors (GM) was dropping Velcro from its highest supplier quality rating. GM allowed Velcro 90 days of time period to set up and start a program of total quality management (TQM) or else face the loss of not only an important customer (GM) but also Velcro's most promising growth market. At this time, Velcro had 23 Quality Control (QC) people at their plant. To the machine operators, quality was the responsibility of QC people. The QC people were stationed at certain points and they would

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