Semester – II

18MBAP201 PRODUCTION AND OPERATIONS MANAGEMENT 5H – 4C

Instruction Hours / week: L: 4 T: 1 P : 0 **Marks: Internal: 40 External: 60 Total: 100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES:

To make the students

1. To understand the Operations management and operation strategy concepts and its application in business.
2. To recognize the importance factory location, plant location, Plant layout and facility layout.
3. To formulate the production planning and control systems and ensure efficient scheduling for production.
4. To understand and apply the forecasting techniques in estimating the requirement of resources.
5. To understand the quality management practice and TQM tools and its application in improving the organizational performance.

COURSE OUTCOMES :

Learners should be able to

1. Understand the core features of the operations and production management function at the operational and strategic levels.
2. Evaluate and decide the best plant and factory location and layout.
3. Forecast the requirement and make accurate production planning , inventory planning and schedule the production.
4. Obtain the knowledge of applying a quality management TQM tools to improve organizational effectiveness.
5. Effectively communicate ideas, explain procedures in oral and written forms to different audiences.

UNIT I Operations Management and Operations Strategy

Nature, Importance, historical development, transformation processes, differences between services and goods, Operations Strategy, Competitive Capabilities and Core Competencies, Operations Strategy as a Competitive Weapon, Linkage Between Corporate, Business, and Operations Strategy, Developing Operations Strategy, Elements or Components of Operations Strategy, Competitive Priorities, Manufacturing Strategies, Service Strategies, Global Strategies and Role of Operations Strategy

UNIT II Location, Layout, material handling and Maintenance

Location Strategies: Introduction, Location Planning Process

Facility or Layout Planning and Analysis: : Introduction, Objectives of Layout, Classification of Facilities, Basis for Types of Layouts, Why Layout decisions are important, Nature of layout problems, Redesigning of a layout, Manufacturing facility layouts, Types of Layouts, Layout Planning, Evaluating Plant Layouts, Assembly Line Balancing, Material handling - Material Requirements Planning (MRP) - Manufacturing Resources Planning (MRP II) - Enterprise Resource Planning (ERP) Maintenance Management- Reliability and Maintenance - Replacement Techniques

UNIT III Production Planning and controlling, Scheduling

Production planning and Control– objectives , functions, PPC in different types of manufacturing systems – Purpose of Operations Scheduling, Factors Considered while Scheduling, Scheduling Activity under PPC, Scheduling Strategies, Scheduling Guidelines, Approaches to Scheduling, Scheduling Methodology – Gantt Chart and sequencing (Problems), Scheduling in Services

UNIT IV Forecasting

Forecasting: Introduction, The Strategic Importance of Forecasting, Benefits, Cost implications and Decision making using forecasting, Classification of Forecasting Process, Methods of Forecasting, Forecasting and Product Life Cycle, Selection of the Forecasting Method, Qualitative Methods of Forecasting, Quantitative Methods, Associative Models of Forecasting, Accuracy of Forecasting

UNIT V TQM, JIT and Supply chain

Total Quality Management: Introduction, Meaning and Dimensions of Quality, Quality Control Techniques, Quality Based Strategy, Total Quality Management (TQM), Towards TQM – ISO 9000 as a Platform, Total Productive Maintenance (TPM) - Statistical Process Control (SPC) (Problems)

Just-In-Time : Introduction, Characteristics of JIT, Key Processes to Eliminate Waste, Implementation of JIT, Pre-requisites for implementation, JIT Inventory and Supply Chains - Supply Chain Management, Managing supply chain, Supply chain integration..

Note: Problems 20 Marks and Theory 80 Marks

SUGGESTED READINGS:

1. Jay Heizer, Barry Render, Chuck Munson, Amit Sachan (2017), *Operations Management : Sustainability and Supply chain Management*, 12th edition, Pearson Education, New Delhi.
2. Krajewski, L.J et.al (2015), *Operations Management*, 11th edition, Pearson Education, New Delhi.
3. Russel, Taylor (2015), *Operations and Supply Chain Management*, 8th edition, Wiley, New Delhi.
4. B. Mahadevan (2015). *Operations Management : Theory and Practice*, 3rd edition, Pearson Education, New Delhi.
5. Pannerselvam. (2012). *Production and Operations Management*, 3rd edition, PHI, New Delhi.

KARPAGAM ACADEMY OF HIGHER EDUCATION

(Deemed to be University)
(Established under section 3 of UGC Act 1956)
Coimbatore-641021
Department of Management

Name: **G HARIHARAN (Assistant Professor)**
Department: **Management**
Subject Code: **17MBAP201** Semester: **II** Year: **2018-20 Batch**
Subject: **Production and Operations Management - Lesson Plan**

UNIT 1- Operations Management and Operations Strategy			
S. No	**Lecture Hours**	**Contents**	**References**
1	1	Introduction to Production and Operations Management	R_1: Page No: 02
2	1	Definition and Need of Production and Operations Management	R_2: Page No: 02-03
3	1	Historical Contribution of OM	R_5: Page No: 04-05
4	1	System Concept of Production, Goods Vs Services	R_5: Page No: 04-07
5	1	Tutorial 1: Video Analysis Merchandize Benz Production Plant	
6	1	Operations Strategy-Definition, Importance, Competitive Capabilities and core competencies	R_2: Page No: 56, 62
7	1	Operations Strategy- Linkage between Corporate, Business, and Operations Strategy, Developing Operations Strategy, Competitive Priorities	R_2: Page No: 56-62
8	1	Operation Strategy for Manufacturing and Service sectors	R_2: Page No: 69-72
9	1	Global Strategies and Role of Operations Strategy-Case	R_2: Page No: 60
10	1	Tutorial 2: Video Analysis Zara Textile Operations Strategy	-
11	1	Recapitulation and discussion of Important questions	
Total Number of hours planned for Unit 1			**11**
UNIT 2- Location, Layout, Material Handling and Maintenance			
1	1	Location Strategies: Introduction, Location Planning Process	R_2: Page No: 442-448
2	1	Layout Planning: Introduction, Objectives, Classification of Facilities	R_5: Page No: 98-103
3	1	Types of Layouts, Importance of layout decision, Manufacturing facility layouts, Evaluating Plant Layouts	R_2: Page No: 299-300, W_1, R_4: Page No: 116

4	1	Tutorial 3: Location Problem	R_5: Page No: 95
5	1	Assembly Line Balancing (ALB)-Meaning	R_5: Page No: 183-184
6	1	Problem -ALB	R_5: Page No: 183-184
7	1	Material Handling-MRP, MRP-II, ERP	R_2: Page No: 726-729,743-744
8	1	Problem -ALB	R_2: Page No: 319-324
9	1	Tutorial 4: Problem -ALB	R_5: Page No: 183-184
10	1	Maintenance Management-Meaning and Need, Equipment Life Cycle, Measures of Maintenance Performance (MTBF, MTTR and Availability)	R_4: Page No: 608-615
11	1	Recapitulation and discussion of Important questions	
Total Number of hours planned for Unit 2			**11**
UNIT 3- Production Planning and Controlling, Scheduling			
1	1	Production Planning Control- Introduction, Objectives, function	R_5: Page No: 280-284
2	1	PPC in different types of manufacturing systems	W_2
3	1	Tutorial 5: Scheduling, Need and basis for scheduling, Scheduling alternative terminologies,	R_5: Page No: 380-385
4	1	Factors Considered while Scheduling, Approaches to Scheduling	R_1: Page No: 769-771
5	1	Production Planning Case Study	
6	1	Job Sequencing –Problem-EDD, SPT	R_5: Page No: 388-389
7	1	Johnson's Rule	R_2: Page No: 788
8	1	Tutorial: 6: Johnson's Rule-Two station flow shop, Problem	R_2: Page No: 788-789
9	1	Johnson's Rule-Two station flow shop-Problem	R_2: Page No: 789-790
10	1	Gantt Chart, Scheduling in Services	R_2: Page No: 773-774, R_1: Page No: 775
11	1	Recapitulation and discussion of Important questions	
Total Number of hours planned for Unit 3			**11**
UNIT 4- Forecasting			
1	1	Forecasting- Introduction	R_2: Page No: 535

2	1	Tutorial: 7: Importance of Forecasting, Benefits	R_5: Page No: 73
3	1	Cost implications and Decision making using forecasting	R_5: Page No: 74
4	1	Classification of Forecasting Process	R_5: Page No: 74
5		Unilever Case Analysis	R_2: Page No: 536
6	1	Methods of Forecasting • Quantitative Method • Qualitative Method	R_5: Page No:77-90
7	1	Tutorial: 8: Forecasting Problems	R_2: Page No: 549
8	1	Forecasting and Product Life Cycle	W_3
9	1	Associative Models of Forecasting, Accuracy of Forecasting	R_2: Page No: 565, R_5: Page No: 274-275
10	1	Tutorial 9 : Forecasting Problems	R_2: Page No: 568
11	1	Recapitulation and discussion of Important questions	
Total Number of hours planned for Unit 4			**11**
UNIT 5- TQM, JIT and Supply chain			
1	1	Total Quality Management- Meaning, Dimension, Scope	R_4: Page No: 248-251
2	1	Tutorial: 10 Quality Control Techniques Control Charts ❖ R Charts ❖ X Charts	R_2: Page No: 202-218
3	1	Control Charts	R_2: Page No: 208-209
4	1	Quality Based Strategy, Total Quality Management	R_2: Page No: 196
5	1	ISO 9000 Series, Total Productive Maintenance, Objectives, Waste Eliminated and Benefits of TPM	R_5: Page No: 490-492, R_5: Page No: 469-470
6	1	Just in Time- Characteristics, Elimination Waste, Implementation, Supply Chain Management- Concept, Integration	R_2: Page No: 483-485, R_1: Page No: 393-404
7	1	Tutorial 11: SPC Problem	R_2: Page No: 214
8	1	Recapitulation and discussion of Important questions	
Total Number of hours planned for Unit 5			**08**
9	1	Discussion of previous year ESE Question papers	
10	1	Discussion of previous year ESE Question papers	

11	1	Discussion of previous year ESE Question papers	
Total Number of hours planned for Unit 5 and discussion of previous year ESE Question papers			**08+03=11**

SUGGESTED READINGS:

1. Jay Heizer, Barry Render, Chuck Munson, Amit Sachan (2017), *Operations Management : Sustainability and Supply chain Management*, 12th edition, Pearson Education, New Delhi.
2. Krajewski, L.J et.al (2015), *Operations Management*, 11th edition, Pearson Education, New Delhi.
3. Russel, Taylor (2015), *Operations and Supply Chain Management*, 8th edition, Wiley, New Delhi.
4. B. Mahadevan (2015). *Operations Management : Theory and Practice*, 3rd edition, Pearson Education, New Delhi.
5. Pannerselvam. (2012). *Production and Operations Management*, 3rd edition, PHI, New Delhi.

Websites:

1. W_1: www.yourarticlelibrary.com/industries/plant-layout/plant-layout...importance/90129
2. W_2: https://bizfluent.com/info-7899360-types-manufacturing-systems.html
3. W_3:http://public.kenanflagler.unc.edu/2017msom/MSOM%20and%20SIG%20Program/Track%205/C/MSOM2017_1_0199.pdf

UNIT-I

SYLLABUS

Operations Management and Operations Strategy- Nature, Importance, historical development, transformation processes, differences between services and goods. Operations Strategy, Competitive Capabilities and Core Competencies, Operations Strategy as a Competitive Weapon. Linkage Between Corporate, Business, and Operations Strategy, Developing Operations Strategy, Elements or Components of Operations Strategy. Competitive Priorities, Manufacturing Strategies, Service Strategies, Global Strategies and Role of Operations Strategy.

INTRODUCTION:

In an Organization, strategic growth and competitiveness are depending upon the effective utilization of the critical productive resources of the organization. Production/operations management is the process, which combines and transforms various resources used in the production/operations subsystem of the organization into value added product/services in a controlled manner as per the policies of the organization. Therefore, it is that part of an organization, which is concerned with the transformation of a range of inputs into the required outputs (products/services) having the requisite quality level.

CONCEPT OF PRODUCTION:

Production is defined as *"**the step-by-step conversion of one form of material into another form through chemical or mechanical process to create or enhance the utility of the product to the user.**"* Thus production is a value addition process. At each stage of processing, there will be value addition.

Edwood Buffa defines production as '*a process by which goods and services are created*'. Some examples of production are: manufacturing custom-made products like, boilers with a specific capacity, constructing flats, some structural fabrication works for selected customers, etc., and manufacturing standardized products like, car, bus, motor cycle, radio, television, etc.

CONCEPT OF OPERATIONS:

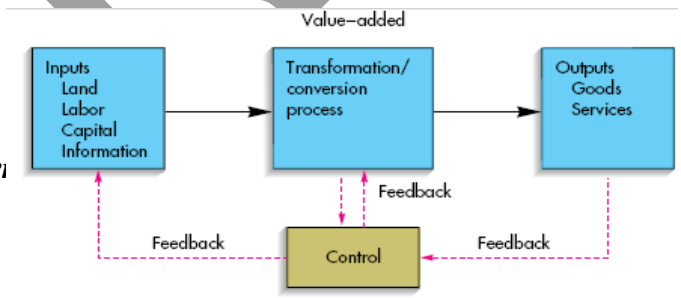
The operations function consists of all activities *directly* related to producing goods or providing services. Hence, it exists both in manufacturing and assembly operations, which are *goods-oriented,* and in areas such as health care, transportation, food handling, and retailing, which are primarily *service-oriented.* Table 1–1 provides illustrations of the diversity of operations management settings.

Type of Operations	Examples
Goods producing	Farming, mining, construction, manufacturing, power generation
Storage/Transportation	Warehousing, trucking, mail service, moving, taxis, buses, hotels, airlines
Exchange	Retailing, wholesaling, banking, renting or leasing, library loans
Entertainment	Films, radio and television, plays, concerts, recording
Communication	Newspapers, radio and TV newscasts, telephone, satellites, the Internet

Table 1-1 Examples of Types of Operations

The operations function is the core of most business organizations; it is responsible for the creation of an organizations goods or services. Inputs are used to obtain finished goods or services using one or more transformation processes (eg. Storing, transporting, cutting). To ensure that the desired outputs are obtained, measurements are taken at various points in the transformation process (feedback) and then compared with previously established standards to determine whether corrective action is needed (control).

Fig. the conve



Fi g1.1: Conversion process of inputs and outputs.

The essence of operative function is to add value during the transformation process: Value added is the term used to describe the difference between the cost of inputs and value or price of outputs. In addition to value added, operations must be efficient. **Efficiency** means being able to perform activities well, and at the lowest possible cost. Table 1.2 provides examples of inputs, transformation, and outputs and Table 1–3 provides some specific illustrations of the transformation process.

Inputs	Transfonnation	Outputs
Land	Processes	Goods
Human	Cutting, drilling	Houses
Physical	Transporting	Automobiles
Intellectual	Teaching	Clothing
Raw materials	Farming	Computers
Energy	Mixing	Machines
Water	Packing	Televisions
Chemicals	Canning	Food products
Metals	Consulting	Textbooks
Wood	Copying, faxing	Magazines
Equipment		Shoes
Machines		CD players
Computers		Services
Trucks		Health care
Tools		Entertainment
Facilities		Car repair
Hospitals		Delivery
Factories		Gift wrapping
Offices		Legal
Retail stores		Banking
Other		Communication
Information		
Time		

Table 1.2: Examples of inputs, transformation, and outputs

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

Table1.3 Illustrations of the transformation process

DIFFERENCE BETWEEN MANAUFACTURING AND SERVICE ORGANISATIONS:

Organizations can be divided into two broad categories: **manufacturing organizations** and **service organizations,** each posing unique challenges for the operations function. There are two primary distinctions between these categories.

First, manufacturing organizations produce physical, tangible goods that can be stored in inventory before they are needed. By contrast, service organizations produce intangible products that cannot be produced ahead of time. Second, in manufacturing organizations most customers have no direct contact with the operation. Customer contact is made through distributors and retailers. For example, a customer buying a car at a car dealership never comes into contact with the automobile factory. However, in service organizations the customers are typically present during the creation of the service. Hospitals, colleges, theaters, and barber shops are examples of service organizations in which the customer is present during the creation of the service.

The differences between manufacturing and service organizations are not as clear cut as they might appear, and there is much overlap between them. Most manufacturers provide services as part of their offering, and many service firms manufacture physical goods that they deliver to their customers or consume during service delivery. For example, a manufacturer of furniture may also provide shipment of goods and assembly of furniture. On the other hand, a barber shop may sell its own line of hair care products. The differences between manufacturing and services are shown in Figure 1-3, which focuses on the dimensions of product tangibility and the degree of customer contact.

Fig 1.3: Characteristics of Manaufacturing and Service Organisations

Difference between Goods Vs Services:

PRODUCTION SYSTEM VS SERVICE SYSTEMS (Goods Vs Services)

Focus	Production System	Service Systems
1. Product Nature	Tangible	Intangible
2. Characteristics	Physical dimensions	Service description
3. Properties	Size and Shape	Place and time
4. Production	Produced in an industrial environment	Produced in market environment
5. Process	Often standardized	Often customized
6. Function	It's a function of materials	It's a function of personnel
7. Quality	Quality inherent in product	Quality inherent in process
8. Location and Layout	Influenced largely by raw materials, labour supply and inventory considerations.	Influenced strongly by location and convenience of customers.
9. Specification	Physical dimensions	Service description
10. Performance	Reliable and efficient	Dependable and effective
11. Marketability	Design and appearance	Comfort and appeal
12. Quality control	Quality inherent in stored product.	Quality in the service and process (eg. Time, environment)

KAHE

Functions of Operations Management

1. Facility Location & Layout Design: The decision of the location for the facility, manufacturing unit or service outfit, geographically. The layout design determines how the internal facilities (departments, equipments, service stations, workstations etc) will be arranged.
2. Job design and work measurement: The structuring of work tasks assigned to an employee and the study of the tasks that make up the job. The work measurement activity involves the timing of the tasks that comprise a job. The job design and work measurement activities are carried out to optimize output. Design of the production processes, type of process design, & investment and economic analysis also studied to achieve maximum productivity.
3. Demand forecasting: Organizations need to forecast the demand for their products and services so that all relevant plans can be developed for the future.
4. Planning and controlling operations: Short term, medium term & Long term
5. Materials Management-The materials management activity involves the grouping of management functions supporting materials flow.
6. Inventory control and Management: Planning & controlling of inventories (RM, WIP, FG)
7. Purchase Management: include vendor development, selection of suppliers, contract negotiation, value analysis, make or buy decisions and maintaining the high ethics .
8. Total Quality Management: Collective efforts of all managers and employees on satisfying customer expectations by continually improving operation management processes and products.
9. Supply Chain Management: It enables organizations to meet customer requirements in time with improved facility utilisation, optimimal inventory etc. Right Time available, Right qty of Product to Right customer at least cost.
10. Project Management: A thorough knowledge of project management procedures, tools and techniques is essential for the operations manager.
11. Maintenance Management: The objective of maintenance management is to ensure that the systems are working at their optimum efficiency and is essential to the organization for productivity, increase operational life of equipments and keep safe working conditions.

KAHE

Need for Operations Management

- Every Organizations produces same product or services.
- All managers have to plan work, central quality & ensure productivity of their subordinate.
- Efficiently serving customers required the knowledge of OM. Servicing a customer well means in a timely fashion with exceptional quality.
- It lies at the heart of business activity they use human & material resources to create the product that either makes an organization healthy & competitive or course it to fail.
- Designing & operating processes that are quick, accurate & inexpensive to meet the customer demand which is key for building a competitive advantage.

Importance of Operations Management:

1. Understanding strategic objectives: Operations managers must clearly understand the goals of the organization and develop a clear vision of exactly how operations will help achieve them. This also involves translating these goals into implications for the operation's performance, objectives, quality, speed, dependability, flexibility and cost.

2. Developing an operations strategy: Due to the numerous decision-making involved with operations, it is critical that operations managers have a set of guidelines that are align with the organization's long term goals.

3. Designing the operation's products, services and processes: Design involves determining the physical form, shape and composition of products, services and processes.

4. Improving the performance of operation: Operations managers are expected to continually monitor and improve the overall performance of their operation.

Also you can include

It helps in

- Project Management
- Product Design
- Forecasting
- Process Analysis

KAHE

- Work Measurement
- Facility Layout
- Inventory Control
- Scheduling
- Materials Management

HISTORICAL MILESTONES:

Production systems have existed since the earliest days of civilization as evidenced by the first Olympic games, building the Great Wall of China, or erecting the Egyptian pyramids, and you will see operations management at work. Operations management did not emerge as a formal field of study until the late 1950s and early 1960s, when scholars began to recognize that all production systems face a common set of problems and to stress the systems approach to viewing operations processes.

Many events helped shape operations management. Some of the most significant historical milestones and their influence on the development of operations management are summarized in the table below along with the current trends.

KAHE

Concept	Time	Explanation
Industrial Revolution	Late 1700s	Brought in innovations that changed production by using machine power instead of human power.
Scientific management	Early 1900s	Brought the concepts of analysis and measurement of the technical aspects of work design, and development of moving assembly lines and mass production.
Human relations movement	1930s to 1960s	Focused on understanding human elements of job design, such as worker motivation and job satisfaction.
Management science	1940s to 1960s	Focused on the development of quantitative techniques to solve operations problems.
Computer age	1960s	Enabled processing of large amounts of data and allowed widespread use of quantitative procedures.
Just-in-time systems (JIT)	1980s	Designed to achieve high-volume production with minimal inventories.
Total quality management (TQM)	1980s	Sought to eliminate causes of production defects.
Reengineering	1980s	Required redesigning a company's processes in order to provide greater efficiency and cost reduction.
Environmental issues	1980s	Considered waste reduction, the need for recycling, and product reuse.
Flexibility	1990s	Offered customization on a mass scale.
Time-based competition	1990s	Based on time, such as speed of delivery.
Supply chain management	1990s	Focused on reducing the overall cost of the system that manages the flow of materials and information from suppliers to final customers.
Global competition	1990s	Designed operations to compete in the global market.
Electronic commerce	Late 1990s; early twenty-first century	Used the Internet for conducting business activity.

Fig. Historical Development of Operations Management

THE INDUSTRIAL REVOLUTION

The **Industrial Revolution** had a significant impact on the way goods are produced today. Prior to this movement, products were made by hand, by skilled craftspeople in their shops or homes. Each product was unique and made by an individual. The Industrial Revolution changed all that. It started in the 1770s with the development of a number of inventions that relied on machine power instead of human power. The most important of these was the steam engine, which was invented by James Watt in 1764. The steam engine provided a new source of power that was used to replace human labor in textile mills, machine-making plants, and other facilities. The concept of the factory was emerging. In addition, the steam engine led to advances in transportation, such as railroads, that allowed for a wider distribution of goods.

About the same time, the concept of *division of labor* was introduced. First described by Adam Smith in 1776 in *The Wealth of Nations,* this important concept became one of the building blocks of the assembly line. Division of labor means that the production of a good is broken down into a series of small, elemental tasks, each of which is performed by a different worker. The

repetition of the task allows the worker to become highly specialized in that task. Division of labor allowed higher volumes to be produced. This, coupled with advances in transportation, enabled distant markets to be reached by steam-powered boats and railroads.

A few years later, in 1790, Eli Whitney introduced the concept of *interchangeable parts.* Prior to that time, every part used in a production process was unique. With interchangeable parts, parts are standardized so that every item in a batch of items fits equally. This concept meant that we could move from one-at-a-time production to volume production, for example, in the manufacture of watches, clocks, and similar items.

SCIENTIFIC MANAGEMENT

Scientific management was an approach to management promoted by Frederick W. Taylor at the turn of the twentieth century. Taylor was an engineer with an eye for efficiency. Through scientific management he sought to increase worker productivity and organizational output. This concept has two key features. First, it is assumed that workers are motivated only by money and are limited only by their physical ability.

Taylor believed that worker productivity is governed by scientific laws, and that it is up to management to discover these laws through measurement, analysis, and observation. Workers are to be paid in direct proportion to how much they produce. The second feature of this approach is the separation of the planning and doing functions in a company, which means the separation of management and labor. Management is responsible for designing productive systems and determining acceptable worker output. Workers have no input into this process—they are permitted only to work.

Many people did not like the scientific management approach. This was especially true of workers, who thought that management used these methods to unfairly increase output without paying them accordingly. Still, many companies adopted the scientific management approach. Today many see scientific management as a major milestone in the field of operations management, and it has had many influences on operations management. For example, *piece rate incentives,* in which workers are paid in direct proportion to their output, came out of this movement. Also, a widely used method of work measurement, *stopwatch time studies,* was introduced by Frederick Taylor. In stopwatch time studies, observations are made and recorded of a worker performing a task over many cycles. This information is then used to set a time standard for

performing the particular task. This method is still used today to set a time standard for short, repetitive tasks.

The scientific management approach was popularized by Henry Ford, who used the techniques in his factories. Combining technology with scientific management, Ford introduced the *moving assembly line* to produce Ford cars. Ford also combined scientific management concepts with division of labor and interchangeable parts to develop the concept of *mass production.* These concepts and innovations helped him increase production and efficiency at his factories.

THE HUMAN RELATIONS MOVEMENT

The early twentieth century was dominated by the scientific management movement and its philosophy. However, this changed with the publication of the results of the **Hawthorne studies.** The Hawthorne studies were conducted at a Western Electric plant in Hawthorne, Illinois, in the 1930s. The purpose was to study the effects of environmental changes, such as changes in lighting and room temperature, on the productivity of assembly-line workers. The findings from the study were unexpected; the productivity of the workers continued to increase regardless of the environmental changes made. Elton Mayo, a sociologist from Harvard, analyzed the results and concluded that the workers were actually motivated by the attention they were given. The idea of workers responding to the attention they are given came to be known as the *Hawthorne effect.*

Many sociologists and psychologists went to Hawthorne to study these findings, which led to the **human relations movement,** an entirely new philosophy based on the recognition that factors other than money can contribute to worker productivity. The impact of these findings on the development of operations management has been tremendous. The influence of this new philosophy can be seen in the implementation of a number of concepts that motivate workers by making their jobs more interesting and meaningful. For example, the Hawthorne studies showed that scientific management had made jobs too repetitive and boring. *Job enlargement* is an approach in which workers are given a larger portion of the total task to do. Another approach used to give more meaning to jobs is *job enrichment,* in which workers are given a greater role in planning.

Recent studies have shown that environmental factors in the workplace, such as adequate lighting and ventilation, can have a major impact on productivity. However, this does not contradict the principle that attention from management is a positive factor in motivation.

MANAGEMENT SCIENCE

While one movement was focusing on the technical aspects of job design and another on the human aspects of operations management, a movement called **management science** was developing that would make its own unique contribution. Management science focused on developing quantitative techniques for solving operations problems. The first mathematical model for inventory management was developed by F.W. Harris in 1913. Shortly thereafter, procedures were developed for statistical sampling theory and quality control.

World War II created an even greater need for the ability to quantitatively solve complex problems of logistics control, weapons system design, and deployment of missiles. Consequently, management science grew during the war and continued to grow after the war was over. Many quantitative tools were developed to solve problems in forecasting, inventory control, project management, and other areas. Management science is a mathematically oriented field that provides operations management with tools that can be used to assist in decision making. A popular example of such a tool is linear programming.

THE COMPUTER AGE

The 1970s witnessed the advent of the widespread use of computers in business. With computers, many of the quantitative models developed by management science could be used on a larger scale. Data processing was made easier, with important effects in areas such as forecasting, scheduling, and inventory management. A particularly important computerized system, material requirements planning (MRP), was developed for inventory control and scheduling. Material requirements planning was able to process huge amounts of data to compute inventory requirements and develop schedules for the production of thousands of items. This type of processing was impossible before the age of computers. Today the exponential growth in computing capability continues to impact operations management.

JUST-IN-TIME

Just-in-time (JIT) is a major operations management philosophy, developed in Japan in the 1980s, that is designed to achieve high-volume production using minimal amounts of inventory. This is achieved through coordination of the flow of materials so that the right parts arrive at the right place in the right quantity; hence the term, *just-in-time*. However, JIT is much more than the coordinated movement of goods. It is an all-inclusive organizational philosophy that employs

teams of workers to achieve continuous improvement in processes and organizational efficiency by eliminating all organizational waste. Although JIT was first used in manufacturing, it has seen use in the service sector, for example, in the food service industry. JIT has had a profound impact on changing the way companies manage their operations. It is credited with helping turn many companies around and is used by companies including Honda, Toyota, and General Motors. JIT promises to continue to transform businesses in the future.

TOTAL QUALITY MANAGEMENT

Customers demand higher quality in their products and services. Companies have been forced to focus on improving quality in order to remain competitive in this situation. **Total quality management (TQM)** is a philosophy, promulgated by "quality gurus" such as W. Edwards Deming, that aggressively seeks to improve product quality by eliminating causes of product defects and making quality an all-encompassing organizational philosophy. With TQM everyone in the company is responsible for quality. TQM was practiced by some companies in the 1970s and became pervasive in the 1990s.

BUSINESS PROCESS REENGINEERING

Business process **reengineering** means redesigning a company's processes to increase efficiency, improve quality, and reduce costs. In many companies things are done in a certain ways that has been passed down over the years. Reengineering requires asking why things are done in a certain way, questioning assumptions, and then redesigning the processes. Operations management is a key player in a company's reengineering efforts.

FLEXIBILITY

Traditionally companies competed by either mass-producing a standardized product or offering customized products in small volumes. One of the current competitive challenges for companies is the need to offer a greater variety of product choices to customers of a traditionally standardized product. This is the challenge of **flexibility,** which means being able to offer a wide variety of products to customers.

One example of flexibility is **mass customization,** which is the ability of a firm to highly customize its goods and services to different customers. Mass customization requires designing flexible operations and using delayed product differentiation, also called postponement.

This means keeping the product in generic form as long as possible and postponing completions of the product until specific customer preferences are known.

TIME-BASED COMPETITION

One of the most important trends in companies today is **competition based on time.** This includes developing new products and services faster than the competition, reaching the market first, and meeting customer orders most quickly. For example, two companies may produce the same product, but if one is able to deliver it to the customer in two days whereas the other delivers it in five days, the first company will make the sale and win over the customers. Time-based competition requires specifically designing the operations function for speed.

SUPPLY CHAIN MANAGEMENT

Supply chain management (SCM) involves managing the flow of materials and information from suppliers and buyers of raw materials all the way to the final customer. The objective is to have everyone in the chain work together to reduce overall cost and improve quality and service delivery. Supply chain management requires a team approach, with functions such as marketing, purchasing, operations, and engineering all working together. This approach has been shown to result in more satisfied customers, meaning that everyone in the chain profits. SCM has become possible with the development of information technology (IT) tools that enable collaborative planning and scheduling. The technologies allow synchronized supply chain execution and design collaboration, which enables companies to respond better and faster to changing market needs.

GLOBAL MARKETPLACE

Today businesses must think in terms of a **global marketplace** in order to compete effectively. This includes the way they view their customers, competitors, and suppliers. Key issues are meeting customer needs and getting the right product to markets as diverse as the Far East, Europe, or Africa. Operations management is responsible for most of these decisions. OM decides whether to tailor products to different customer needs, where to locate facilities, how to manage suppliers, and how to meet local government standards. Also, global competition has forced companies to reach higher levels of excellence in the products and services they offer.

ENVIRONMENTAL ISSUES

KAHE

There is increasing emphasis on the need to reduce waste, recycle, and reuse products and parts. Society has placed great pressure on business to focus on air and water quality, waste disposal, global warming, and other **environmental issues.** Operations management plays a key role in redesigning processes and products in order to meet and exceed environmental quality standards. The importance of this issue is demonstrated by a set of standards termed ISO 14000. Developed by the International Organization for Standardization (ISO), these standards provide guidelines and a certification program documenting a company's environmentally responsible actions.

ELECTRONIC COMMERCE

Electronic commerce (e-commerce) is the use of the Internet for conducting business activities, such as communication, business transactions, and data transfer. Since the late 1990s the Internet has become an essential business medium, enabling efficient communication between manufacturers, suppliers, distributors, and customers. It has allowed companies to reach more customers at a speed infinitely faster than ever before. It also has significantly cut costs as it provides direct links between entities. Electronic commerce can occur between businesses, known as **B2B** (**business to business**) commerce, and makes up the highest percentage of transactions. A more commonly known type of e-commerce occurs between businesses and their customers, known as **B2C** exchange, as seen with on-line retailers such as Amazon.com. E-commerce is creating **virtual marketplaces** that continue to change the way business functions.

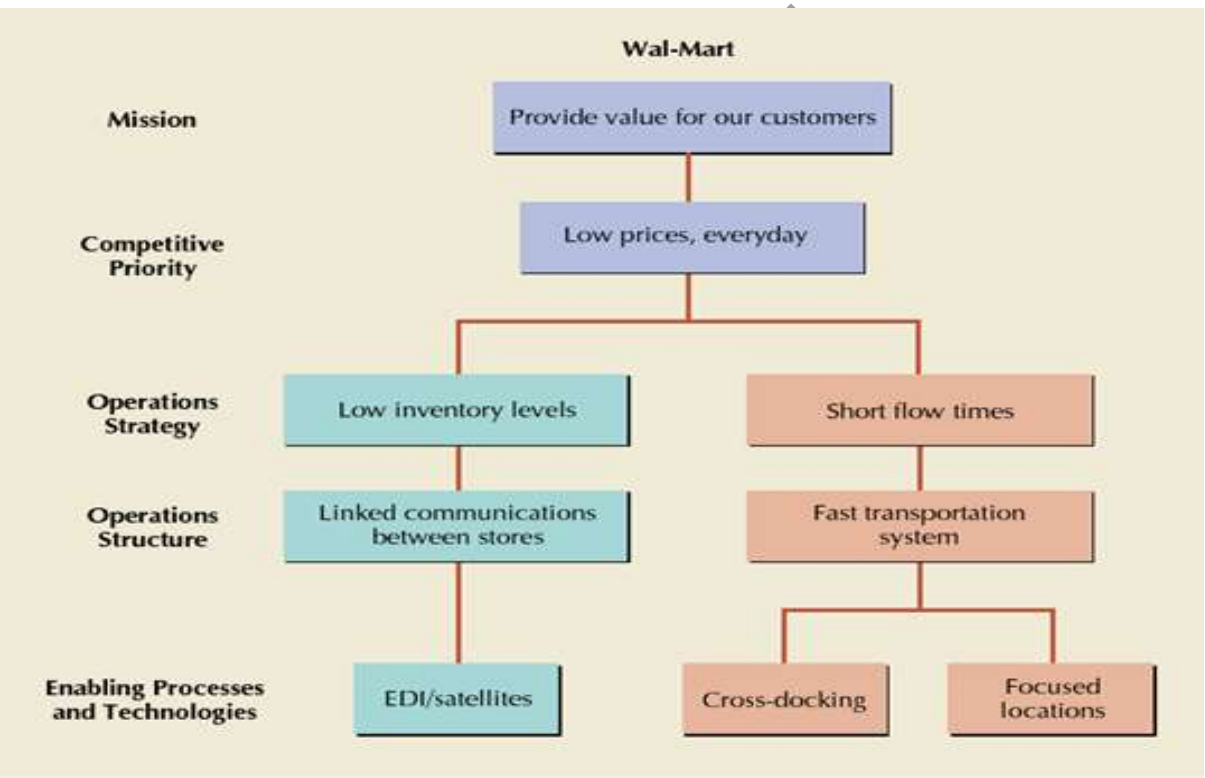
OPERATIONS STRATEGY

- It is concerned with setting broad polices & plans for using the resources of a firm to best support its competitive strategy.
- It is about beings different from your competitors.
- *Either doing different things or doing things differently.*
- It specifies how operations can achieve the organization goals, within the framework of corporate strategy

Operation Strategy at Walmart:

- Industry- Retail
- Founder Sam Walton (1962)
- No.of Location: 11,047 Units (Sep 2013)
- Employee: 2.2 million

- "*Save Money Live Better*", replacing the "*Always Low Prices, Always*"
- Capturing the Market Share with" Everyday Low Price" Strategy
- Training Employees because People are key to Wal-mart business.
- Buy at Less and Sell at less



OPERATIONS STRATEGY

- ✓ It is concerned with setting broad polices & plans for using the resources of a firm to best support its competitive strategy. It is about beings different from your competitors. *Either doing different things or doing things differently.*
- ✓ It specifies how operations can achieve the organization goals, within the framework of corporate strategy.

There are four levels at which strategies are formulated:

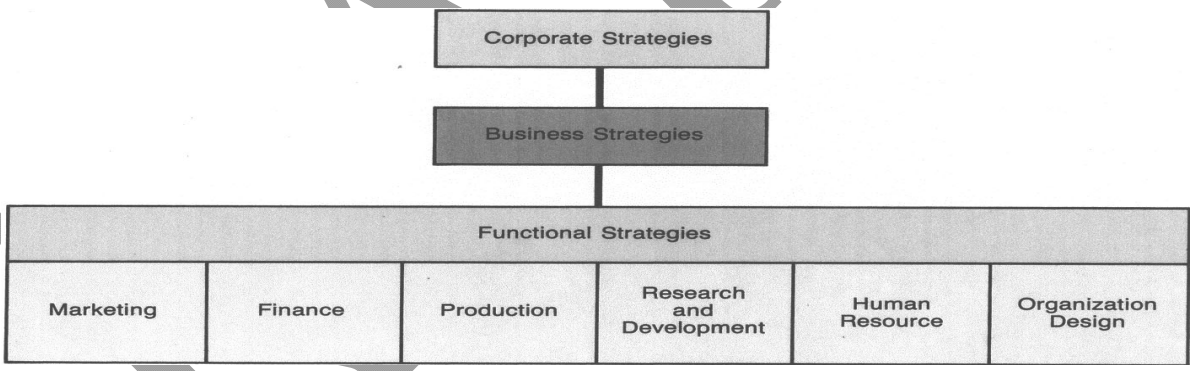
A. Corporate Level
B. Global Level
C. Business Unit Level

D. Functional Level

(A). Corporate Level Strategy

- It is formulated by top management
- The company should decide where it wants to be in 10 or 15 years,
- Market Standing, Innovation, Productivity, physical and financial resources, profitability, managerial performance and development, worker-performance and attitude, Social responsibility.

Corporate Level Strategies	
1. Growth Strategies	(a) Internal Growth (b) Horizontal Integration (c) Horizontal related diversification (d) Conglomerate Diversification (e) Vertical Integration of related business (f) Vertical Integration of un related business (g) Mergers and Strategic alliances
2. Stability Strategy	----
3. Retrenchment Strategies	Turnaround, Divestment, Liquidation



(B) Global Level Strategy

Increasing profit through global expansion is possible due to:

1. Location Economies:

- It is economic benefits that arising from a value creation activity in the optimal location for that activity.
- Lower cost of value media (2) It can enable company to differentiate its products from competitors.
- Ex: Philips, Nokia Manufacturing products in China because Low cost labor.

2. Experience Curve:

- It refers to the systematic decrease in production costs that have been observed to occur over the life of a product.
- It allows a company to lower its cost structure and achieve a cost advantage in relation to its competitors.

3. Transferring Distinctive competencies:

- Distinctive capabilities are the source of competitive advantage.
- Ex: Toyota's distinctive competencies allow it to produce high quality, well designed cars at a lower cost than any other company in the world.

4. **Leveraging the skills of global subsidiaries**: International Strategy, Multi domestic strategy, Global strategy, Transnational Strategy.

(D) Business Unit Level Strategy

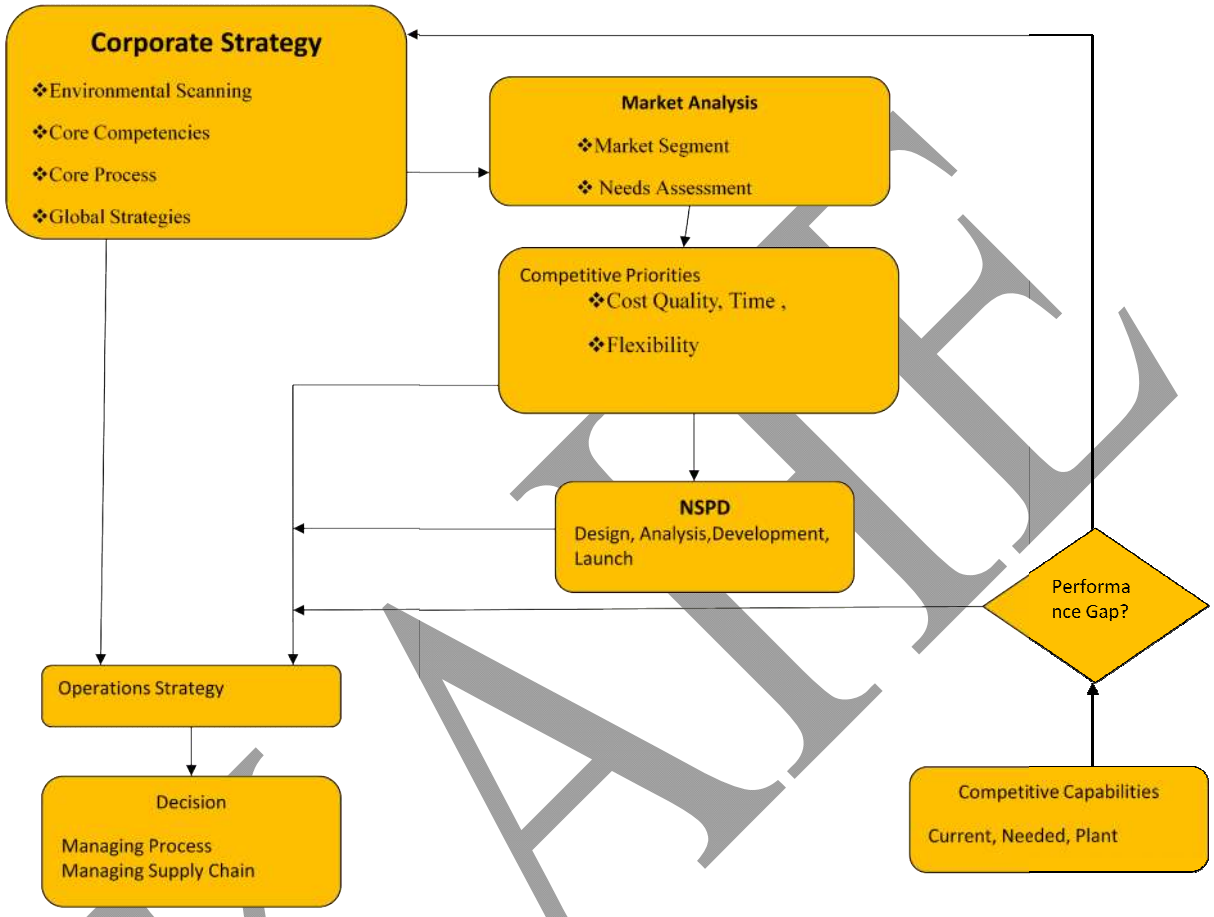
- A business unit is an organizational subsystem that has a market, a set of competitors, and a goal distinct from those of the other subsystems in the group.
- Business Level Strategy decides the base for competing with rivals.
- The concept of SBU- Strategic Business Unit was pioneered by General Electric Company.

(E) Functional Level Strategy

Functional Strategies				
Marketing	Finance	Production	Research and Development	Human Resource

- Functional Strategies identify the basic course of action that each department must pursue in order to help the business unit to attain its goals.

STRATEGY FORMULATION PROCESS



Competitive Priorities:

- Cost or Price
  - Make the Product or Deliver the Service Cheap Ex:Big Bazaar
- Quality
  - Make a Great Product or Deliver a Great Service Ex: Ferrari and Mcdonald
- Delivery Speed
  - Make the Product or Deliver the Service Quickly
- Delivery Reliability Ex: FedEx (Speedy, reliable, Overnight delivery)
  - Deliver It When Promised
- Coping with Changes in Demand

- Change Its Volume

- Flexibility and New Product Introduction Speed
  - Change It

Order Winners:

Order winners are the criteria that differentiates the products and services of one firm from another .

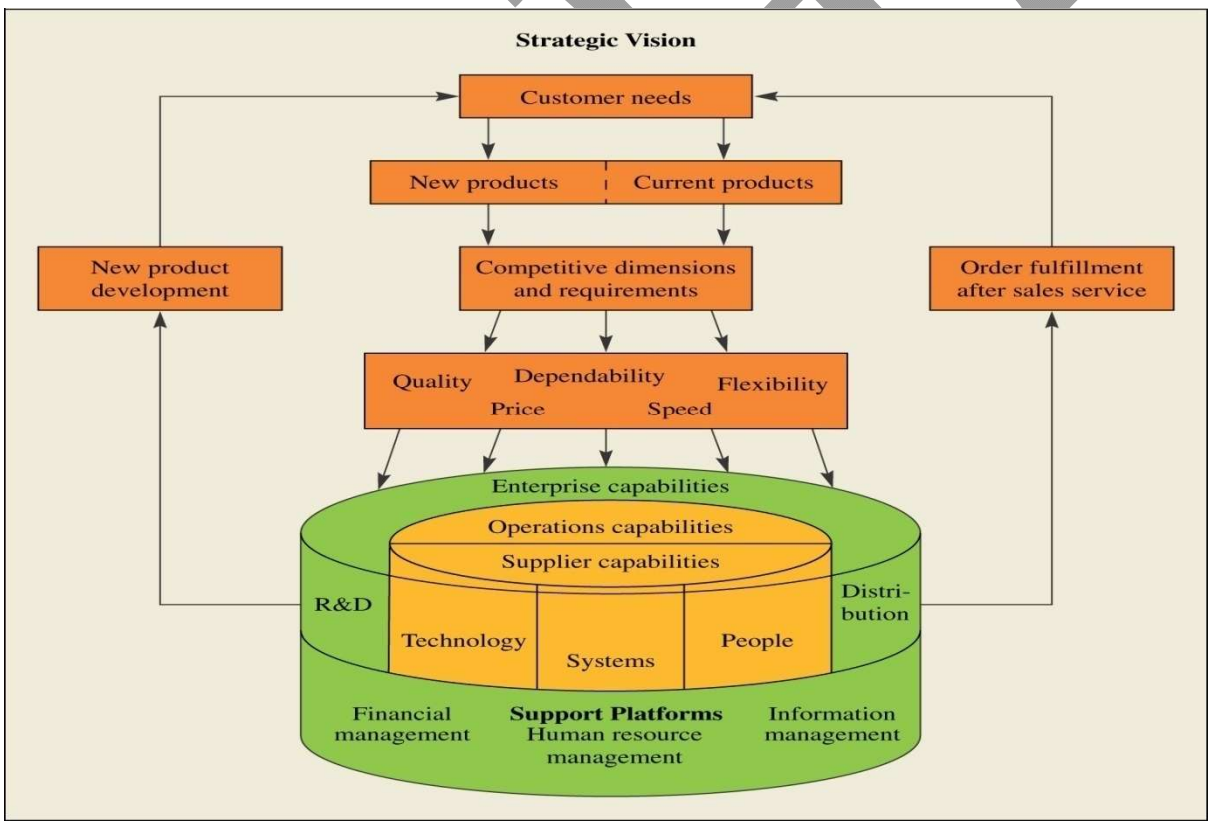
Order Qualifiers:

Order qualifiers are the screening criteria that permit the firms products to be considered as candidates for purchase by customers.

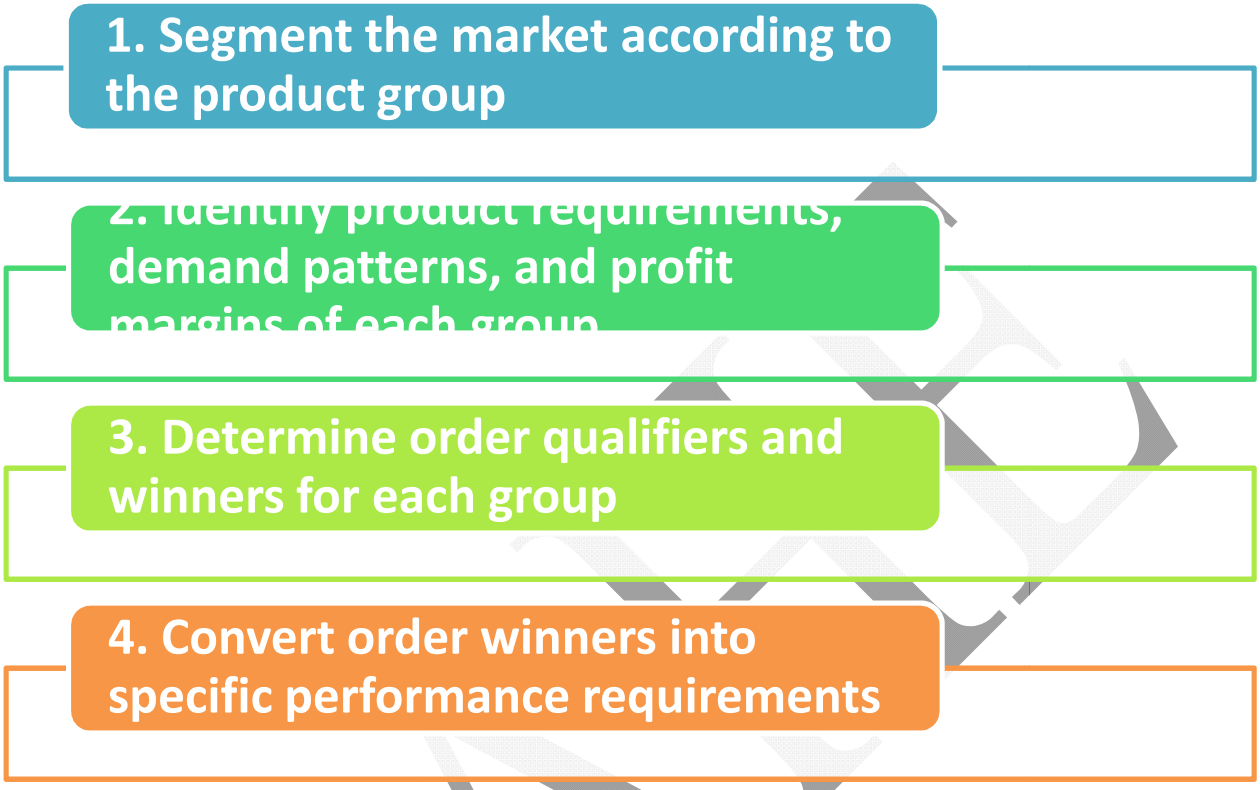
Ex: Japanese Automobile (Toyota) Order Winners (Quality, Reliability, Price)

Ford, GM, Chrysler – Order Qualifier

Customer Driven Operations Strategy



Steps in Developing a Manufacturing Strategy



Operations Strategy in Service Sectors:

- Service Firms may use the Plant with in a Plant (PWP) structure to achieve focus.
- PWP -Different Locations within the facility are allocated to different product lines, each with their own product lines.
- Ex:Hospital (Cardiac Units, Oncology Units, labor & delivery units)
- Retail Outlets (Different sections, Women's sports wear, Men clothing, Children apparel)
- Minimize the confusion associated with shifting from one type of strategy to another

Part A (ONE Mark)

Multiple Choice Questions

Part B (2 Marks)

1. Define Productions and Operations management.
2. What does the term Operations strategy?
3. What is meant by 'competitive strategy'?
4. List four performance characteristics that a company can choose to emphasize to have competitive advantage:
5. What are order winning and order qualifying attributes? Give three examples of each in the service and manufacturing industries.
6. List out the competitive priorities of operations.

Part C (6 Marks)

1. "Paying attention to the smallest details of production can be strategic importance"- Elucidate the statement.
2. Explain the system concept of Production system.
3. Define the production system Explain how the concept of productions system helps in understanding of Production and operations management.
4. Explain in details the various elements of operations strategy.
5. Explain the recent trends in production and operations management
6. Explain the various elements of adopting operations strategy in manufacturing firms.
7. Elucidate the various objectives of Operations Management
8. Describe the need for production and operations Management.
9. What are the steps involved in strategic formulation process? How does manufacturing technology provide unique advantages to organization in providing products and services to customers?
10. Briefly describe the strategy formulation process.

KAHE

Part D (Case Study- 11 Marks)

Busy Monday morning, Rahul bhai was getting ready to go to Office in Kochi. Thirty years, old Rahul Bhai purchased a Honda City car from ABC dealer in Trivandrum on 2008. He could not start his car due to overnight rain. After some moments, he started his car. He was rushing up to go to office. On the middle of the road, the car got jump started. He was annoyed with his car's performance.

The Manufacturers and dealers offer variety of services for their products like arranging car loan, five years warranty period, assisting Insurance and Roadside Assistance Programme etc. They are charging a considerable amount of money for their services. Particularly, Roadside Assistance Programme which means whenever car breaks down, the battery failure, more smoke comes from silencer or carelessly locked door. In such an emergency case, the customer can make a call the toll free number provided and help will arrive at your location. If car cannot be fixed immediately, some programmes offer to tow it to the nearest service station and find accommodation or a replacement car for customer in the mean time. If car is new, the manufacturer or dealer has given you the option of registering for a Roadside Assistance Programme at the time of purchase.

Companies like Volkswagen offers Roadside Assistance Programme free of cost during the two year warranty period. Honda offers five year warranty period. They charge for Roadside Assistance Programme, 1750/-INR for the first year of service, 2900/- INR in th second, 3700/-INR in the third, 4600/-INR in the fourth and 6000/-INR in the fifth year. Compare to Chevrolet too has a subscription fee 1000/- INR during the first year or 2700/-INR for a three year programme. After warranty period, they charge a flat 1350/-INR per year.

If customers purchase second hand vehicle, the manufacturer or dealer unlikely to give you the benefit of Roadside Assistance Programme. In addition, Manufacturer would not be willing to extend such services after the warranty period. Further, the signing up of the Roadside Assistance programme is quite complicated with most manufacturers including details of dealership customer purchased the vehicle from and vehicle identification number that establishes that the automobiles qualifies for the programme.

However, third party enter into the Roadside Assistance Programme, companies like Crossroads India Assistance (CRIA), Carzcare and MyTVS. They provide similar services offered by manufacturers or dealers. In addition, they can also save you money on services such as towing your

vehicle in case of a breakdown that cannot be rectified on spot. Most service providers offering concessional rates on this facility. The major drawbacks of some of third parties restrict their services to certain territories. For example, CRIA provides RoadSide Assistance programme only in 23 cities in Country. MyTVS assures customers of assistance anywhere in India, barring J&K and the North East.

Also, Roadside Assistance Programme cap the number of free services customer can entitles to in a year. If car breaks down frequently, it's probably best to junk it! Third parties' service cost is less than obtaining similar kit from manufacturer or dealer after vehicle has crossed a certain age. For example CRIA start at 799/- plan in New Delhi/NCR, MyTVS' Basic gold membership plan 1250/- per year.

Q1: As an Operation Manager of a Third Party Company, What operations Strategy should focus for increasing customer satisfaction?

Q2: Recommend What Competitive Priorities, Manufacturers and dealers should highlights in their operations.

KAHE

KARPAGAM ACADEMY OF HIGHER EDUCATION, COIMBATORE

DEPARTMENT OF MANAGMENET

Unit 1- Introduction to Operations Management and Operations Strategy- Multiple Choice Questions- Each Question carries ONE Mark

SI.NO	Question	Option 1	Option 2	Option 3	Option 4	Answer
1	A strategy which aims to produce a perfect product which will suit everybody is called	Product orientation	Marketing orientation.	Production orientation.	Perfect orientation	Product orientation.
2	A strategy which aims to produce the maximum amount of goods at the lowest possible price is called	Production orientation.	Selling orientation.	Societal marketing.	Cost orientation.	Production orientation.
3	Someone who has responsibility for marketing decisions concerning a group of products is	A product manager.	A brand manager.	A sales manager.	A marketing manager.	A product manager.
4	Which of the following is true?	value is always lower than price.	value is what consumers are prepared to pay.	cost is always lower than price.	price is always lower than value.	value is what consumers are prepared to pay.
5	Demand is created when	A need is identified	A significant group of people want to buy something	People who can afford something want to buy it	Marketers persuade people to want something	People who can afford something want to buy it
6	The paradigm that leads to more complex products at ever-increasing prices is _____.	Product orientation	Production orientation	Marketing orientation	Sales orientation	Product orientation
7	Someone who is responsible for finding out what individual customers need, and explaining how the firm's products meet those needs, is a	brand manager	salesperson	sales manager	market research manager	salesperson
8	Someone who controls media purchases and deals with advertising agencies is an	Sales manager	Brand manager	Advertising manager	Market research manager	Advertising manager

9	A specific satisfier for a need is called as	Product	Demand	Want	Market	Want
10	Long-term capacity planning deals with which of the following factors	overtime budgets	investment in new facilities	inventories	workforce sizes	investment in new facilities
11	Input measures of capacity are preferred when there are	Flexible flow processes	High-volume processes	Service processes	Low customizations	Flexible flow processes
12	A measure of the reserve capacity a process has to handle in unexpected increases in demand is the _____.	capacity utilization rate	capacity cushion	capacity bottleneck	capacity constraint limit	capacity cushion
13	In general, a less capital-intensive industry such as a hotel chain would do well with a utilization rate of	18%	30-40%	60-70%	100%	60-70%
14	An expansionist capacity strategy is NOT indicated when	a pre-emptive marketing strategy is used	capacity expansion is consistently ahead of demand	expansion is made in large increment	expansion will lead to economies of scale	expansion will lead to economies of scale
15	Chang and Chang observe that the competition is increasing the size of its warehouses. They have decided to do the same. They are following a strategy	Theory of constraints	Expansionist	Follow the leader	Wait-and-see	Follow the leader
16	When evaluating alternative capacity decisions, qualitative concerns exclude?	Cash flows	Uncertanities about demands	Competative reactions	Technology changes	Cash flows
17	Efficiency is given by	Actual output divided by design capacity	Capacity divided by utilization	Actual output divided by effective capacity	Effective capacity divided by actual output	Actual output divided by effective capacity

18	The maximum output of a system in a given period is called the	Efficiency	Effective capacity	Design capacity	Break-even point	Design capacity
19	Costs that continue even if no units are produced are called	Fixed costs	Mixed costs	Marginal costs	Variable costs	Fixed costs
20	A facility with a design capacity of 1,000 units, an actual average of 800 units, and effective capacity of 850 units has an efficiency of…….	80%	50%	85%	94%	94%
21	A facility with a design capacity of 1,000 units, an actual average of 800 units, and effective capacity of 850 units has a utilization of …….	85%	80%	125%	94%	80%
22	Which of the following actions would be best if a firm faced highly seasonal demand for a perishable product	hire and fire employees as demand fluctuate	build up inventory when demand is low	add warehouse and production building space to accommodate the highest period of demand	offer a product with a complementary demand pattern	offer a product with a complementary demand pattern
23	The first steps of capacity planning and control do not include	Identifying the alternative capacity plan	Measuring aggregate demand and capacity	Studying the effect of queuing theory	Choosing the most appropriate capacity plan	Studying the effect of queuing theory
24	Yield management is not especially useful where	The service cannot be sold in advance	Capacity is relatively fixed	The service/product can be stored	The market can be fairly clearly segmented	The service/product can be stored
25	Which of the following is not a measure of utilisation?	uptime in a factory.	number of hours available for production.	room occupancy level in hotel.	load factor for aircraft.	number of hours available for production.

26	Identify the best definition of planning	core activity of planners and planning departments	setting an organisation's objectives and the means of reaching them	devising ways of achieving the objectives of an organisation	an integrated process in which plans are formulated, carried out and controlled	setting an organisation's objectives and the means of reaching them
27	What are the three levels of planning	Top, middle and bottom	Headquarters, divisional and local	Operational, intermediate and strategic	short term	Operational, intermediate and strategic
28	What is the planning horizon	time ahead for which there is no information	time period within which uncertainty is very low	maximum time for which managers can make plans	time between making a plan and putting it into effect	time between making a plan and putting it into effect
29	We identified several internal benefits of objectives, goals and a sense of mission Which is not included _____	Basis to resolve disputes	Unity of directions	Basis of plans and decisions	None of the above	Basis to resolve disputes
30	What is measurement ship	collecting too much performance data	discussing "the numbers" at every opportunity	surveying by naval architects	trying to agree low objectives so as to look good later	trying to agree low objectives so as to look good later
31	What is the more formal term for what is known as 'Plan B'?	A contingency plans	A circumstantial plans	Conductive plans	concentration plans	A contingency plans
32	Demand for a given item is said to be dependent if	the item has several children	there is a deep bill of materials	the finished products are mostly services (rather than goods)	there is a clearly identifiable parent	there is a clearly identifiable parent
33	Dependent demand and independent demand items differ in that	for any product, all components are dependent-demand items	the need for independent-demand items is forecasted	the need for dependent-demand items is calculated	a,b & c are true	a,b & c are true

34	A master production schedule specifies	The financial resources required for production	What component is to be made, and when	What product is to be made, and when	The labour hours required for production	What product is to be made, and when
35	A master production schedule contains information about	quantities and required delivery dates of all sub-assemblies	quantities and required delivery dates of final products	inventory on hand for each sub-assemblies	inventory on hand for each final products	quantities and required delivery dates of final products
36	Business cycle, price trends, National Economy are	Macro Factors	Micro Factors	Controllable Factors	factoring	Macro Factors
37	_____ also called part lists or building lists is the document generated at the design stage	MRP (Material Requirement Planning)	MPS (Master Production Schedule)	BOM (Bill of Materials)	bill of exchange	BOM (Bill of Materials)
38	_____ is the time that elapses between issuing replenishment order and receiving the material in stores.	replenishment time	lead time	idle time	safety stock	lead time
39	____ is the task of buying goods of right quality, in the right quantities, at the right time and at the right price.	Purchasing	Supplying	Scrutinizing	demand	Purchasing
40	Which is not a part of 5R's of buying	right quality	right quantity	right source	right person	right person
41	Purchasing responsibilities can be divided into Buying, Clerical and division	packing	traffic	record	follow up	traffic
42	Buying according to the requirements is called	Hand to mouth buying	Seasonal Buying	Scheduled Buying	Tender Buying	Hand to mouth buying

43	Procuring an item in staggering deliveries according to the delivery schedule finished to the supplier by the buyer	seasonal buying	scheduled buying	hand to mouth buying	tender buying	scheduled buying
44	Buying of the annual requirements of an item during its season	Seasonal Buying	Hand to mouth buying	Scheduled Buying	Tender Buying	Seasonal Buying
45	Raw Materials and WIP can be classified under-	indirect materials	direct materials	finished materials	standard parts	direct materials
46	____ are the basic materials which have not undergone any conversion since their receipt from suppliers	WIP	Work Made Part	Raw Material	Finished Part	Raw Material
47	Decisions which are primarily focused on design activities are called……..	Structural decisions	Design decisions	Infrastructural decisions	Strategic decisions	Structural decisions
48	A possible move to commodity standardisation will occur at which stage of the product–service life cycle?	Maturity	Decline	Introduction	Growth	Decline
49	During the decline stage of the product–service life cycle, the number of competitors will…….	Be stable	Increase	Be few	Decline	Decline
50	Market needs are largely met by which stage of the product–service life cycle?	Introduction	Decline	Maturity	Growth	Decline
51	For corporate banking, which of the following are likely to be key internal performance objectives?	Flexibility, cost, speed	Flexibility, quality, dependability	Dependability, speed, cost	Speed, cost, quality	Flexibility, quality, dependability
52	Things which directly and significantly contribute to gaining business are termed:	Critical factors	Competitive factors	Order winning factors	Qualifying factors	Order winning factors
53	Another term for the bottom up perspective is the concept of:	Emergent strategies	Hierarchical strategies	Experiential strategies	Group strategies	Emergent strategies

54	The operations, marketing, product–service development departments will all need to consider how best they should organise themselves. This is called:	Business strategy	Functional strategy	Operations strategy	Corporate strategy	Functional strategy
55	Decisions about what types of business the group wants to be in, what parts of the world it wants to operate in, and how to allocate its cash between its various businesses, all relate to:	Business strategy	Functional strategy	Operations strategy	Corporate strategy	Corporate strategy
56	Which of the following is true of the relationship between the content and the process of strategy?	They influence each other	Content influences process	They are independent of one another	Process influences content	They influence each other
57	The set of specific decisions and actions which shape the strategy are known as:	The content of strategy	The operationalisation of strategy	The tangibles of strategy	The process of strategy	The content of strategy
58	Which of the following decisions is NOT usually related to strategy?	Decisions that define the position of an organisation relative to its environment	Decisions involving the translation of market requirements into operations processes	Decisions which have a widespread effect on the organisation	Decisions which move an organisation closer to its short-term goals	Decisions which move an organisation closer to its short-term goals
59	Which of the following performance objectives are key to Ryanair's strategy?	Speed and dependability	Flexibility and cost	Cost and dependability	Quality and speed	Cost and dependability
60	A model for comparing the gap between market requirements and achieved performance is:	The Hill methodology	The operations strategy matrix	The Platts-Gregory procedure	The operations resources perspective	The Platts-Gregory procedure

UNIT-II

SYLLABUS

Location, Layout, Material Handling and Maintenance- Location Strategies: Introduction, Location Planning Process Facility or Layout Planning and Analysis: Introduction, Objectives of Layout, Classification of Facilities, Basis for Types of Layouts, Why Layout decisions are important, Nature of layout problems, Redesigning of a layout, Manufacturing facility layouts, Types of Layouts, Layout Planning, Evaluating Plant Layouts, Assembly Line Balancing, Material handling - Material Requirements Planning (MRP) - Manufacturing Resources Planning (MRP II) - Enterprise Resource Planning (ERP) Maintenance Management- Reliability and Maintenance - Replacement Techniques

FACILITY LOCATION

INTORDUCTION

The location planning is one of the major decisions of the organization. It is a strategic decision by nature. The general objective of facility location is to optimize the establishment cost and logistics cost of the product. For manufacturing units, the location is broadly categorized into factory location and warehouse location. If it is an existing organization, the relative location gets importance. The establishment of facility location includes the costs associated with land, construction, manpower, and state and local expenses and regulations. Logistics costs, are those directly related to the shipping of supplies and products to customers and other branches of the distribution network.

In services organizations, due to the nature of the industry location decision is very important and has to be nearer to the customer base. The service which is provided is intangible, and hence the storage is restricted to the input area. The customer participation in the service process is more, and hence the location of facility is necessarily customer centric.

KAHE

LOCATIONS OF FACILITIES

In every organization location of facility is an integral part of business planning process. Though it is considered that location decision is a one time process, often the mangers encounter situations that calls for expansion or balancing the existing facilities.

Firms such as banks, fast food restaurant, super markets and retail stores view locations as a marketing strategy and they look for locations that will help them to expand their markets. A similar situation occurs when an organization experiences a growth in demand for its products or services that cannot be satisfied by expansion at an existing location. The addition of a new location to complement an existing system is often a realistic alternative. Location decisions for many types of businesses are made rather infrequently, but they tend to have a significant impact on the organization. There are two primary reasons that make location decisions a highly important part of production systems design. One is that they entail long-term commitment, which makes mistakes difficult to overcome. The other is that location decisions often have an impact on operating costs (both fixed and variable) and revenues as well as on operations. Profit oriented organizations base their decisions on profit potential, while non profit organizations strive to achieve a balance between cost and the level of customer service they provide. The organizations will try to identify the best location available.

The location options for any organization are as follows:

1. Expanding the existing facility.
2. Add new locations while retaining existing ones, as is done in many retail stores.
3. Shut down one location and move to another.

KAHE

FACTORS OF PLANT LOCATION:

a) Availability of Raw Material: Nearness to the place of the raw material will give advantage on the transportation cost, so that the profitability can be improved. When the raw material is heavy or is consumed in bulk. Then plant location has to be nearer to the raw material site.

b) Nearness to Market it reduces the cost of transportation as well as the chances of the finished products getting damaged and spoiled on the way, especially the perishable products. Moreover, a plant being nearer to the market can capture a big market share and can render quick service to the customers.

c) Transport Facilities: A lot of money is spent both in transporting the raw materials and the finished goods, depending upon the size of raw material and finished goods, a suitable method of transportation like road, rail, water or air is selected and accordingly the plant location is decided. One point which must be kept in mind is that the cost of transportation should remain fairly small in proportion to the total cost.

d) Availability of Labour : Stable labour force right kind, of adequate size and at reasonable rates with its proper attitude towards work are a few factors which govern plant location to a major extent.

e) Availability of Fuel and Power: The main sources of energy are electrical power, coal, oil, etc. in the case of power intensive industries like steel manufacturing units or continuous process industries like petrochemical and cement, the availability of fuel and power will be one of the major deciding factors in plant location.

f) Climate: Depending on the type of industry and the products that are being manufactured, this is a different factor. For instance, in the case of textile mills climatic conditions with adequate humidity is a basic essential criterion. That is the reason many textile mills have been put up in Bombay, Coimbatore region.

g) Water Availability: In industries like textile dying, paper or chemicals. The requirement of good quality water is one of the basic requirement for plant location. The water is required for processing or for effluent ejection into the rivers or specifically for waste disposal.

h) Government Policies: The central and state government may declare many taluks as backward and give numerous concessions like tax holiday, uninterrupted power supply,

capital subsidy, easy availability of loans, etc., for balanced development of regions in the country.

i) Land: Topography, area, the shape of the site, cost, drainage and other facilities, the probability of floods and earthquakes will influence the selection of the location,

j) Community Attitude: Industries like matches, crackers, hosiery and leather have flourished because of the positive attitude of the community towards these industries.

k) The presence of related industries will give many advantages like availability of skilled labourers, standard components.

l) Housing facilities.

m) Security.

n) Local by-laws, taxes, building restrictions

o) Existence of other service facilities like hospital marketing centres, schools, banks, post offices, clubs.

These factors, depending on the product to be manufactured or the industry may separately or collectively have to be given the required weightage. In the process, many alternatives may emerge. The management decision will be taken after weighing all the alternatives and selecting the best among them.

STEPS INVOLVED IN LOCATION DECISION:

- Identification of the location objectives through Vision and Mission statements of the organization.
- Enumeration of associated constraints
- Identify the relevant qualitative and quantitative decision criteria.
- Identify the relevant models from Break even analysis, Linear programming, Simulation, Economic cost analysis and Qualitative factor analysis.
- Design data capture method and capture data.
- Apply the selected model to evaluate the alternative.
- Select the location that satisfaction the criteria
- Locate the facility.

TECHNIQUES USED FOR FACILITY LOCATION

a. Industry Precedence –

- Basic Assumption : if the location is best for many companies in the same industry, then it holds good for a new company too.
- No need for conducting detailed location study.
- Location choice is subject to the "Principle of Precedence".

b. Preferential Factor

- Decision is dictated by Personal factor.
- Individual preference
- Not a professional approach; but widely used.

c. Dominant Factor

- Availability of raw material may be a dominant factor in case of Cement. Oil exploration, Mining industries.
- Contrast to preferential factor.
- Existence of good infrastructure and skilled personnel is a dominant factor for establishing IT companies.

For evaluating quantitative factors, the techniques used are:

- Total cost method
- Locational Break even analysis

For evaluating qualitative factors, the techniques used are:

- Factor Ranking
- Factor Weight Rating

KAHE

LOCATIONAL BREAK EVEN ANALYSIS:

Locational break even analysis is a quantitative analysis. In this, the economic analysis of various location options are analyzed. This is similar to the Cost – Volume – Profit analysis carried out in the earlier chapter.

The locational break even analysis can be carried out using the following steps.

- Identify the number of locational alternatives available for establishing the facility.
- Determine the costs – Fixed and Variable – associated with each alternative.
- Calculate the total cost (TC) for each locational alternative.
- Consider Annual Production Volume on the x-axis and Annual Total cost on the Y-axis.
- Draw the total cost line for all the alternatives in the graph.
- Analyse and arrive at the quantity range suitable for each location.
- Decide on the location which meets the organizational requirements.

Factor Rating Method:

Location Factor Rating

The decision where to locate is based on many different types of information and inputs. There is no single model or technique that will select the "best" site from a group. However, techniques are available that help to organize site information and that can be used as a starting point for comparing different locations.

In the **location factor rating** system, factors that are important in the location decision are identified. Each factor is weighted from 0 to 1.00 to prioritize the factor and reflect its importance. A subjective score is assigned (usually between 0 and 100) to each factor based on its attractiveness compared with other locations, and the weighted scores are summed. Decisions typically will not be made based solely on these ratings, but they provide a good way to organize and rank factors.

EXAMPLE — Location Factor Rating

The Dynaco Manufacturing Company is going to build a new plant to manufacture ring bearings (used in automobiles and trucks). The site selection team is evaluating three sites, and they have scored the important factors for each as follows. They want to use these ratings to compare the locations.

		Scores (0 to 100)		
Location Factor	*Weight*	*Site 1*	*Site 2*	*Site 3*
Labor pool and climate	0.30	80	65	90
Proximity to suppliers	0.20	100	91	75
Wage rates	0.15	60	95	72
Community environment	0.15	75	80	80
Proximity to customers	0.10	65	90	95
Shipping modes	0.05	85	92	65
Air service	0.05	50	65	90

SOLUTION:

The weighted scores for each site are computed by multiplying the factor weights by the score for that factor. For example, the weighted score for "labor pool and climate" for site 1 is

$$(0.30)(80) = 24 \text{ points}$$

The weighted scores for each factor for each site and the total scores are summarized as follows:

	Weighted Scores		
Location Factor	*Site 1*	*Site 2*	*Site 3*
Labor pool and climate	24.00	19.50	27.00
Proximity to suppliers	20.00	18.20	15.00
Wage rates	9.00	14.25	10.80
Community environment	11.25	12.00	12.00
Proximity to customers	6.50	9.00	9.50
Shipping modes	4.25	4.60	3.25
Air service	2.50	3.25	4.50
Total score	77.50	80.80	82.05

Site 3 has the highest factor rating compared with the other locations; however, this evaluation would have to be used with other information, particularly a cost analysis, before making a decision.

COST FACTOR

In plant location, apart from the availability of technology, etc., the major deciding factor will be the cost of the final product. The ideal plant location is the one which result in lowest cost of production and distribution of the items in the market. For some production facilities, the basic necessity itself may be that it has to be located nearer to the market, that is, the facility has to be created in the urban area. For some others it can be located at remote rural areas. Cost is associated with each decision. Other than this, there are other advantages as well as disadvantages.

PROBLEM NO.1

The operations manager has obtained the following details from various sources. His job is to identify the optimal location for establishing the production facility.

S.No	Item	Site A	Site B	Site C
	A.Fixed Costs	Rs.	Rs.	Rs.
1.	Land	3,00,000	6,00,000	4,50,000
2.	Building	4,50,000	5,50,000	4,00,000
3.	Other Fixed costs	50,000	50,000	50,000
	B.Operating Cost/Year			
4.	Labour	6,00,000	5,00,000	5,20,000
5.	Transportation	2,20,000	1,80,000	2,00,000
6.	Power	60,000	75,000	50,000
7.	Fuel	20,000	25,000	18,000
8.	Water	3,000	8,000	5,0000
9.	Miscellaneous	50,000	75,000	60,000

The details on Insurance and taxes are :

Local tax on the fixed cost is 10%, 12% and 8% for Site – A,B and C respectively.

The insurance covers the fixed cost component and it is flat 15% for all the locations.

Solution: Total Fixed cost = (1+2+3) + Local tax + Insurance cost

Total Operating cost/year = (4+5+6+7+8+9)

Item	Site –A	Site – B	Site - C
Total Fixed Cost :			
(1+2+3)	8,00,000	12,00,000	9,00,000
Local Tax	80,000	1,44,000	72,000
Insurance	1,20,000	1,80,000	1,35,000
Total F.C	10,00,000	15,24,000	11,07,000
Total Operating Cost/Year	9,53,000	8,63,000	8,53,000
Grand total	19,53,000	23,87,000	19,60,000

Site A and C are competing with each other on the grand total cost.

Going by the calculations, Site – A is selected as the location with minimum cost.

A close look at the total fixed cost and total annual operating cost will give us more insight.

The fixed cost (one time expense) of Site – C is higher by 11.07%, whereas the annual operating cost is lower by 1 – [(8,53,000/9,53,000)]=10.5 percent.

This is a recurring reduction in the annual production cost of the organization. Hence, optimal location is Site – C.

PROBLEM NO – 2

An economic survey is conducted by a manager to identify a suitable location for his organization. Use the following cost data and decide on the location for establishing the facility.

QUANTITATIVE FACTORS COST OF	Location Cost (Rs.)		
	Urban	Semi Urban	Rural
Land	12,00,000	17,00,000	11,00,000
Building	1,00,00,000	1,12,00,000	1,00,00,000
Power	1,00,000	80,000	60,000
Water	50,000	70,000	60,000
Labour	25,00,000	20,00,000	15,00,000
Fuel	4,00,000	3,00,000	5,00,000
Raw Materials	14,00,000	15,00,000	17,00,000
Incoming Freight	6,00,000	5,00,000	8,00,000
Outgoing Freight	10,00,000	8,00,000	9,00,000
Cost	1,72,50,000	1,81,50,000	1,66,20,000
Taxes (% of cost)	10%	8%	5%
Total Project cost	1,89,75,000	1,96,02,000	1,74,51,000
Qualitative Factor			
Work Culture	Unionized	Party organized	Non organised
Established Infrastructure	Very good	Good	Average
Standard of living	Costly	Average	Moderate
Community attitude	Good	Average	Hostile

ANALYSIS:

The positive factors for the Rural location is the cost, which is the minimum at Rs. 1,74,51,000. Other positive factors are : Unorganised unions, moderate standard of living.

The negative factors are : hostile community attitude and average available infrastructure.

If the management has the capability to win over the community, Rural location is the host.

RATE OF RETURN METHOD (RoR)

The rate of return is the expected rate of return on the investment made on a specific location. It is computed as:

$$Rate of\ \mathrm{Re}turn = \frac{Total\ \mathrm{Re}venue - TotalExpenses}{GrossInvestment}$$

PROBLEM NO. 3

A company manufacturing chemical want to expand their capacity by establishing the production facility at a new location. Two locations and their details are presented below. Using these, identify the best location using the Rate of Return method.

S. No.	Item	Location – I	Location – II
1.	Capital investment	10,00,000	12,00,000
2.	Total Revenue/Year	13,00,000	17,00,000
3.	Raw material cost /year	3,00,000	3,75,000
4.	Labour Cost / year	4,00,000	4,25,000
5.	Sales and Distribution cost / year	70,000	1,15,000
6.	Annual Electricity cost	1,30,000	1,00,000
7.	Annual water supply cost	50,000	1,00,000
8.	Effluent treatment facility	Individual facilities	Common facilities

9.	Concentration of similar units	High	Very high

SOLUTION :

The total expense is calculated by adding the items C to G.

Total Expense of Location – 1 = Rs. 9,50,000

Total Expense of Location – 2 = Rs.11,50,000

$$Rate of \text{ Re}turn(Location-1) = \frac{Rs.13,00,000 - Rs.9,50,000}{Rs.10,00,000}$$

$$Rate of \text{ Re}turn(Location-2) = \frac{Rs.17,00,000 - Rs.11,50,000}{Rs.12,00,000}$$

$$= 45.8\%$$

It is advisable to locate the chemical unit in Location – 2 as it has:

1. High Rate of Return (45.8%)
2. Common effluent treatment facility, which is an important requirement for waste disposal and
3. Very high concentration of similar units will help to effectively handle pollution and community related issues.

KAHE

PLANT LAYOUT

LAYOUT

- *Layout*: the configuration of departments, work centers, and equipment, with particular emphasis on movement of work (customers or materials) through the system
- Allocation of Space and the arrangement of machines and equipments in such a manner that overall operating costs are minimized.

Arrangement of various work centers, departments, equipments and support services too is the focus of layout. Specific emphasis on the flow of materials and movement of men in the organization is given while designing the layout. The flow patterns of the work activities affect the:

- Utilization of facilities
- Efficiency of materials handling
- Inventory at all stages viz., raw material, work-in progress and finished goods.
- Labour productivity
- The number of accidents in the factory
- Quality of the product and
- Quantum of production.

Decision on product design, facility location and capacity planning will affect the layout and vice – versa. Efforts to increase the capacity may involve modification in layout and changes in location. Any time, a new location is established or products or services are introduced or changed, layout is affected.

IMPORTANCE OF LAYOUT

Layout decisions are important on the following counts:

- Requires substantial investments of money and effort
- Involves long-term commitments
- Has significant impact on cost and efficiency of short-term operations
- It is a strategic decision
- Affects the cost structure of the product.

KAHE

NEED FOR LAYOUT PLANNING

The need arises on two occasions – one while creating a new layout; and another while modifying the existing layout. There are valid reasons for redesigning the existing layout and they are:

- Frequent changes in scheduling
- Inefficient operations
- Pilling up of work-in-progress at each work centre.
- Numerous bottlenecks
- Idle time of equipments, machineries and material handling equipments.
- Labour productivity is low
- Low employee morale
- Changes in product or service design
- Introduction of new products or services
- Outdated technology
- Over-stretched equipment
- Increase in rework
- Scrap increase
- Changes in the environment or legal aspects.

OBJECTIVES OF GOOD PLANT LAYOUT

a. Economies of materials - Overall simplification of production process in terms of

- Equipment utlisation
- Minimization of delays
- Reducing manufacturing time
- Better provision for maintenance.

b. Overall integration of men, materials, machinery, supporting activities and any other consideration which may give a better compromise.

c. Provision for MH equipments and other basic amenities to minimize material handling cost.

d. Floor space saving

- Effective space utilization

KAHE

- Less congestion and confusion

e. Continuous Production for Increased output and reduced work-in-progress.

f. Provision for better supervision and control

g.Better working environment - To provide safety

h. Workers convenience

- Worker / Job satisfaction
- Improved morale.

i. Waste minimization and higher usage

j. avoid unnecessary capital investment

k. Higher flexibility and adaptability to changing conditions

l. To improve production process to and reduced production cycle time and get better product quality

m. Proper utilization of cubic space.

PRINCIPLES OF LAYOUT

The basic principles or plant layout is as follows:

- Continuous Flow
- Avoid Back tracking
- Cubic Space utilization
- Flexibility
- Minimise Material Handling
- Use of Gravity to minimise MH costs

The total movement of material should be minimum. For this, one has to consider the movement distances between different work areas as well as the number of times such movements occur per unit period of time.

The arrangement of the work area should have as much congruence as possible with the flow of materials within the plant (from the stage of raw materials to the stage of finished goods). By 'flow' it was not meant a particular straight line direction, but the different stages through which the material passes before it becomes a finished product. The stages at which value is added to the product and the sequence of the work areas should correspond with each other, as much as possible.

KAHE

In effect, there should be no back-tracking and very little interruption in the flow of the product from the raw materials stage to the finished product.

A good layout should take into consideration all the three dimensions of space available. In addition to the floor space, the vertical space available should also be taken into account while designing the work areas.

The layout should be adaptable or flexible enough to allow for probable changes in the future as all systems should anticipate changes in the future.

The layout should ensure adequate safety and satisfactory working conditions for the employees.

A good layout has to satisfy, therefore, the availability of space, the size and work area requirements of machinery and other utilities, the flow direction, type and number of movements of the material, the men working in the plant, and also the future anticipated changes. The principle is one of integrating all these aspects.

TYPES OF LAYOUT

The layout design can be carried out on the basis of:

- Work flow.
- The function of the production system.

CLASSIFICATION BY WORK FLOW:

There are four basic types of layout based on the work flow format and they are :

- Product layout
- Process layout
- Combination layout
- Fixed position layout
- Cellular layout

KAHE

PRODUCT LAYOUT

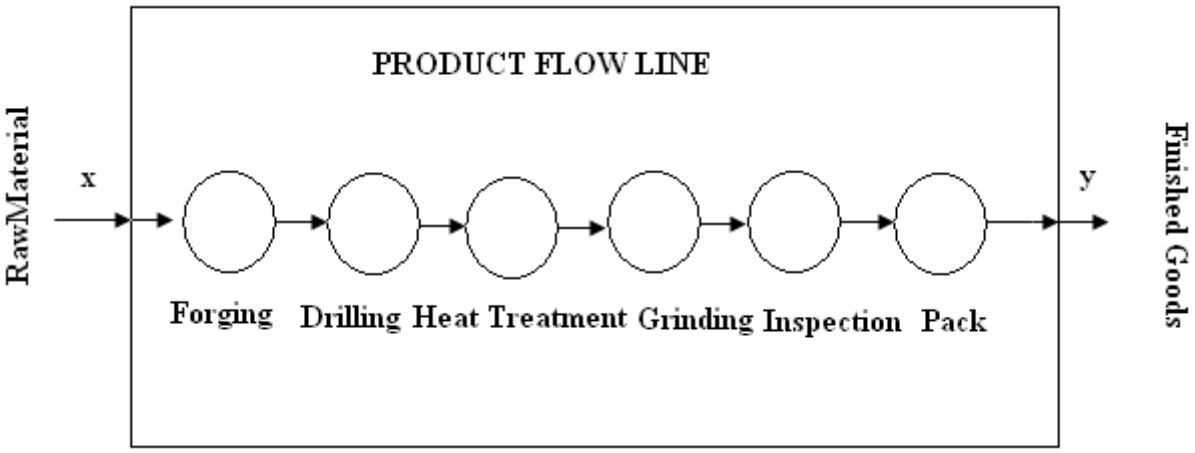
Arrangement of machines according to the sequence involved in manufacturing a product from the Input stage to the Output stage is called a Product layout or Line layout. The flow is an unbroken line from raw material to the finished goods. It is a Layout that uses standardized processing operations to achieve smooth, rapid, high-volume flow.

Example : Automobile Manufacturing, Food Processing.

The product layout is preferred under situations where it is required to achieve a smooth and rapid flow of large of volume of products (in the case of goods production) and customer (in case of services) through a system. This layout is ideal for product focused systems.

The highly standardized product or service which requires highly standardized, respective processing operations uses this type of layout. In the product layout, only one product or one type of product is produced in the specified place or shop floor.

If a product is assembled in the product layout, it is called as an Assembly line.



Product Layout

The raw materials enter from one end (x) and value addition takes place at each and every stage of the operations. Finally it comes out of the shop floor(y) as finished goods. Then it is moved over to the market directly or to the storage yard.

Product layouts are suitable for manufacturing products having the following characteristics:

- High volume of production
- Quick cycle time of manufacturing

- Standardisation of product
- Reasonably stable product demand
- Less variety

Advantages of Product Layout

- High rate of output
- Low unit cost
- Labor specialization
- Low material handling cost
- High utilization of labor and equipment
- Established routing and scheduling
- Routine accounting and purchasing

Disadvantages of Product Layout

- Creates dull, repetitive jobs
- Poorly skilled workers may not maintain equipment or quality of output
- Fairly inflexible to changes in volume
- Highly susceptible to shutdowns
- Needs preventive maintenance
- Individual incentive plans are impractical

PROCESS LAYOUT

Arranging machines performing similar functions or process together in particular place to enhance variety of operation is called Process Layout or Functional Layout. The layout can handle varied processing requirements.

Example : Job shops, Hospitals, Departmental Stores.

The process layout is developed for process focused systems. These layouts are designed to accommodate various products or services that uses all or few of the processes available in the shop floor. The processing units are organized by functions into each department on the assumptions that

KAHE

certain skills and facilities are available in each department. Similar equipments and operations are grouped together. For example, turning, milling, foundry and heat treatment.

Product or services which requires all or few of these operations are converted into batches and moved in. The sequences of operations are not a straight line as in product layout; but zig zag. This is dictated by technical considerations. Different products may call for different processing requirements and their equipments. The use of general purpose machines provide flexibility necessary to handle a wide range of processing requirements. Workers who operate the equipments are usually skilled or semi-skilled.

Advantages of Process Layouts

- Can handle a variety of processing requirements
- Not particularly vulnerable to equipment failures
- Equipment used is less costly
- Possible to use individual incentive plans

Disadvantages of Process Layouts

- In-process inventory costs can be high
- Challenging routing and scheduling
- Equipment utilization rates are low
- Material handling slow and inefficient
- Complexities often reduce span of supervision
- Special attention for each product or customer
- Accounting and purchasing are more involved

FIXED POSITION LAYOUT

This is a type of layout in which the product, by virtue of its bulk or weight, remains at one location. The required equipments and machineries are moved to the work spot and the conversion process is carried out. This layout is characterized by a fixed facility that is designed to turn out more than one of a given product.

Examples: Ship building, Aircraft Assembly.

KAHE

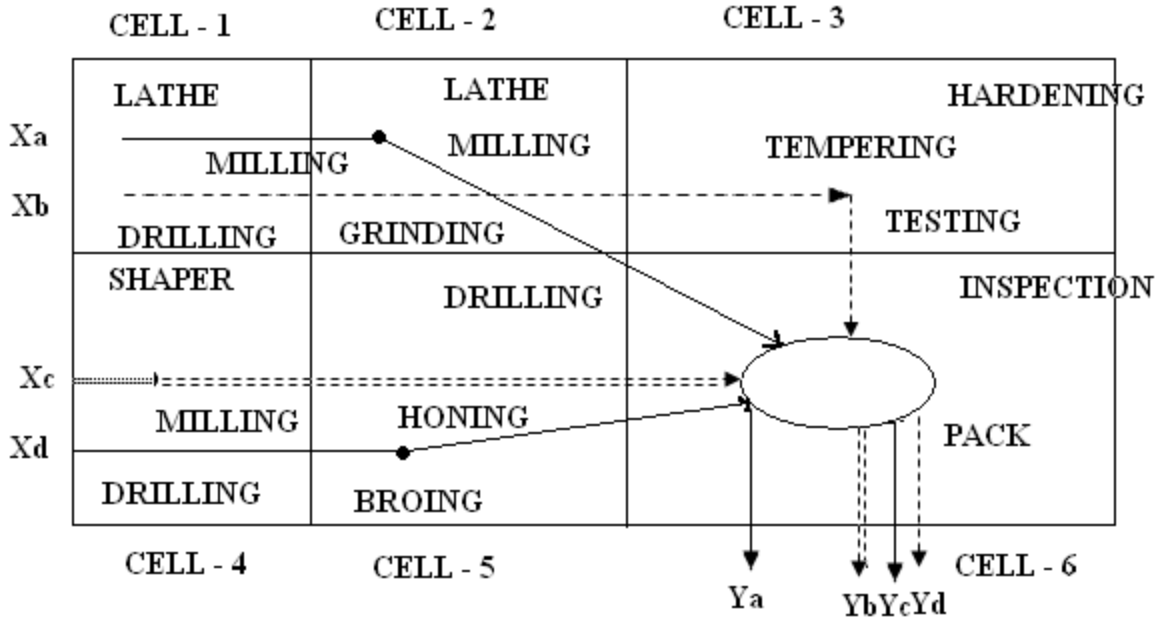
CELLULAR LAYOUT

This is a layout that derives the advantages of both product and process layouts. Interlinked processing facilities required for certain group of products are coupled together and brought under a 'cell'. There will be many cells in this layout.

Example : Custom built job shops, Specialty hospitals, Beauty Parlours.

Consider the layout in the figure below. It consists of six cells, Each cell is clubbed with the frequency used adjacent facilities. Cell- 1 consists of turning, mining and drilling facilities; Cell -2 has turning grinding and milling facilities and so on. Cell -6 is a common inspection and packing facilities.

The cellular layout is a layout that tries to derive the advantage of both product and process layout.



Cellular Layout

CELLULAR LAYOUT: ADVANTAGES

- Suitable for mass production also.
- Higher degree of flexibility than product layout in handling variety of products.
- Employs high degree of automation, but still posses flexibility.
- Can serve a fluctuating market demand.
- Better supervision and control.

- Skill requirement is skewed towards specialization.
- Capacity utilization is between product and process layouts.

GROUP TECHNOLOGY

The grouping into part families of items with similar design or manufacturing characteristics.

COMPARISION OF LAYOUTS

S.No	Item	Product Layout	Process Layout	Cellular Layout
1	Orientation	Product	Process	Process in cells
2	Product	Standardized Large volume Fixed rate of production	Diversified products Facility sharing Output varies with product Rate of output varies Flexible	Limited standardization Diverse product
3	Mfg. flexibility	Inflexible	Flexible	Highly flexible
4	Capital required	Large	Moderate	In between process and product layout
5	Type of equipments	Special purpose machines Sophisticated process Dedicated	General purpose machines Shared facilities	Combination of special and general purpose machines Sharing of facilities is of higher order.
6	Workflow	Straight line flow Repeated operation One or few setups	Zig-zag work flow Varied sequence of operations Very frequent set-ups	Zig –zag, but to a limited extent Limited sequence of operations Moderate number of set ups
7	Operation cycle time	Least	High	Moderate
8	Inventory	Very low	High	Moderate
9	Product cost	Low	High	Moderate
10	Human Skill	Specialized	Generalized	Mostly generalized, little amount of specialization is needed
11	Capacity	Very high	Moderate	Low
12	Material Handling	Automated Predictable	Less automation Unpredictable	Moderate level of automation within the

KAHE

		In lots of large volume	One or few	cells Few
13	Maintenanc e	Preventive	Breakdown	Planned
14	Support staff	Large in number Highly specialized skills	Few in number General skills	Moderate in number Slightly specialised skills

LAYOUT DESIGN PROCEDURE

The layout design is based on the factors discussed above. Once we have those information we use different tools and techniques for layout.

Tools and Techniques of layout

- Process Charts – OPC & FPC
- Process flow diagram
- Machine datacard
- Visualisation of layout

– Two dimensional plan

-Three dimensional plan

- Computer softwares like CORELAP, CAN-Q.

LAYOUT DESIGN PROCEDURE

1. Statement of specific objectives, scope and factors to be considered.
2. Collection of basic data on sales forecast and production volumes, production schedules, part lists, operations to be performed and their sequences, work measurement, existing layouts, building drawings.
3. Preparation of various kinds of charts such as flow process charts, flow diagram, string diagram, templates etc.
4. Designing the production process.
5. Planning the material flow pattern and developing the overall material handling plan.
6. Calculation of requirement of work centers and equipments.

7. Planning individual work centers.
8. Selection of material handling cost.
9. Determine the storage requirements.
10. Planning the auxiliary and service facilities.
11. Determination of routing, space requirements for each work station and service department, employee facilities etc.,
12. Draw building specification to fit requirements of the layout.
13. Preparation of floor plan
14. Preparation of tentative or draft layout plans.
15. Preparation of work schedule for installation of layouts.
16. Preparation detail layout drawing and get approval of the top management.

CELLULAR MANUFACTURING

Cellular Manufacturing (CM) refers to a manufacturing system wherein the equipment and workstations are arranged in an efficient sequence that allows a continuous and smooth movement of inventories and materials to produce products from start to finish in a single process flow, while incurring minimal transport or waiting time, or any delay for that matter. CM is an important ingredient of lean manufacturing.

Work Cell: The single process flow set-up described is a 'work cell'. A work cell is defined as a collection of equipment and workstations arranged in a single area that allows a product or group of similar products to be processed completely from start to finish. It is, in essence, a self-contained mini-production line that caters to a group of products that undergo the same production process.

Benefits of Cellular Manufacturing

- higher production efficiency
- elimination of waste
- reduced inventory levels
- optimized use of floor space
- shorter production cycle times
- higher effective manufacturing capacity &

KAHE

- improved customer response time.

LINE BALANCING

The process of assigning tasks to work stations in such a way that the workstations have approximately equal time requirements is referred to as line balancing. An assembly line should be balanced. Each work station in the assembly line should have the same operating time and the various operations should be sequenced properly. There should be perfect balance between the output rates of the parts and the subassemblies. However, it is not always possible that the parts reach in a steady stream immediately before subassembly. This may be because of the limitations as regards materials, me and equipments or it may be economical to manufacture and supply parts in batches. The flow control section has to cope with such situations and thus carry big inventories and arrange facilities for storage.

Line balancing minimizes the idle time along the line and results in high utilization of labour and equipment. Lines that are perfectly balanced will have a smooth flow of work as activities along the line are synchronized to achieve higher efficiency.

Steps involved in assembly line balancing:

1. **Draw the precedence diagram**:- It is a precedence diagram which virtually portrays the tasks that are to be performed along with the sequential requirements, that is, the order in which each task must be performed. The diagram is read from left to right, so that the initial tasks are on the left and the final tasks are on the right.
2. **Determine the Cycle Time**: - The cycle time is the maximum time allowed at each work station to perform the assigned tasks before the work moves on. The cycle time also establishes the output rate of the line.

   $$\text{Cycle time} = \frac{\text{Operating time avialabe per day}}{\text{Desired output rate}} = \frac{OT}{D}$$

3. **Determine the theoretical number of workstations**:- The number of workstations needed is a function of the desired output rate and our ability to combine all elemental tasks into the workstations. We ca determine the same as follows:

Theoretical minimum no. of Workstations

= Sum of task Times $= \sum t / CT$

Cycle time

4. **Perform the balancing**:

   a. Make assignments to workstations in order, beginning with station 1. Task are assigned to workstations moving from left to right through the precedence diagram.

   b. Before each assignment, use the following criteria to determine which tasks are eligible to be assigned to a workstation.

      (i) All preceding tasks in the sequence have been assigned.

      (ii) The task time does not exceed the time remaining at the workstation.

      (iii) If no task are eligible move on to the next workstation.

   c. After each assignment, determine the time remaining at the current workstation by subtracting the sum of times for tasks already assigned to it from the cycle time.

   d. Break ties that occur using one of these rules:

      (i) Assign task with the longest task time first.
      (ii) Assign the task with the greatest number of followers.
      (iii) If there is still tie, choose one task arbitrarily.

   e. Continue until all tasks have been assigned to workstations.

5. **Calculate the Efficiency of the line and the percentage of idle time or balance delay**.

Percentage of idle time

= Total idle time of all workstations x 100

Actual no. of Workstation x Cycle time

Efficiency = 100 – percentage of idle time.

MATERIAL REQUIREMENT PLANNING:=

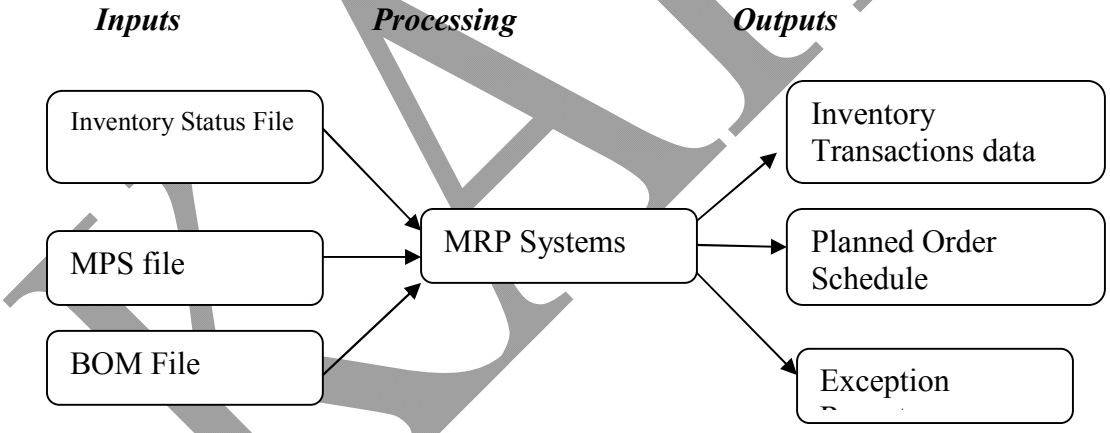
The basic inputs for MRP

1. Product structure or Bill of Materials (BOM)
2. MPS for the final assembly
3. Economic order quantity
4. Beginning inventory

BILL OF MATERIALS:

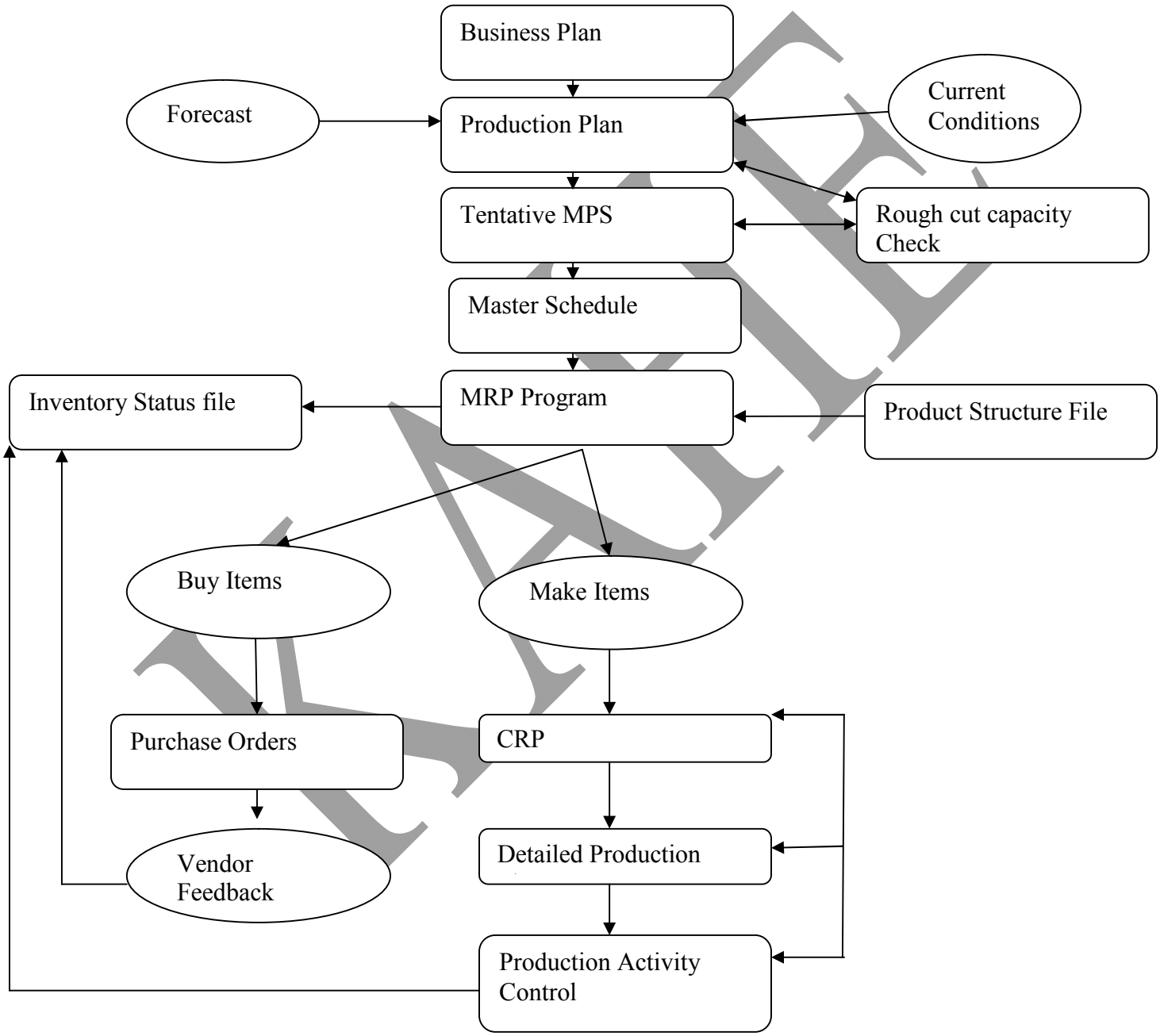
- List of components, ingredients, and materials needed to make product
- Provides product structure
- Items above given level are called parents
- Items below given level are called children

Operations of MRP System



KAHE

Information flow for Planning and controlling with MRP



Manufacturing Resource Planning (MRP-II)

- Successor to the material requirements planning (MRP), it integrates planning of all aspects (not just production) of a manufacturing firm.
- MRP-II includes functions such as business planning, production planning and scheduling, capacity requirement planning, job costing, financial management and forecasting, order processing, shop floor control, time and attendance, performance measurement, and sales and operations planning.
- Goal: Plan and monitor all resources of a manufacturing firm (closed loop):
- Manufacturing
- Marketing
- Finance
- Engineering
- Simulate the manufacturing system

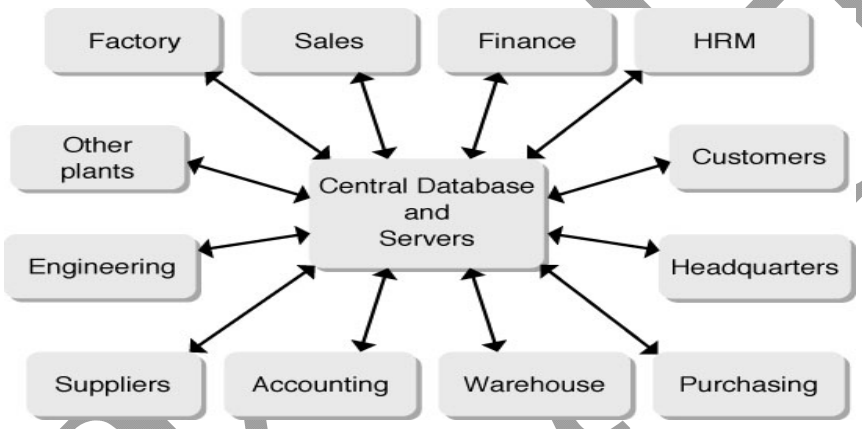
Enterprise Resource Planning:

- Enterprise Resource Planning Systems is a computer system that integrates application programs in accounting, sales, manufacturing, and other functions in the firm
- This integration is accomplished through a database shared by all the application programs
- An extension of the MRP system to tie in customers and suppliers
  - Allows automation and integration of many business processes
  - Shares common data bases and business practices
  - Produces information in real time
- Coordinates business from supplier evaluation to customer invoicing
- ERP modules include
  - Basic MRP
  - Finance
  - Human resources

KAHE

- Supply chain management (SCM)
- Customer relationship management (CRM)

- ERP can be highly customized to meet specific business requirements
- Enterprise application integration software (EAI) allows ERP systems to be integrated with
  - Warehouse management
  - Logistics
  - Electronic catalogs
  - Quality management
- ERP systems have the potential to
  - Reduce transaction costs
  - Increase the speed and accuracy of information
- Facilitates a strategic emphasis on JIT systems and integration



Advantages of ERP Systems:

1. Provides integration of the supply chain, production, and administration
2. Creates commonality of databases
3. Can incorporate improved best processes
4. Increases communication and collaboration between business units and sites
5. Has an off-the-shelf software database
6. May provide a strategic advantage

Disadvantages of ERP Systems

1. Is very expensive to purchase and even more so to customize
2. Implementation may require major changes in the company and its processes

3. Is so complex that many companies cannot adjust to it
4. Involves an ongoing, possibly never completed, process for implementation
5. Expertise is limited with ongoing staffing problem.

MAINTENANCE MANAGEMENT

- ✓ It is necessary to keep materials, tools and equipment in good condition in order to achieve desired result.
- ✓ If the working equipments are in good running condition, the products obtained will be of required quality and the process will be reliable. Therefore it is necessary to maintain the plant.
- ✓ **Set of organized activities that are carried out in order to keep the item in its best operational condition with minimum cost required**

Objectives of Maintenance Management:

1. To increase functional reliability of production facilities.
2. To enable desired quality through correctly adjusted, serviced and operated equipments
3. To maximize the useful life of equipments.
4. To minimize cost of production.
5. To minimize frequency of interruptions.
6. To enhance the safety of manpower.

Need for Maintenance Management:

1. Dependability of service
2. Assured quality
3. Prevent equipment failure Cost control
4. Huge investment in equipment

Functions of Maintenance Management:

1. Inspection.
2. Repair.
3. Overhaul.
4. Lubrication.

KAHE

5. Salvage.

Equipment Life Cycle or Bath Tub Curve:

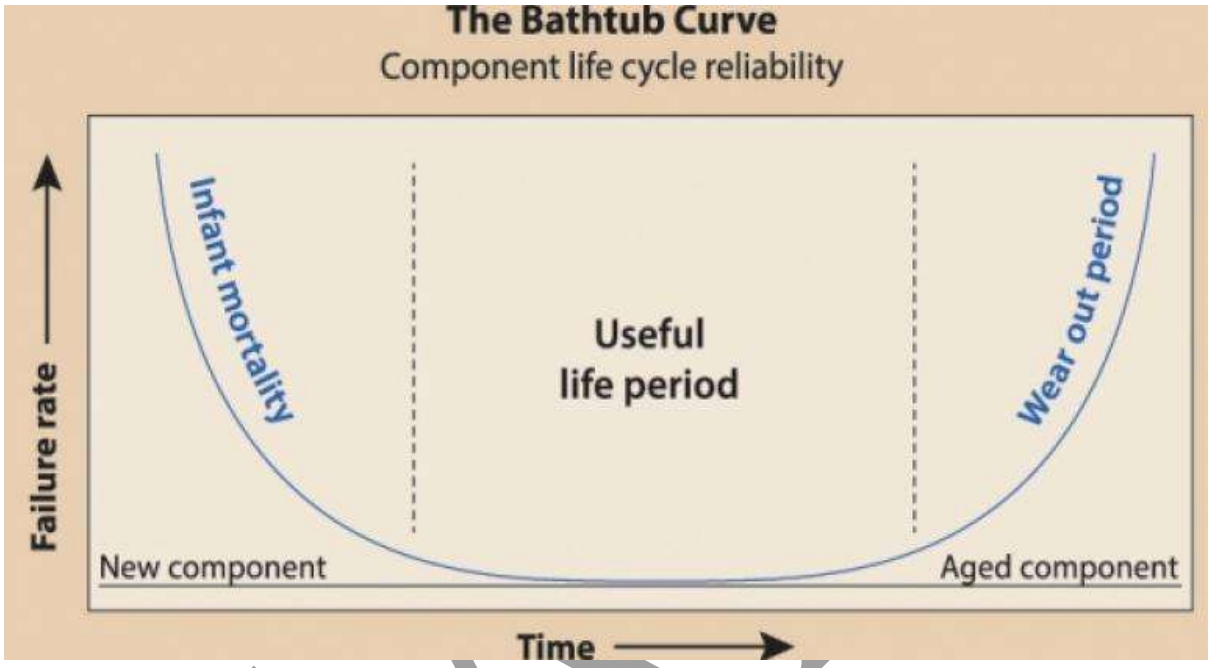


Figure: Equipment Life cycle- Maintenance Management

The **bathtub curve** is widely used in reliability engineering. It describes a particular form of the hazard function which comprises three parts:

- The first part is a decreasing failure rate, known as early failures.
- The second part is a constant failure rate, known as random failures.
- The third part is an increasing failure rate, known as wear-out failures.

The name is derived from the cross-sectional shape of a bathtub: steep sides and a flat bottom.

The bathtub curve is generated by mapping the rate of early **"infant mortality"** failures when first introduced, the rate of random failures with constant failure rate during its **"useful life"**, and finally the rate of **"wear out"** failures as the product exceeds its design lifetime.

In less technical terms, in the early life of a product adhering to the bathtub curve, the failure rate is high but rapidly decreasing as defective products are identified and discarded, and early sources of potential failure such as handling and installation error are surmounted. In the mid-life of a product—generally speaking for consumer products—the failure rate is low and constant. In the late life of the product, the failure rate increases, as age and wear take their toll on the product. Many consumer product life cycles strongly exhibit the bathtub curve.

While the bathtub curve is useful, not every product or system follows a bathtub curve hazard function, for example if units are retired or have decreased use during or before the onset of the wear-out period, they will show fewer failures per unit calendar time (not per unit use time) than the bathtub curve.

Measures of Maintenance Performance:

MTBF and MTTR:

- MTBF, or Mean Time between Failures, is a metric that concerns the average time elapseed between a failure and the next time it occurs. These lapses of time can be calculated by using a formula.
- Whereas the MTTR, or Mean Time To Repair, is the time it takes to run a repair after the occurrence of the failure. That is, it is the time spent during the intervention in a given process.

Overall Equipment Efficiency (O.E.E)

O.E.E. = Up time % X Speed % X Quality %

Up time = (MTBF-MTTR) X 100

MTBF- Mean Time between Failures

MTBF = Total Running Time/No.of. Failures

$$\text{Speed \% efficiency} = \frac{\text{Actual cycle time X 100}}{\text{Design Cycle time}}$$

$$\text{Quality \% Efficiency} = \frac{\text{Good Parts Produced X 100}}{\text{Total Parts Produced}}$$

- Mean Time between Failures and Mean Time To Repair are two important KPI's in plant maintenance management and lean manufacturing.

- Mean Time between Failures = (Total up time) / (number of breakdowns)
- Mean Time To Repair = (Total down time) / (number of breakdowns)
- "Mean Time" means, statistically, the average time.
- "Mean Time between Failures" is literally the average time elapsed from one failure to the next. Usually people think of it as the average time that something works until it fails and needs to be repaired (again). As reliable production processes are crucial in a Lean Manufacturing environment, MTBF is vital for all lean initiatives
- "Mean Time To Repair" is the average time that it takes to repair something after a failure.
- For something that cannot be repaired, the correct term is "Mean Time To Failure" (MTTF). Some would define MTBF – for repair-able devices – as the sum of MTTF plus MTTR. .In other words, the mean time between failures is the time from one failure to another. This distinction is important if the repair time is a significant fraction of MTTF.
- Here is an example. A light bulb in a chandelier is not repairable, so MTTF is most appropriate. (The light bulb will be replaced). The MTTF might be 10,000 hours.
- On the other hand, without oil changes, an automobile's engine may fail after 150 hours of highway driving – that is the MTTF. Assuming 6 hours to remove and replace the engine (MTTR), Mean Time between Failures is 150 hours.
- Like automobiles, most manufacturing equipment will be repaired, rather than replaced after a failure, so Mean Time between Failures is the more appropriate measurement.

What is Availability?

- The "availability" of a device is, mathematically, MTBF / (MTBF + MTTR) for scheduled working time.
- The automobile in the earlier example is available for 150/156 = 96.2% of the time. The repair is unscheduled down time.
- With an unscheduled half-hour oil change every 50 hours – when a dashboard indicator alerts the driver – availability would increase to 50/50.5 = 99%.
- If oil changes were properly scheduled as a maintenance activity, then availability would be 100%.

KAHE

Part A- (ONE Mark)
Multiple Choice Questions

Part B- (TWO Marks)

1. What is the importance of Plant Location decision?
2. Define Plant layout.
3. What are the different types of layout?
4. Define Cellular manufacturing System.
5. Define Cycle time.
6. What do you mean by heuristic rule?
7. What is meant by Assembly Line Balancing?
8. List out the objectives of facility location.
9. List out the benefits of good layout.
10. What is cellular layout?
11. What is Material Requirement Planning?
12. What are the inputs and outputs required by MRP processing logic?
13. What is BOM?
14. Define MTBF?
15. What is MTTR?
16. What is Availability?
17. What is Maintenance Management?
18. List out the need of maintenance Management.
19. Draw the Bath tub curve of Maintenance Management.
20. List out the advantages of ERP.
21. Define ERP?
22. What do you understand by Master Production Schedule?

KAHE

23. What is the importance of ERP in today's organisation?
24. What are the inputs to MRP?
25. Define MRP?
26. What is meant by Bill of Materials? Give example.

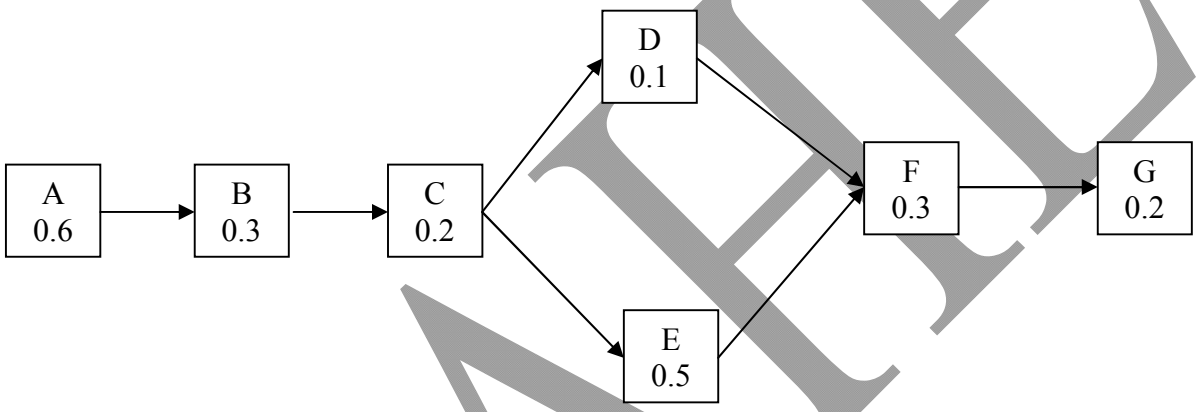
Part C- 5 Marks

1. Explain the factors affecting the plant location decision in detail.
2. 120 Pizzas are to be produced per night. Tasty Restaurant works from 16.00 hrs to 01.00 hrs. Given the following set of tasks and their relationship may a balanced the assembly line. Calculate the Cycle time, idle time, number of work station and balanced efficiency.

Task	A	B	C	D	E	F
Immediate Predecessors Task	-	A	A	B,C	D	E
Duration (hrs)	2	1	2	3	3	3

3. Explain the different types of layout with suitable examples. Also discuss their advantages and disadvantages. (Draw neat diagrams wherever required)
4. What is meant by Assembly Line balancing? Define cycle time and explain its various implications.
5. Discuss the merits and demerits of Process layout and Product Layout.
6. Ram Lal Ltd is considering the two location options for locating new cloths manufacturing Chennai and Bangalore. The company has existing facility Hyderabad which gauges at the market of Southern part of country. The new plant will cater to other parts of country. The company estimates the fixed cost and variable cost Chennai for facilitate Rs. 2 million and Rs. 30 /Cloths respectively. On the other hand Bangalore the fixed cost and variable cost are estimated at Rs. 1.8 million and Rs. 40 /cloth respectively. A cloth manufacturer in Chennai can be sold at Rs. 100/- and same cloth manufacturer in Bangalore can be sold Rs. 120/- The management of company choose that location option for few facilitates at which breakeven lower. Which option company chooses according to criteria.
7. Give the general format of an MRP report using a hypothetical example.
8. Explain the various methods of determining the order size in MRP?

9. Elucidate the business application of ERP.
10. What is MRP? What are the inputs and outputs required by the MRP processing logic?
11. What is ERP? Elucidate the steps in ERP implementation?
12. Explain the equipment life cycle of Maintenance Management.
13. The precedence diagram for assembly activities from "A" to "G" is shown with element time requirement shown in minutes. The line operates 7 hrs/day. An output of 600 units/day is decided. Compute: (a) Cycle time (b) Theoretical minimum number of workers (c) Balance efficiency



Part D Case Study : **11 Marks**

The 'dream car' project of Ratan Tata, the Chairman of one of India's largest and most respected business conglomerates is located in West Bengal. In 2005-06 the group had revenues of US$21.9 billion—the equivalent of about 2.8 per cent of the country's GDP—and a market capitalization of US$46.9 billion. Tata dreams to create a car to be sold in the Indian markets with a price tag of Rs 100,000. The car will have a Euro IV compliant 700 cc petrol engine, a suspension, and a steering system designed for its size. Targeting the burgeoning middle-class, Tata Motors plans to roll out its car in the next three years by using a low-cost assembly operation. The car will be smaller compared to most existing cars on the road and will be produced in larger volumes, with all the high-volume parts manufactured in one plant. The other cost-cutting measures relate to intensive use of plastics on the body of the car and eliminating dealer margin. The group is looking at a very low-cost assembly operation and the use of modern-day adhesives instead of welding. There are some issues concerning

safety, mainly because of the car's modest size, but Tatas are determined to resolve them before the car reaches the market. In view of the socio-economic dimension in manufacturing the car, the company is looking at small satellite units, with very low break- even points, where the cars would be assembled, sold, and serviced. Tatas are planning to encourage local entrepreneurs to invest in these units, and to train these entrepreneurs to assemble the fully knocked-down or semi-knocked-down components that Tatas would send. These entrepreneurs would also sell and service the assembled vehicles. This approach would replace the dealer, and, therefore, the dealer's margin. It will lead to an assembly-cum-retail operation that would be combined with very low-cost service facilities.

During early 2006, Tatas started scouting for a good location for their dream car plant. The three states initially looking lucrative for the location were—Karnataka, West Bengal, and Uttaranchal. Dharwad in Karnataka had the advantage of geographic location, being located between Bangalore and Pune (where Tatas have major facilities). The Karnataka government also offered water and power tariff sops and agreed to Tata's proposed move to build a township near the scheduled facility. The West Bengal government, which is currently in an industrialization drive in the state, enticed the Tatas with various subsidies and sops. It tried to convince Tatas to set up the factory in the backward district of West Midnapore near Kharagpur. In today's competitive environment, the car Tatas would be manufacturing would be the cheapest car available in the country, and the task they have undertaken is very challenging. Hence, they have taken into consideration all aspects, including logistics. Since the price factor is so important in this project, the choice of location is very critical. Apart from the availability of proper infrastructure and skilled labour, the company has to take into consideration social infrastructure such as proximity of educational institutions for the children of its employees. Out of the six different places offered by the West Bengal government, the company found Singur, about 50 kilometres north-west of Kolkata to be the most suitable.

If a particular company wants a big chunk of land for setting up a large plant, it is not possible for it to purchase land from each and every farmer. This is particularly true in West Bengal where fragmentation of land is very high. The state government came forward to acquire the land for the project. When the opposition raised issues against it, the government gave the justification that it is for a public purpose. According to the government, industrialization means employment generation

and development of society. The entire people of the state will be benefited from the new project. Therefore, the land acquisition was in public interest.

Setting a healthy precedent, the West Bengal government agreed to pay compensation to farmers for acquiring their land at a generous rate—almost 150 per cent more than the prevailing market price. This was much more than what most other state governments had ordained as the price to be paid for acquiring land from farmers for setting up industries or special economic zones. For instance, owners of single-crop land in Singur got Rs 840,000 per acre and Rs 1 .2 million an acre if the land was used for double-cropping, while in Maharashtra, farmers got only Rs 24,000 an acre. However, this comparison may not be appropriate.

The land in Singur has a greater market value as it is close to the National Highway No. 2, connecting Kolkata with Delhi, and the land in question in Maharashtra may not enjoy a similar advantage. Yet, it has to be conceded that the compensation package decided by the West Bengal government is generous and an important factor in convincing over 9,000 land-owners at Singur (over 94 per cent of the total land to be acquired). These farmers have agreed to the deal and have already received their compensation money from the state government. Land acquisition in Singur has been completed and the land has been handed over to the West Bengal Industrial Development Corporation (WBI DC). Now WBIDC is the owner of the land. Till 2 December 2006, Rs 766.4 million has been disbursed as compensation to the farmers who have lost their land. Around 9,020 farmers have received compensation for 635 acres of land. Eighty-eight recorded bargadars (sharecroppers) have already received a payment of Rs 1 .7 million and the number of persons yet to receive payment, till 2 December 2006, was around 3,000.

Another allegation by the opposition against the State government is that land acquired for a private enterprise cannot be considered a public purpose. It is further alleged that the acquisition of land has not followed the established procedure of the company making advance payment.

Thirdly, there is a perception that the Tata small car project has acquired land far in excess of what it actually requires to set up a factory of that capacity. Maruti Udyog is situated in a total land area of 300 acres and has an installed capacity of 3,50,000 cars a year. The Singur land being handed over to the Tatas is three times more than what Maruti Udyog has and that too for producing only 1,00,000 cars. The question in everyone's mind is why the Tatas need 997 acres of land and whether there are

other facilities that are being planned in that same area. Due to such issues, questions on the justification of allocating the Singur land to the Tatas will continue to be raised.

Agitations against the project started immediately after the fencing of the land was done. Singur's uneasy peace was shattered during early February 2007 as pro-farmland forces clashed with the police in phases throughout the day. It was a grim reminder of the fact that the Tatas' problems there are still far from over. The state government received an unequivocal support by Ratan Tata, who has said his group will not move out of West Bengal. Tata Motors has also proposed a weekly forum meeting where farmers meet company executives and clear doubts.

Some of the opposition parties are still not satisfied and are not restricting their agitation only to Singur.

Questions:

Q1. Why did Tatas prefer to locate their 'dream car' plant at Singur, West Bengal despite other equally good options such as Dharwad and Uttaranchal?

Q2. How do you think the problems at Singur can be amicably resolved by Tatas for earliest construction of their plant?

KAHE

KARPAGAM ACADEMY OF HIGHER EDUCATION, COIMBATORE						
DEPARTMENT OF MANAGMENET						
Unit 2- Facility Location, Layout, Material Handling and Maintenance Management- Multiple Choice Questions- Each Question carries ONE Mark						
SI.NO	**Question**	**Option 1**	**Option 2**	**Option 3**	**Option 4**	**Answer**
1	Product layout is preferably used for _____ .	Repetitive processing	Intermittent processing	Quantitative processing	Qualitative Processing	Repetitive processing
2	The most significant advantage of U-shaped layout is	Cost minimization	Easy handling of process	Increased flexibility in work	Profit maximization	Increased flexibility in work
3	Location decisions are viewed primarily as part of	marketing strategy	growth factors	financial aspect	both (a) and (b)	both (a) and (b)
4	Which of these layouts is most suitable for processing sugar from sugar beets or sugar cane?	Process-oriented layout	Fixed-position layout	Focused factory	Product-oriented layout	Process-oriented layout
5	Process layout is used for _____ .	Repetitive processing	Intermittent processing	Quantitative processing	Qualitative Processing	Repetitive processing

6	When the flow of materials is variable	line balancing is most suitable	layout by product is most suitable	layout by fixed position is most suitable	layout by process is most suitable	layout by process is most suitable
7	Mass customization uses which of these techniques to deliver its order winners?	kanban	modularity	just in time	efficient consumer response	modularity
8	Which of the following is not a characteristic of a well-designed process	Each element is consistent with the purpose of the operating system	The process is user-friendly	Consistency is not easy to maintain at every stage	The whole process is cost-effective	Consistency is not easy to maintain at every stage
9	Which of the following is a characteristic of a well-designed process?	whole process is not easy to understand	whole process is robust	whole process has ineffective links	whole process is not cost effective	whole process is robust
10	What is a robust process?	One that can take small variations	One that is very strong in parts	One that is very consistent	One that is easily understood	One that can take small variations
11	According to Value Creation Partners which of the following does not indicate that a process is not working	some operations take too long	there are too many process reviews and changes	inventory sits idle	complexity and exceptions are unlikely to occur	complexity and exceptions are unlikely to occur

12	The three types of process map are a relationship map, a cross-functional map and a	Process Blueprint map	Process Distribution map	Process Flowchart map	Process Delivery map	Process Flowchart map
13	In a process flow chart transportation is depicted by an	circle	triangle	square	arrow	arrow
14	In a process flow chart storage is depicted by a _____ .	circle	triangle	square	arrow	triangle
15	A useful process improvement tool is Pareto Analysis. This is also known as the	60/40 rule	70/30 rule	80/20 rule	90/10 rule	90/10 rule
16	A useful process improvement tool to search for the root cause of a problem is the _____ process?	3 What	4 Who	5 Why	6 Where	5 Why
17	Technology is widely used in operations. What type of technology interaction is a typical hotel check in	passive self-service	customer and employee interaction	hidden technology interaction	no customer interaction with the technology	no customer interaction with the technology

18	Which of the following is not a physical factor that can influence the choice of location for an operation?	Access to customers	Nature of the communication links	Access to raw materials	Access to raw materials	Access to customers
19	Which of the following is not a socio-economic factor that can influence the choice of location for an operation	local labour markets	transportation networks	business climates	proximity to competitors	transportation networks
20	Locating several mobile phone shops in the same part of a town is an example of _____	Competitive clustering	Saturation clustering	Saturation marketing	Competitive clustering	Competitive clustering
21	The initial decision whether a manufacturer fabricates in-house or uses an outside supplier is known as _____	An Offshoring decision	An Outsourcing decision	A Make-or-Buy decision	A Purchasing decision	A Make-or-Buy decision
22	Which of these layout types is most associated with a mass process	Fixed position layout	Process layout	Product layout	Cell layout	Product layout
23	Which of these layout types is most associated with a project process?	Fixed position layout	Process layout	Product layout	Cell layout	Fixed position layout

24	Which of these layout types is most associated with a batch processing operation	fixed position layout	process layout	product layout	cell layout	cell layout
25	The physical environment of a service operation is often referred to as the _____	Manu scape	Land scape	Service scape	Physical scape	Service scape
26	Which one does not use operations management?	a bank	an hospital	a supermarket	they all use it	an hospital
27	Which came last in the development of manufacturing techniques?	Lean production	Division of labor	Mass production	Craft production	Lean production
28	The type of processing structure that is used for producing discrete products at higher volume is	Work center	Batch	Assembly Line	Project Layout	Assembly Line
29	A system designed for competing effectively in a specific marketplace is called a _____	strategic models	business models	business plans	strategic plans	business models

30	Which of the following types of manufacturing layout is considered a hybrid	process layout	product layout	fixed-position layout	cellular layout	cellular layout
31	Which of the following is NOT a mark of a good layout in manufacturing	Straight line flow patter	Predictable production line	Bottleneck operation	Open plant floor	Bottleneck operation
32	Assembly lines relate most closely to a	functional layouts	product layouts	process layouts	departmental layouts	product layouts
33	Compute the required cycle time for a process that operates 8 hours daily with a required output of 300 units per day.	.625 minutes	1.6 minutes	37.5 minutes	.027 minutes	1.6 minutes
34	According to the authors, when balancing an assembly line, it is best to start by:	Establishing rules by which tasks are to be assigned to work stations	Computing the minimum number of work stations	Determining the required cycle times	Assigning tasks to individual work stations	Establishing rules by which tasks are to be assigned to work stations
35	Which of the following is NOT an element of a service scape	lighting	symbols	spatial layout	prices	prices

36	Which of the following is NOT a method which is used in location analysis?	linear programming-transportation model	best location method	cost analysis	center of gravity method	best location method
37	Which of the following is NOT a qualitative factor in location decisions?	Exchange rates	Worker education and skills	Product content requirements	Local infrastructures	Exchange rates
38	The concept of Agile organization refers to	flexibility	quality	profitability	quick response	quick response
39	_____ ensures that manufacturing concerns are systematically incorporated into the design process.	Design for manufacture	Modular design	Design for robustness	Quality function deployment	Design for manufacture
40	One solution to the problem of how you can gain the cost benefits of standardization without losing the market advantages of product	Design for robustness	Quality function deployment	Modular design	Process planning	Modular design
41	Which one of the following is the overall objective of product and service design	customer satisfaction and variety	reliability and variety	quality and reliability	customer satisfaction and profitability	customer satisfaction and profitability

42	In which of the following layouts, work stations are arranged according to the general function they perform without regard to	product	process	fixed-position	storage	process
43	Which one of the following is the correct order of layout types from low volume/high variety to high volume/low variety?	Fixed position, process, cell, product	Fixed position, cell, process, product	Fixed position, process, product, cell	Process, fixed position, cell, product	Fixed position, process, cell, product
44	What would be the output capacity if an assembly line operates for 7 hours per day with a cycle time of 2.0 minutes?	210 units per day	3.5 units per day	0.004 units per day	14 units per day	210 units per day
45	A design that focuses on reducing the number of parts in a product and on assembly methods and sequence is known as	Design for manufacturing	Design for recycling	Design for assembly	Design for disassembly	Design for assembly
46	Advantages of Process Layout Include _____ .	Equipment used is less costly	Low unit cost	Labor specialization	Low material handling cost	Equipment used is less costly
47	MRP stands for	Materials Requirements Planning	Management Reaction Planning	Master Resources Planning	Manufacturing Resource Planning	Materials Requirements Planning

48	MPS stands for	Master Planning System	Material Production Schedule	Master Production Schedule	Material Planning System	Master Production Schedule
49	Closed Loop MRP means	actual inventory is counted regularly and adjustment made to the inventory record	capacity and resource planning is included in the MRP logic	unused materials are returned to stores and recorded back into the system	actual sales are netted off the forecasts in the MPS	capacity and resource planning is included in the MRP logic
50	Enterprise Resource Planning (ERP) has been criticised on a number of grounds Which of the following is not a common	it can have a disruptive effect on the organisation's operation	implementation is expensive	the effect it has on businesses is disappointing	it doesn't allow decisions and databases from all parts of the organisation to be integrated	it doesn't allow decisions and databases from all parts of the organisation to be integrated
51	In MRP (Materials Requirements Planning) the Bill of Materials is	The required output from a process over time	A list of required safety stock item	The product structure showing where common parts are used	The sum of stock-on-hand and work-in-progress	The product structure showing where common parts are used
52	The outputs of a MRP II system are	Material Requirement Plans / scheduled purchase orders / capacity	Sales order priorities / Bills of Materials / Material Requirement Plans	Stock quantities / Bills of Materials / Master Production Schedules	Capacity requirement plans / stock quantities / stock locations	Material Requirement Plans / scheduled purchase orders / capacity requirement plans
53	Three inputs for every MRP system are	Sales forecast, delivery costs, capacity plan	Average replenishment time, re-order point, economic order quantity	Stock on hand, Master Production Schedule, Bill of Materials	Bill of Materials, sales forecast, sales history	Stock on hand, Master Production Schedule, Bill of Materials

54	Belt of an electric motor is broken, it needs	Corrective maintenance	Scheduled maintenance	Preventive maintenance	Timely maintenance	Corrective maintenance
55	(Number of breakdowns / Available machine hours) =	Maintenance effectiveness	Frequency of breakdown	Effectiveness of maintenance planning	Machine failure hours	Frequency of breakdown
56	(Down time in hours / Availal	Maintenance effectiveness	Frequency of breakdown	Effectiveness of maintenance planning	Machine failure hours	Maintenance effectiveness
57	A systematic approach for maintenance is	Problem – Cause – Diagnosis – Rectification	Problem– Diagnosis – Cause – Rectification	Problem – Measure – Diagnosis – Rectification	Problem– Diagnosis – Measure – Rectification	Problem – Cause – Diagnosis – Rectification
58	With the increase in preventive maintenance cost, breakdown maintenance cost	Increases	Decreases	Remain same	Any of the above	Decreases
59	The ____ goes on increasing with the increase in degree of maintenance efforts.	Cost of down time	Cost of spares and maintenance	Labour and Overhead Cost	Operation Cost	Labour and Overhead Cost

60	Scheduled maintenance is _____ between breakdown maintenance and the preventive maintenance.	Joint	Compromise	bridge	in	Compromise

UNIT-III

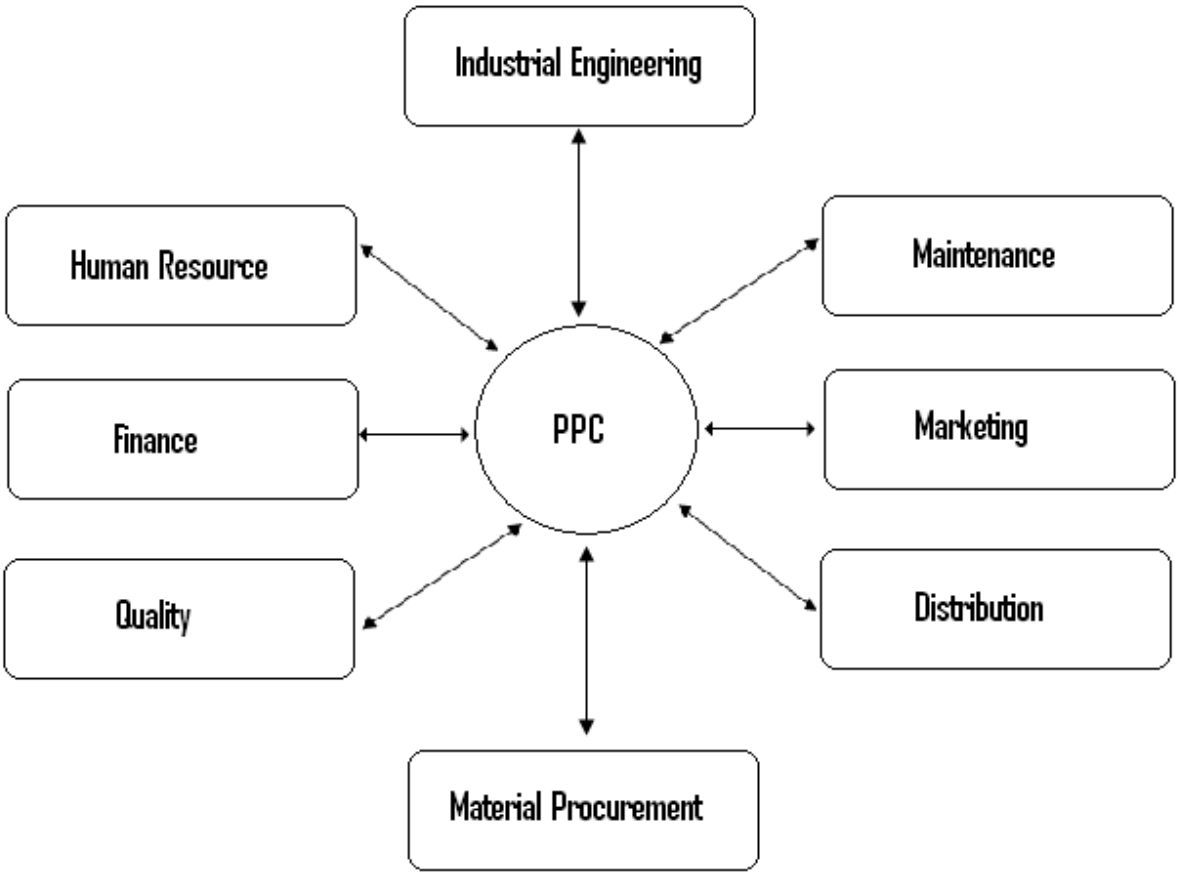
SYLLABUS

Production Planning and Controlling, Scheduling- Production planning and Control– objectives, functions, PPC in different types of manufacturing systems. Purpose of Operations Scheduling, Factors Considered while Scheduling, Scheduling Activity under PPC, Scheduling Strategies, Scheduling Guidelines, Approaches to Scheduling, Scheduling Methodology. Gantt Chart and sequencing (Problems), Scheduling in Services.

PRODUCTION PLANNING AND CONTROL

Production planning and control (PPC) is an effort to optimize the process of conversion of raw materials into finished products required in the market. Since various activities are involved the conversion of raw materials into finished goods, PPC is and has to be an integrated function if the organization has to derive maximum benefit out of planning. The procurement of raw materials, the quality control and inspection of raw materials, inventory levels of in-process and finished goods, the production costs, the labour availability, the machinery and equipments that is available, the warehousing capacity available etc., all have their influence on the planning of production operations which convert the raw material into finished goods. All the functions have inter-links; and the more such inter-links are considered in the planning process, the better will be the planning process. Figure below explains the inter relationship between shop floor management and other functions of management. The more integrative the PPC, the better will be the planning decisions.

KAHE



Products are manufactured by the transformation of raw material(into finished goods). This is how production is achieved. Planning looks ahead, anticipates possible difficulties and decides in advance on how the production be carried out. The control phase makes sure the programmed production is constantly maintained.

Production is a process or procedure developed to transform a set of inputs like men, materials, capital, information and energy into a specified set of outputs like finished products and services in proper quantity and quality.

It consists of series of sequential operations to produce a desirable product acceptable to customer and meet the customer demand with respect to quality and intended function. Planning and control are the two important components of the management process. Production planning and control is a tool which coordinates all the manufacturing activities in a production system. Production planning starts with the analysis of the given data (i.e. demand for

products, delivery schedule etc.) and on the basis of the information available, a scheme of utilization of firm's resources like machines, men and materials are worked out to obtain the target in the economical way. Once the plan is prepared, then the operations are performed in line with the details given in the plan. Production control comes into action if there is any deviation between the actual and planned. The corrective action [if any deviation] is taken so as to achieve the targets as per the plan by using control techniques.

Definition:

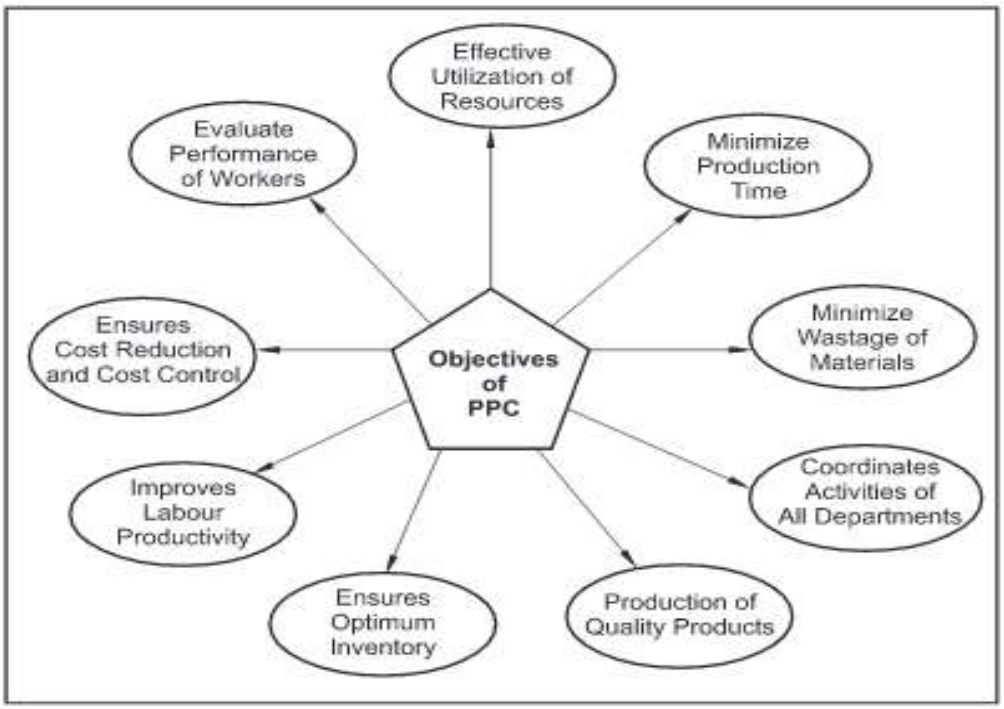
According to Charles A. Koepke "Production Planning and Control is defined as the coordination of the series of functions according to a plan which will economically utilize the plant facilities and regulate the orderly movement of goods during the entire manufacturing cycle from the procurement of all materials to the shipping of finished goods at a predetermined rate".

Production planning and control is a way of regulating as well as directing the movement of goods to whole of the production cycle, right from raw materials to the final delivery of the products so that the objective like maximum production, minimum inventory as well as customer service are fully satisfied.

Objectives of production planning and control

1. To deliver quality goods in required quantities to the customer in the required delivery schedule in order to achieve maximum customer satisfaction.
2. To ensure optimum utilization of resources/materials.
3. To minimize the production/manufacturing cycle time.
4. To maintain optimum inventory levels.
5. To schedule production facilities in optimum manner.
6. To coordinate the activities of different departments relating to production to achieve regular, steady and balanced flow of production.
7. To ensure confirmation of delivery commitments.
8. To ensure production of quality products.
9. To keep the plant free from production bottleneck.
10. To ensure effective cost reduction and cost control.
11. To evaluate the performance of various shops & individuals.

12. To develop alternative plans in order to meet any emergency or contingency.
13. To maintain spare capacity to deal with rush orders.



Factors affecting PPC

The various factors which affects the production planning and control are listed below

1. The nature of product and quantity of product.
2. The nature and availability of various equipments and materials required for manufacturing process.
3. The size of orders and the production run.
4. The nature and type of manufacturing system.
5. The nature and type of manufacturing method adopted.

Benefits of production planning and control

1. It maintains good coordination between the departments.
2. It reduces the employee and plant idle time.
3. It ensures the optimum utilization of resources.
4. It helps in achieving the quality standards so that the quality of output is ensured.

5. It minimizes the wastes, scrap, rework and also the rectification hour.
6. It also helps in utilizing idle time of the machine.
7. It makesures the availability of right supplies at right time [inventory control].
8. It avoids bottlenecks in the production process.
9. It ensures better services to customers by delivering quality goods within the specified time period.

FUNCTIONS OF PPC

A production planning and control system has many functions to perform, some, before the arrival of raw materials and tools, and others while the raw material undergoes processing. The various functions are also sub-divided as follows.

- Forecasting & Estimating
- Routing
- Scheduling
- Loading
- Dispatching
- Progress Reporting
- Expediting
- Ordering
- Inventory Control

The details of various functions are:

1. Forecasting: Estimation of type, quantity and quality of future work.
2. Process planning and routing: Finding the most economical process of doing a work and (then) deciding how and where the work will be done.
3. Scheduling: It is the time phase of loading and determines when and in what sequence the work will be carried out. It fixes the starting as well as the finishing time for the job.
4. Loading: Assignment of work to manpower, machinery etc.
5. Dispatching: It is the transition from planning to action phase. In this phase the worker is ordered to start the actual work.
6. Progress reporting:

a) Data regarding the job progress is collected.

b) It is interpreted by comparison with the preset level of performance.

7. Expediting means taking action if the progress reporting indicates a deviation of the plan from the originally set targets.
8. Ordering is the process of ensuring that all the resource are available for production, if not order for the resources and get them for production.
9. Inventory control: It involves determining the requirements and control of materials.
10. Replanning – Replanning of the whole affair becomes essential, in case expediting fails to bring the deviated plan to its actual (right) path.

PRODUCTION CONTROL

Scheduling completes the planning phase of production planning and control. The next is 'Dispatching'. After dispatching is the control phase or control of production which consists of two parts (a) Progress reporting and (b) Corrective action.

A control system involves four states namely: (i) Observation, (ii) Analysis, (iii) Corrective action, and (iv) Post-operation evaluation. A production control system considers these elements in its different functions.

The control of production in necessary to be sure that the production schedules are being met and the job will be delivered as per the pre decided (scheduled) plans. Production control involves an information feedback mechanism and a system of corrective action. Production control follows up the scheduled plans, compares the actual output with the planned one, and points out deviation, if any, so that the same can be corrected through the adjustments of men, materials and machines.

In brief, a production control group:

- Receives work progress reports;
- Compares them with the scheduled plans;
- Removes causes of delays in production;
- Modifies the schedules or plant capacities; and
- Expedites the work.

Stages of Production Planning and Control

The stages of Production planning and control has three phases namely:

1. Planning Phase
2. Action Phase
3. Control Phase

Phases of production planning and control

Planning Phase

Planning is an exercise of intelligent anticipation in order to establish how an objective can be achieved or a need fulfilled in circumstances, which are invariably restrictive. Production planning determines the optimal schedule and sequence of operations economic batch quantity, machine assignment and dispatching priorities for sequencing. It has two categories of planning namely

1. Prior planning
2. Active planning.

PRIOR PLANNING

Prior planning means pre-production planning. This includes all the planning efforts, which are taking place prior to the active planning.

Modules of pre-planning

The modules of prior planning are as follows:

1. Product development and design is the process of developing a new product with all the features, which are essential for effective use in the field, and designing it accordingly. At the design stage, one has to take several aspects of design like, design for selling, design for manufacturing and design for usage.

2. Forecasting is an estimate of demand, which will happen in future. Since, it is only an estimate based on the past demand, proper care must be taken while estimating it. Given the sales forecast, the factory capacity, the aggregate inventory levels and size of the work force, the manager must decide at what rate of production to operate the plant over an intermediate planning horizon.

3. Aggregate planning aims to find out a product wise planning over the intermediate planning horizon.

4. Material requirement planning is a technique for determining the quantity and timing for the acquisition of dependent items needed to satisfy the master production schedule.

ACTIVE PLANNING

The modules of active planning are: Process planning and routing, Materials planning. Tools planning, Loading, Scheduling etc.

1. Process planning and routing is a complete determination of the specific technological process steps and their sequence to produce products at the desired quality, quantity and cost. It determines the method of manufacturing a product selects the tools and equipments, analyses how the manufacturing of the product will fit into the facilities. Routing in particular prescribes the flow of work in the plant and it is related to the considerations of layout, temporary locations for raw materials and components and materials handling systems.
2. A material planning is a process which determines the requirements of various raw materials/subassemblies by considering the trade-off between various cost components like, carrying cost, ordering cost, shortage cost, and so forth.
3. Tools' planning determines the requirements of various tools by taking process specification (surface finish, length of the job, overall depth of cut etc.), material specifications (type of material used, hardness of the material, shape and size of the material etc.) and equipment specifications (speed range, feed range, depth of cut range etc.).
4. Loading is the process of assigning jobs to several machines such that there is a load balance among the machines. This is relatively a complex task, which can be managed with the help of efficient heuristic procedures.
5. Scheduling is the time phase of loading and determines when and in what sequence the work will be carried out. This fixes the starting as well as the finishing time for each job.

Action Phase

Action phase has the major step of dispatching. Dispatching is the transition from planning phase to action phase. In this phase, the worker is ordered to start manufacturing the product. The tasks which are included in dispatching are job order, store issue order, tool order, time ticket, inspection order, move order etc.

The job order number is the key item which is to be mentioned in all other reports/orders.

Stores issue order gives instruction to stores to issue materials for manufacturing the product as per product specifications. As per tooling requirements for manufacturing the product, the tool Order instruct the tool room to issue necessary tools.

Time ticket is nothing but a card which is designed to note down the actual time taken at various processes. This information is used for deciding the costs for future jobs of similar nature and also for performing variance analysis, which helps to exercise control.

Job order is the official authorization to the shop floor to start manufacturing the product. Generally, the process sequence will contain some testing and inspection. So, these are to be instructed to inspection wing in the form of inspection order for timely testing and inspection so that the amount of rework is minimized. The manufacture of product involves moving raw materials/subassemblies to the main line. This is done by a well-designed materials handling system. So, proper instruction is given to the materials handling facilities for major movements of materials/subassemblies in the form of a move order. Movements which involve less distance and fewer loads are managed at the shop floor level based on requests from operators.

Control Phase

The control phase has the following two major modules:

1. Progress reporting, and
2. Corrective action.

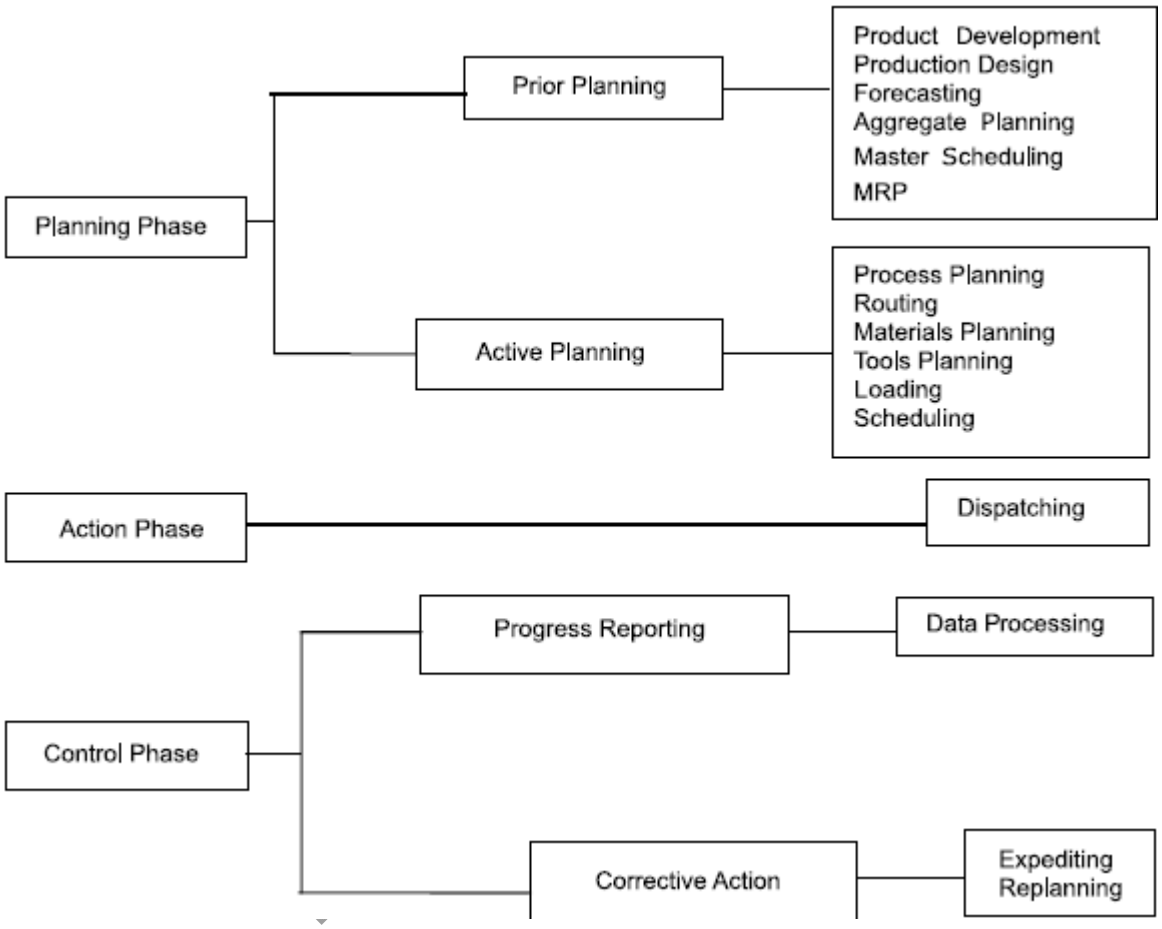
1. PROGRESS REPORTING

In progress reporting, the data regarding what is happening with the job is collected. Also, it helps to make comparison with the present level of performance. The various data pertaining to materials rejection, process variations, equipment failures, operator efficiency, operator absenteeism, tool life, etc., are collected and analyzed for the purpose of progress reporting. These data are used for performing variance analysis, which would help us to identify critical areas that deserve immediate attention for corrective actions.

2. CORRECTIVE ACTION

The tasks under corrective action primarily make provisions for an unexpected event. Some examples of corrective actions are creating schedule flexibility, schedule modifications, capacity modifications, make or buy decisions, expediting the work, pre-planning, and so on. Due to

unforeseen reasons such as, machine breakdown, labor absenteeism, too much rejection due to poor material quality etc., it may not be possible to realize the schedule as per the plan. Under such condition, it is better to reschedule the whole product mix so that we get a clear picture of the situation to progress further. Under such situation, it is to be re-examined for selecting appropriate course of action. Expediting means taking action if the progress reporting indicates deviations from the originally set targets. Pre-planning of the whole affair becomes essential in case the expediting fails to bring the deviated plan to its right path.



PROGRESS CONTROL

Once the actual production has started, it becomes essential to keep an eye at the progress of the work so that, if required, timely corrective action can be taken. Progress control means – trying to achieve the standards set, i.e., a certain level of efficiency or a certain volume of production in a specified duration. The system of progress control should be such that it furnishes timely, adequate and accurate information about the progress made, delays and under – or over –loading.

STEPS INVOLVED IN PROGRESS CONTROL

a) Setting up a system to watch and record the progress of the operating facility.
b) Making a report of the work progress or work accomplishment.
    - Control group for necessary control action, and
    - Accounting group for recording material and labour expenditures.
c) Interpretation of the information contained in the progress report by the control group.
d) Taking corrective action, if necessary.

FOLLOW UP OR EXPEDITING

The manufacturing activity of a factory is said to be in control when the actual performance is as per the planned performance. Follow up or expediting regulates the progress of materials and the components through the production process. Follow up serves as a catalytic agent to fuse the various separate and unrelated production activities into the unified whole the means progress. Follow up is concerned with the reporting of production date and the investigating of any deviation from the predetermined production (or time) schedules. Follow up ensures that the promise (i.e. of delivery dates) is backed up by performance.

The work within the organization can be expedited by the following tow principles:

(i) The exception principle, and
(ii) The fathering principle.

In exception principle, the scheduling group (on the basis of progress reports), explores the jobs behind the schedule. The expediting group take up such jobs, procures necessary materials, tools,

etc., i.e.,(expediting group) solves all problems related to these jobs and intimates the scheduling group to reschedule them.

ORDERING:

According to fathering principle each expeditor is made responsible for a job or a group of jobs for which he has to ensure the availability of the resources and arrange the same for smooth flow of production. This is a control process which ensures that all resources needed for production are available.

INVENTORY:

"Inventory is a detailed list of movable goods such as raw materials; work in process, finished goods, spares, tools consumables and general supplies necessary to manufacture a product and to \maintain plant and machinery".

INVENTORY CONTROL is an activity / activities that are necessary to maintain the inventory at the desired level to ensure that the investment in inventory is optimal and also the service level is as expected by the production department.

SCHEDULING

In brief, scheduling means ---- when and in what sequence the work will be done. It involves deciding as to when the work will start and in certain duration of time how much work will be finished. Scheduling deals with orders and machines, i.e., it determines which order will be taken up on which machine and in which department by which operator. While doing so, the aim is to schedule as large amount of work as the plant facilities can conveniently handle by maintaining a free flow of material along the production line.

Scheduling may be called the time phase of Loading. Loading means the assignment of task or work to a facility whereas scheduling includes in addition, the specification of time and sequence in which the order/work will be taken up.

A production schedule is similar to a railway time table and shows which machine is doing what and when. A production schedule is a statement of target dates for all orders or operations in

hand and reveals their starting and finishing dates. Scheduling finalises the planning phase of Production Planning and Control System.

FACTORS AFFECTING SCHEDULING

The following factors affect production scheduling and are considered before establishing the scheduling plan.

(a) External factors

- Customer's demand,
- Customer's delivery dates, and
- Stock of goods already lying with the dealers and retailers.

(b) Internal factors

- Stock of finished goods with the firm,
- Time interval to process finished goods from raw material. In other words – how much time will be required to manufacture each component, subassembly and the assembly (i.e., the final product),
- Availability of equipment and machinery; their total capacity and specifications,
- Availability of materials; their quantity and specifications,
- Availability of manpower (number, type and kind of skills),
- Additional manufacturing facilities if required, and
- Feasibility of economic production runs.

SCHEDULING AND CONTROL OF PRODUCTION

Once the planning (work) to meet sales is complete and a set of decisions have been formulated using Graphical or Linear programming methods the next step is the implementation of the decisions through detailed plans and schedules. Schedules are made for the use of facilities like equipment and manpower.

Scheduling and control and production focuses attention on the following:

(a) Knowing the total overall production targets – how to determine the amount of each product be manufactured if there are products of different types and sizes?

(b) How to decide about and deploy work force (different types of workers and kinds of skills) and equipment to achieve the target production rate?

(c) How to determine individual work assignments?

(d) What should be the information system to feed back quickly and accurately the actual output duly compared with the scheduled one?

Scheduling and Control of production have one stage in between them, which is known as dispatching and it will be discussed under Sec. 7.18. in general, first of all the order is scheduled, then it is dispatched for necessary operation (on the raw material) and lastly the progress of the order is tracked, to be certain that the schedule is being met. This (last) phase of tracking the progress of an order and making corrections (if necessary) is known as control of production.

ADVANTAGES OF MASTER SCHEDULING

- It is simple and easy to understand,
- It can be kept running (i.e., current),
- It involves less cost to make it and maintain,
- It can be maintained by non-technical staff, and
- A certain percentage of total weekly capacity can be allocated for rush orders.

DISADVANTAGES OF MASTER SCHEDULING

- It provides only overall picture, and
- It does not give detailed information. Applications

APPLICATIONS OF SCHEDULING

- IN BIG FIRMS, FOR THE PURPOSE OF LOADING THE ENTIRE PLANT.
- IN Research and Development organizations
- For the overall planning in foundries, computer centres, repair shops, etc.

After framing the overall picture of production requirements through a Master Schedule chart, the detailed schedules are thought of and made for each component and subassemblies so that all parts are available at the time of assembly. There are a number of visual aids and techniques, both in the form of conventional charts and commercially available boards, which aid in detailed

scheduling. The technique to be employed for scheduling purposes depends upon the type of production (intermittent or continuous), type and frequency of tasks, demand patterns, etc. a useful scheduling device normally portrays planned production, actual performance and their comparison. Actually, the Gantt Chart forms the basis of commonly used scheduling techniques.

ORDER SCHEDULING

It is a most elaborate technique. Time is marked horizontally and the vertical axis shows the particular facility (say a machine). The information required to generate an order schedule is the number of parts to be manufactured, name of the machines, their Set-up times, total production time and the date of completion of the order. The scheduling is started by placing the last operation at the date of completion and then working backwards.

Advantages of Order Scheduling

(1) It is very detailed.
(2) The earliest possible completion dates can be met.

Limitations

(1) It is very costly.
(2) It requires accurate (production) time standards and good communication system.
(3) It is difficult to maintain effectively if there are many active orders.

AGGREGATE PLANNING IN SERVICES.

For manufacturing firms the luxury of building up inventories during periods of slack demand allows coverage of an anticipated time when demand will exceed capacity. Services cannot be stockpiled or inventoried so they do not have this option. Also, since services are considered "perishable," any capacity that goes unused is essentially wasted. An empty hotel room or an empty seat on a flight cannot be held and sold later, as can a manufactured item held in inventory.

Service capacity can also be very difficult to measure. When capacity is dictated somewhat by machine capability, reasonably accurate measures of capacity are not extremely difficult to develop. However, services generally have variable processing requirements that make it difficult to establish a suitable measure of capacity. Historically, services are much more labor intensive than

manufacturing, where labor averages 10 percent (or less) of total cost. This labor intensity can actually be an advantage because of the variety of service requirements an individual can handle. This can provide quite a degree of flexibility that can make aggregate planning easier for services than manufacturing.

The primary output of Aggregate Production Planning is to develop a Master schedule which describes the number of units to be produced during each period and the work – force levels required by various time periods.

SEQUENCING

There are two types of environments in manufacturing: job shop and flow shop. The type of environment contributes to scheduling and sequencing decisions and methodology.

A flow shop uses continuous flow processes. These are most commonly found in medium- to high-volume production. All the jobs will have a similar flow pattern from workstation to work station. This shop benefits from the makespan technique. The group of jobs will be completed in the minimum amount of time, while maximizing utilization.

Johnson's rule is a dominant factor in flow shop scheduling. It is a procedure that demonstrates, with all workstations being equal in capability, all jobs should be given the same priority.

1. Scan workstation processing times and find the shortest processing time of the jobs awaiting processing.
2. Schedule the job to the workstation with the shortest processing time. If it's the first workstation, do it as early as possible. If it is a workstation further down the line, schedule it as late as possible.
3. Take out the just-scheduled job(s), and start the process over.

JOB SHOP

A job shop is for low-to-medium volume and schedules its work by jobs or batches. They do not have linear flow to the work. Instead, requirements may vary the job routing. Since the unpredictability is so high, a job shop requires priority sequencing rules. The most common are First Come First Served (FCFS), or Earliest Due Date (EDD), to determine which jobs get the highest priority. In the event of a tie or other factors, other priority sequencing methods can be used to narrow it down. It may come down to just picking one job over another, if all else remains equal.

1. Critical ratio (CR) means the job with the lowest CR is completed next. The ratio is calculated by subtracting the due date from today's date, then dividing by how much shop time is left.

2. Shortest processing time means that the job that will take the shortest amount of time to complete is scheduled next.

3. Slack per remaining operations (S/RO). Slack means the amount of time left after considering processing time and due date. The job with the lowest S/RO is the next one up. It is calculated by subtracting today's date from the due date, and then to subtract the remaining shop time by that figure. Divide by number of jobs left to do to determine the S/RO.

Service Operations Scheduling

Service industries are different than manufacturing although they share a lot of the same principles. Scheduling is no different. Instead of job shop or flow shop, service functions are described as front office or back office.

Front office functions are divergent work flows like job shops. Demand fluctuates, is hard to predict, and requires scheduling to compensate for that. There is significant customer interaction and customization to complete those jobs.

Back office functions have lower customer interaction. Services are more standardized and a known quantity, much like a flow shop. Processes are similar to manufacturing processes -- repetitive and consistent, with little variation.

Labor Limitations

While workstations may be plentiful, workers to operate them may not. When the lacking resource is personnel, operations managers have to adjust their operations scheduling accordingly. Workers can be trained to operate more than one machine to generate some flexibility. It is a competitive edge to be able to change schedules quickly and keep everything moving smoothly along the supply chain.

1. Assign personnel to complete the job that has been in the system the longest.
2. Assign personnel to a workstation that has the most jobs waiting.
3. Assign personnel to jobs with the earliest due date.
4. Assign personnel to workstations with the most standard work to run.

GANTT CHART

KAHE

Most popular and widely used scheduling technique is Gantt Chart. It depicts the plan and actual progress on the same chart. Time is taken in the X-axis and activates in the Y-axis. For example, the Gantt chart is drawn for 4 activities viz. A,B,C and D for a period of seven months.

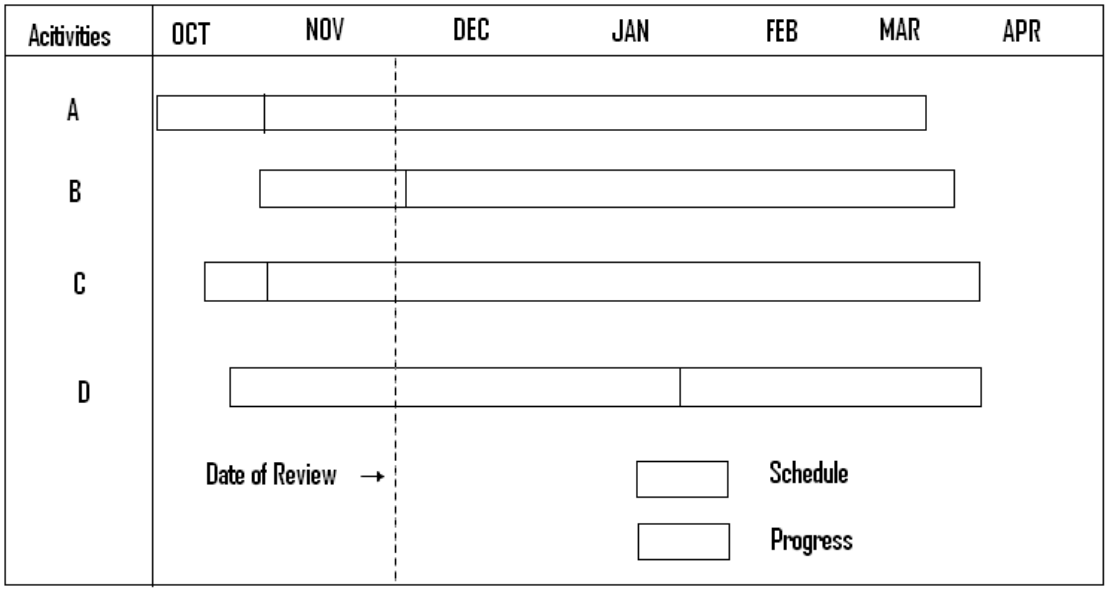


Figure : Gantt Chart

The review data is noted as end November. At that time, activity A is 50% behind schedule; B as per schedule; C is just 25% complete and D is ahead of schedule by more than 100%.

Part A (ONE Mark)

Multiple Choice Questions

Part B (2 Marks)

1. Define Production Planning and Control.
2. List out the different phases of production planning and control.
3. What do you mean by control phase?
4. What is scheduling?
5. What is Gantt chart?

Part C (Each Question Carries 6 Marks)

1. How is scheduling linked to other aspects of production planning? Exaplin with the help of an example.
2. Discuss the use of the Gantt chart for scheduling purpose.
3. Explain the various functions of PPC.
4. Discuss diffrence phases of production planning and control.
5. Explain the significance in the action phase. What are the types of scheduling?
6. What do you mean by control phase? What are activities under this phase? Explain in them in detail.
7. What do you understand by operations scheduling? What are the problems faced in the absence of scheduling?

Part D Case Study (11 Marks)

IndoChem is the Indian subsidiary of a multinational corporation. It is based at Ahmedabad, and manufactures and sells chemical products. By local standards/ its sales volume makes it a typical medium-sized company. Most of the productive capacity is used to supply the domestic market/while any temporary excess capacity is used to produce exportable products. Owing to international competition/ these products are mostly sold to countries like Sri Lanka, Thailand, and Bangladesh at discount prices. Since the profit margins of the company are typically low, exports are still less profitable but desirable in periods of lower demand, to utilize the full capacity and increase total profits.

The globalization process and increased market competition have forced a significant drop in the market share position of the company. By the same token/ the same process conjugated with reduced import tariffs has made the company lose its profitability. The productivity has lowered and/ unless overtime work is widely used, delivery dates are often not met.

Although the production is by process/ as is usual in the chemical industry/ the specific requirements of each customer impose a batch or 'made-to-order' kind of production. Each product is made from the same basic compound/ but is unique according to customer specifications. These

products have variations obtained by the application of additives which change the basic physical and chemical characteristics of the product, such as colour, shock resistance/ and transparency.

The greatest challenge faced by the company was overcoming its low productivity/ as measured by the larger than expected gap between nominal capacity and effective production. The reason for this inefficiency seems to be related to the unproductive time required for cleaning the mixers when a new batch is introduced. Cleaning times vary from 20 to 200 minutes a significant 10 times variation depending on the preceding and succeeding product pair. Thus/ poor sequence planning would generate enormous production inefficiency. For small orders/ the production run was even shorter than the cleaning operation. Figure 9.19 shows the production process at IndoChem. The main activity is the mixer and its output/ a powder product, which/ if the customer desires, can be further processed into a granulated product.

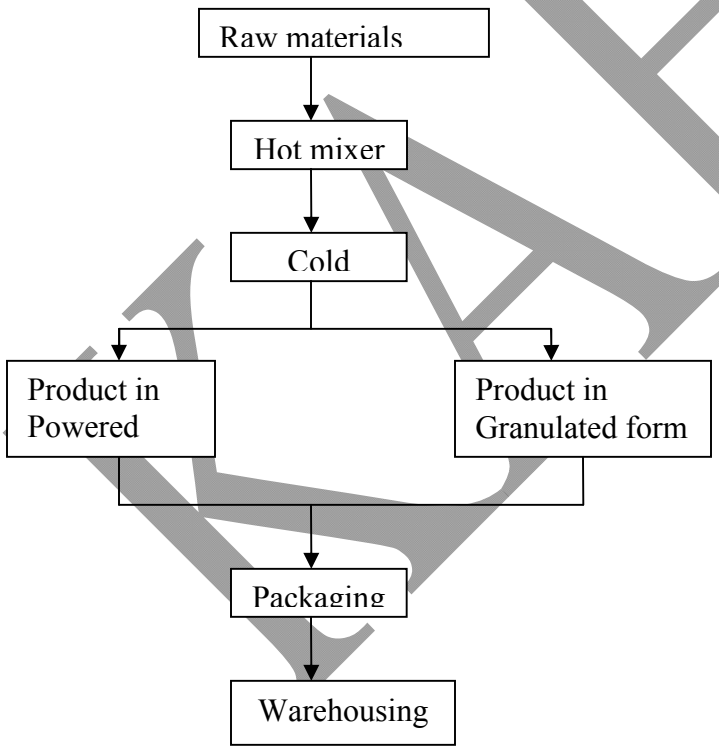


Fig. 9.19 ***Production process at IndoChem***

The company normally operates in two shirts and the maximum capacity depends on the sequence, variety/ and quantity of each batch produced. Every order placed by the customers would

specify the quantity and due date. However/ many customers prefer to split their orders to receive the product on two or more delivery dates. This created the alternative policies of splitting production or producing in batches, which led to earliness costs. Very often, customers asked for a change in the quantities ordered or advanced the due dates. Thus, a revision of the orders already placed constituted the norm rather than an exception. Such a complex environment is a challenge to a company which does not have a clear and round approach to customer needs. Therefore, the absence of a production sequencing routine contributes to the resulting low efficiency, poor customer service, and lack of competitiveness.

To solve the production sequencing problem, the methodology in practice' is a kind of trial and error approach. Production would prioritize lots, according to their due dates, in order to avoid excessive lateness. In periods of lower demand, the existence of idleness would make this policy appear satisfactory. However, in periods of stronger demand, this policy would only be possible at higher production costs, with intensive use of overtime work.

There are many conflicts of the production department with the safes department. This is due to the pressure exerted by the sales department to improve customer service in a difficult environment/ where customers tend to react nervously to their own uncertainties. Thus, the deficiency of production sequencing procedures adds to the internal and classical conflict between production and sales. In addition, the physical distribution system of the company was largely affected by the inefficiencies of the production system as it stood.

The company has a policy of accepting small orders. Small orders usually represent a new or special product/typically requiring long set-uptimes and short production times. The company believed that these orders were unprofitable, due to the long idle times and special laboratory arrangements required to satisfy them. Despite this/ the management was usually willing to accept such orders as a way to please customers and eventually open new market opportunities. Nevertheless/ the effective cost of these orders constituted an open question.

1. Is it strategically right on the part of the company to accept small orders?
2. What should IndoChem do in order to measure set-up costs?
3. Suggest a suitable sequencing method for IndoChem to alleviate its problems.

KAHE

KARPAGAM ACADEMY OF HIGHER EDUCATION						
Department of Management						
Unit 3- Production Planning, Controlling and Scheduling-Multiple Choice Questions- Each Question Carry ONE Mark						
S.NO	**Question**	**Option 1**	**Option 2**	**Option 3**	**Option 4**	**Answer**
1	A……..approach actually schedules, in detail, each resource using the setup and runtime required for each order.	Infinite loading	Finite loading	Forward scheduling	Backward scheduling	Finite loading
2	The objectives of work-center scheduling include(s):	Meeting due dates	Minimizing lead times	Minimizing finish goods inventory	A and B	A and B
3	Which of the following is not a priority rule for job sequencing?	Shortest processing time	Minimum slack time remaining	Last come, randomly served	Critical ratio	Last come, randomly served
4	The first hour principle is best used when……..:	Scheduling two jobs on one machine	Scheduling n jobs on two machines	Applying input/output control	Scheduling personnel in the service industry with changing hourly	Scheduling personnel in the service industry with changing hourly requirements
5	The assignment method is appropriate in solving problems that have the following characteristics:	There are 'n' things to be distributed to 'n' destinations	Though each destination may handle all the things, the final assignment has each thing assigned to one and only one destination	Only one criterion should be used (minimum cost, maximum profit, for example)	A and C	A and C

6	The major functions of shop-floor control are:	Assign priority of each shop order	Provide actual output data for capacity control purposes	Maintain work-in-process quantity information	A, B, and C	A, B, and C
7	The basic tools for shop-floor control include:	Dispatch list	Various status and exception reports	An input/output control report	A, B, and C	A, B, and C
8	Which of the following is not a principle of work-center scheduling?	Obtain feedback each day on jobs that are completed at each work center	Reschedule every day	Schedule jobs as strings, with process steps back-to-back	There is direct equivalence between work flow and cash flow	Obtain feedback each day on jobs that are completed at each work center
9	In scheduling personnel for services, which of following is not an issue?	Consecutive days off	Johnson's rule	Continuous shifts	Expected customer demand	Johnson's rule
10	Johnson's rule is used for:	Scheduling job shops	Minimizing total time to complete all jobs	Scheduling two machine flow shops	B and C	B and C
11	Which of the following is not a part of Five M's?	Material	Machine	Motion	Methods	Motion

12	The correct sequence of operations in production planning and control is	Routing-Scheduling-Dispatching-Follow up	Scheduling-Routing-Dispatching-Follow up	Dispatching-Routing-Scheduling-Follow up	Routing-Scheduling-Follow up-Dispatching	Routing-Scheduling-Dispatching-Follow up
13	Loading may be defined as	Sending the raw material to the machine	Sending the finished material to the store	Assign the work to the facilities	Uploading a software in machine control panel	Assign the work to the facilities
14	Dispatching authorizes the start of production operations by i. Release of material and components from stores to first process. ii. Release of material from process to process. iii. Issue of drawings instruction sheets. Which of the following is (are) true?	only i	only ii	I & ii	i, ii & iii	i, ii & iii
15	The bill of material does not consists of	Part number	Specifications of part	Name of the part	Price of the part	Price of the part
16	Gantt chart is mostly used for	Routing	Scheduling	Followup	Inspection and Quality control	Scheduling
17	Key to chart is provided in	Man machine chart	The load chart	The progress chart	Gantt chart	Gantt chart

18	Centralized and decentralized are the types of	Routing	Scheduling	Followup	Dispatching	Dispatching
19	……. is the first step in a manufacturing planning and control system.	Production planning	Achieving the forecast	Maintaining the required inventory levels	Maintaining the planned backlog	Production planning
20	The cost of a _____ that is too large equals the cost of turning away business.	production plan	resource plan	Backlog	capacity plan	Backlog
21	Moving from the aggregate plan to a master production schedule requires……..	Rough cut capacity plan	Sub-optimization	Disaggregation	Strategy formulation	Disaggregation
22	Aggregate planning is concerned with determining the quantity and timing of production in the	long term	short rem	intermediate term	next term	intermediate term
23	Managers typically do not use sophisticated planning models for aggregate planning because	research has demonstrated that such models seldom work well.	these models do not provide information pertinent to the decision at hand.	the time periods addressed by such models are too long.	they view these models as overly complex and do not fully understand them	they view these models as overly complex and do not fully understand them

24	Which of the following aggregate planning strategies requires employing relatively unskilled personnel to be most effective?	back-ordering during high-demand periods	using part-time workers	varying production rates through overtime or idle time	subcontracting	using part-time workers
25	Which of the following aggregate planning strategies is likely to have the least impact on quality?	using part-time workers	changing inventory level	subcontracting	varying production rates through overtime or idle time	changing inventory level
26	The aggregate planning strategies of (1) varying inventory level or (2) back ordering during periods of high demand have which of the following disadvantages in common?	holding costs	Customers may go elsewhere.	Quality of output may suffer.	It is difficult to exactly match supply with demand.	Customers may go elsewhere.
27	In the service sector, aggregate planning for the production of high-volume intangible output is directed toward	planning for human resource requirements and managing demand.	smoothing the production rate.	attempting to manage demand to keep equipment and employees working.	finding the size of the workforce to be employed.	planning for human resource requirements and managing demand.
28	Which of the following is NOT a mathematical approach to aggregate planning?	linear decision rule (LDR)	graphical and charting methods	transportation method	management coefficients model	graphical and charting methods
29	Which of the following is NOT a capacity option of aggregate planning?	subcontracting	back ordering during high-demand periods	varying production rates through overtime or idle time	changing inventory levels	back ordering during high-demand periods

30	Which of the following is NOT a demand option of aggregate planning?	back ordering during high-demand periods	using part-time workers	counterseasonal product and service mixing	influencing demand	using part-time workers
31	Yield management is of interest in organizations having the characteristic of……	high variable costs.	stable demand.	demand can be segmented.	low fixed costs.	demand can be segmented.
32	Which aggregate planning technique is a trial and error approach that permits many solutions?	graphical and charting methods	the linear decision rule	Bowman's management coefficients model	the transportation method of linear programming	graphical and charting methods
33	The transportation method of aggregate planning requires that	cost factors be linear and positive.	beginning inventory be zero.	ending inventory be zero.	the number of rows be greater than the number of columns.	cost factors be linear and positive.
34	Which statement is characteristic of a mixed strategy for aggregate planning?	Mixed plans typically yield a worse strategy than a pure plan.	Mixed plans are less complex to develop than a chase plan.	Mixed plans seek a minimum cost via a combination of eight planning options.	Mixed plans are less complex to develop than a level plan	Mixed plans seek a minimum cost via a combination of eight planning options.
35	Planning tasks associated with job scheduling, machine loading, and dispatching typically falls under	long-range plans	intermediate-range plans	short-range plans	mission-related planning	short-range plans

36	Dependence on an external source of supply is found in which of the following aggregate planning strategies?	varying production rates through overtime or idle time	using part-time workers	back ordering during high demand periods	subcontracting	subcontracting
37	Which of the following aggregate planning strategies might direct your client to a competitor?	using part-time workers	subcontracting	changing inventory level	varying production rates through overtime or idle time	subcontracting
38	Which of the following statements about aggregate planning is true?	Advertising/promotion is a way of manipulating product or service supply.	Work station loading and job assignments are examples of aggregate production planning	Overtime/idle time is a way of manipulating product or service demand.	Aggregate planning uses the adjustable part of capacity to meet production requirements.	Aggregate planning uses the adjustable part of capacity to meet production requirements.
39	In level scheduling, what is kept uniform from month to month?	product mix	inventory levels	demand levels	production/workforce levels	production/workforce levels
40	Which of the following aggregate planning methods does not work if hiring and layoffs are possible?	linear decision rule	management coefficients model	transportation method	simulation	transportation method
41	Aggregate planning for service firms with high-volume tangible output is directed toward	smoothing the production rate	yield management	centralized purchasing	decreasing the demand rate during peak periods	smoothing the production rate

42	"Yield management" is best described as	a situation where management yields to labor demands	capacity allocation to different classes of customers in order to maximize profits	a situation where the labor union yields to management demands	process designed to increase the rate of output	capacity allocation to different classes of customers in order to maximize profits
43	Which of the following is true regarding forward scheduling? Forward scheduling is the scheduling of	the end items or finished products	the start items or component parts	the final operation first beginning with the due date	jobs as soon as the requirements are known	jobs as soon as the requirements are known
44	The assignment method is	a computerized method of determining appropriate tasks for an operation	a form of linear programming for optimally assigning tasks or jobs to resources	the same thing as the Gantt schedule chart	a method for achieving a balance between forward and backward scheduling	a form of linear programming for optimally assigning tasks or jobs to resources
45	The most appropriate sequencing rule to use if the goal is to dynamically track the progress of jobs and establish relative priority on a common basis is	shortest processing time	earliest due date	longest processing time	critical ratio	critical ratio
46	A recent advance in short term scheduling that makes use of expert systems and simulation in solving dynamic scheduling problems is	forward scheduling	finite scheduling	backward scheduling	infinite scheduling	finite scheduling
47	Which of the following techniques does not contribute to increasing throughput at a bottleneck?	increase capacity of constraint	have cross-trained employees available to operate the constraint	develop alternate routings	move inspections and tests to a position immediately after the bottleneck	move inspections and tests to a position immediately after the bottleneck

48	Factory X is trying to use level use scheduling. If their first target were to cut the current lot size in half, by what proportion must setup cost change?	setup cost must also be cut in half from its current value	setup cost must double from its current value	setup cost must be cut to one fourth its current value	cannot be determined	setup cost must be cut to one fourth its current value
49	Which of the following is true regarding services scheduling?	the emphasis is on staffing levels, not materials	reservation systems are often used a means of manipulating the supply of services	labor use can be intensive, and labor demand is usually stable	the Critical Ratio sequencing rule is widely used for fairness to customers	the emphasis is on staffing levels, not materials
50	Advanced planning systems for aggregate planning rely heavily on _____ to deliver their full potential.	forecasting	constraints	data accuracy	the supply chain	data accuracy
51	Aggregate planning, to be effective, requires inputs from	throughout the supply chain	all customers	all departments	all suppliers	throughout the supply chain
52	A highly effective tool for a company to use when it tries to maximize profits while being subjected to a series of constraints is	aggregate programming	linear programming	distribution programming	Production Programming	linear programming
53	A poor aggregate plan can result in	appropriate inventory levels	efficient use of capacity	lost sales and lost profits	better sales and lost profits	lost sales and lost profits

54	Capacity used to satisfy demand that is higher than forecasted is	safety capacity	safety sales	safety inventory	safety backlog	safety capacity
55	Most strategies that an aggregate planner actually uses are in combination and are referred to as the	level strategy	adjustable strategy	mixed strategy	chase strategy	mixed strategy
56	The goal of aggregate planning is to	satisfy demand in a way that maximizes profit	dissatisfy customers in a way that maximizes profit	dissatisfy customers in a way that minimizes profit	satisfy demand in a way that minimizes profit	satisfy demand in a way that maximizes profit
57	The length of the planning horizon is usually between	three and five years.	three and eighteen months	one and three years	one and three months	three and eighteen months
58	The operational parameter concerned with the number of workers/units of capacity needed for production is	workforce	overtime	production rate	backlog	workforce
59	The planning horizon is	the length of time required to produce the aggregate plan	the solution to the aggregate plan.	the duration of each time period in the aggregate plan	the time period over which the aggregate plan is to produce a solution	the time period over which the aggregate plan is to produce a solution

60	The quality of the aggregate plan can be improved by using information from	only the local firm	only upstream partners	all parts of the supply chain	only downstream partners	all parts of the supply chain

UNIT-IV

SYLLABUS

Forecasting- Introduction, The Strategic Importance of Forecasting, Benefits, Cost implications and Decision making using forecasting, Classification of Forecasting Process, Methods of Forecasting, Forecasting and Product Life Cycle, Selection of the Forecasting Method, Qualitative Methods of Forecasting, Quantitative Methods, Associative Models of Forecasting, Accuracy of Forecasting.

FORECASTING

Introduction

Forecasting is vital to every business organization. Forecasts drive a wide variety of business decisions, from short-term personnel scheduling to long term facility design. Forecasts are the basis for budget allocations, funding of equipment, and long term strategy. Forecasts will determine a large number of operational decisions as for example the technologies used, the capacity of the facilities, the mix of services or products to make, and what are some areas of business opportunities.

Forecasting is both a science and an art. There are no perfect forecasts given the many factors that affect a business organization. Based on this premise, the objective of forecasting is to determine what forecasting method is the most appropriate for what is being forecasted, and to maintain a strict discipline of reviewing forecasts.

Forecasts are typically of two types, qualitative and quantitative. Qualitative methods are based on perception and knowledge and are typically used for long term planning and strategy. Quantitative forecasts are based on past data, mathematical models, and are typically used for medium to short term planning. In many cases a combination of both methods are used, where knowledge is used to modify quantitative forecasts and some data and mathematical models are used in the processes of qualitative forecasting.

Forecasting is the art and science of predicting what will happen in the future. Sometimes that is determined by a mathematical method; sometimes it is based on the intuition of the operations manager. Most forecasts and end decisions are a combination of both.

FORECASTING TIME HORIZONS

Forecasting is conducted by what are referred to as time horizons.

1. Short range forecast. While it can be up to one year, this forecast is usually used for three months or less. It is used for planning purchases, hiring, job assignments, production levels, and the like.

2. Medium range forecast. This is generally three months to three years. Medium range forecasts are used for sales and production planning, budgeting, and analysis of different operating plans.

3. Long range forecast. Generally three years or more in time span, it is used for new products, capital expenditures, facility expansion, relocation, and research and development.

Medium and long range forecasts differ from short range forecasts by other characteristics as well.

1. Medium and long range forecasts are more comprehensive in nature. They support and guide management decisions in planning products, processes, and plants. A new plant can take seven or eight years from the time it is thought of, until it is ready to move into and become functional.

2. Short term forecasts use different methodologies than the others. Most short term forecasts are quantitative in nature and use existing data in mathematical formulas to anticipate immediate future needs and impacts.

3. Short term forecasts are more accurate than medium or long range forecasts. A lot can change in three months, a year, three years, and longer. Factors that could influence those forecasts change every day. Short term forecasts need to be updated regularly to maintain their effectiveness.

TYPES OF FORECASTS

There are three major types of forecasting, regardless of time horizon, that are used by organizations.

1. Economic forecasts address the business cycle. They predict housing starts, inflation rates, money supplies, and other indicators.

2. Technological forecasts monitor rates of technological progress. This keeps organizations abreast of trends and can result in exciting new products. New products may require new facilities and equipment, which must be planned for in the appropriate time frame.

3. Demand forecasts deal with the company's products and estimate consumer demand. These are also referred to as sales forecasts, which have multiple purposes. In addition to driving scheduling, production, and capacity, they are also inputs to financial, personnel, and marketing future plans.

STRATEGIC IMPORTANCE OF FORECASTS

- Operations managers have two tools at their disposal by which to make decisions: actual data and forecasts. The importance of forecasting cannot be underestimated. Take a product forecast and the functions of human resources, capacity, and supply chain management.
- The workforce is based on demand. This includes hiring, training, and lay-off of workers. If a large demand is suddenly thrust upon the organization, training declines and the quality of the product could suffer.
- When the capacity cannot keep up to the demand, the result is undependable delivery, loss of customers, and maybe loss of market share. Yet, excess capacity can skyrocket costs.
- Last minute shipping means high cost. Asking for parts last minute can raise the cost. Most profit margins are slim, which means either of those scenarios can wipe out a profit margin and have an organization operating at cost -- or at a loss.
- These scenarios are why forecasting is important to an organization. Good operations managers learn how to forecast, to trust the numbers, and to trust their instincts to make the right decisions for their firm.

FORECASTING SYSTEM

These seven steps can generate forecasts.

1. Determine what the forecast is for.
2. Select the items for the forecast.
3. Select the time horizon.
4. Select the forecast model type.
5. Gather data to be input into the model.
6. Make the forecast.
7. Verify and implement the results.

Routinely repeat these steps, regardless of the time horizon, to stay abreast of changes in regard to internal and external factors.

ELEMENTS OF GOOD FORECAST

1. Timely
2. Reliable
3. Accurate
4. Meaningful
5. Written
6. Easy to use

FACTORS AFFECTING DEMAND FORECASTING

For making a good forecast, it is essential to consider the various factors governing demand forecasting. These factors are summarized as follows.

1. Prevailing business conditions: While preparing demand forecast it becomes necessary to study the general economic conditions very carefully. These include the price level changes, change in national income, per-capita income, consumption pattern, savings and investment habits, employment etc.

2. Conditions within the industry: Every business enterprise is only a unit of a particular industry. Sales of that business enterprise are only a part of the total sales of that industry. Therefore, while preparing demand forecasts for a particular business enterprise, it becomes necessary to study the changes in the demand of the whole industry, number of units within the industry, design and quality of product, price policy, competition within the industry etc.

3. Conditions within the firm: Internal factors of the firm also affect the demand forecast. These factors include plant capacity of the firm, quality of the product, price of the product, advertising and distribution policies, production policies, financial policies etc.

4. Factors affecting export trade: If a firm is engaged in export trade also it should consider the factors affecting the export trade. These factors include import and export control, terms and conditions of export, exim policy, export conditions, export finance etc.

5. Market behavior: While preparing demand forecast, it is required to consider the market behavior which brings about changes in demand.

6. Sociological conditions: Sociological factors have their own impact on demand forecast of the company. These conditions relate to size of population, density, change in age groups, size of family, family life cycle, level of education, family income, social awareness etc.

7. Psychological conditions: While estimating the demand for the product, it becomes necessary to take into consideration such factors as changes in consumer tastes, habits, fashions, likes and dislikes, attitudes, perception, life styles, cultural and religious bents etc.

8. Competitive conditions: The competitive conditions within the industry may change.

Competitors may enter into market or go out of market. A demand forecast prepared without considering the activities of competitors may not be correct.

PRODUCT LIFE CYCLE

A new product passes through set of stages known as product life cycle. Product life cycle applies to both brand and category of products. Its time period vary from product to product. Modern product life cycles are becoming shorter and shorter as products in mature stages are being renewed by market segmentation and product differentiation.

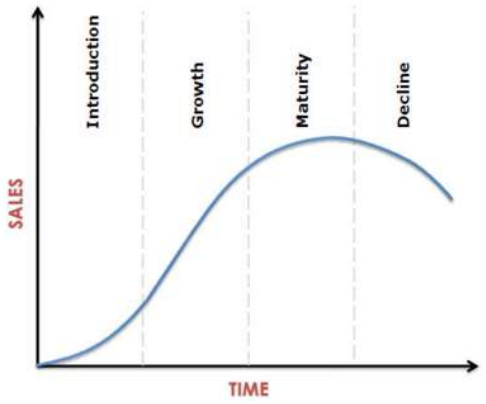
Companies always attempt to maximize the profit and revenues over the entire life cycle of a product. In order to achieving the desired level of profit, the introduction of the new product at the proper time is crucial. If new product is appealing to consumer and no stiff competition is out there, company can charge high prices and earn high profits.

Product life cycle comprises four stages:

1. Introduction stage
2. Growth stage
3. Maturity stage
4. Decline stage

KAHE

Product Life Cycle (PLC)



Introduction stage

Product is introduced in the market with intention to build a clear identity and heavy promotion is done for maximum awareness. Before actual offering of the product to customers, product passes through product development, involves prototype and market tests. Companies incur more costs in this phase and also bear additional cost for distribution. On the other hand, there are a few customers at this stage, means low sales volume. So, during introductory stage company's profits shows a negative figure because of huge cost but low sales volume.

Growth Stage

In this stage, company's sales and profits starts increasing and competition also begin to increase. The product becomes well recognized at this stage and some of the buyers repeat the purchase patterns. During this stage, firms focus on brand preference and gaining market share. It is market acceptance stage. But due to competition, company invest more in advertisement to convince customers so profits may decline near the end of growth stage**.**

Maturity stage

At maturity stage, brand awareness is strong so sale continues to grow but at a declining rate as compared to past. At this stage, there are more competitors with the same products. So, companies defend the market share and extending product life cycle, rather than making the profits, By offering

sales promotions to encourage retailer to give more shelf space to the product than that of competitors. At this stage usually loyal customers make purchases.

Decline stage

Decline in sales, change in trends and unfavorable economic conditions explains decline stage. At this stage market becomes saturated so sales declines. It may also be due technical obsolescence or customer taste has been changed.

At decline stage company has three options:

1. Maintain the product, Reduce cost and finding new uses of product.
2. Harvest the product by reducing marketing cost and continue offering the product to loyal niche until zero profit.
3. Discontinue the product when there's no profit or a successor is available. Selling out to competitors who want to keep the product.

FORECASTING APPROACHES

There are two predominant approaches to forecasting: qualitative approach and quantitative analysis. A qualitative approach uses factors such as experience, instinct and emotion while the quantitative analysis relies heavily on mathematics, historical data and casual variables.

Qualitative methods include:

1. Jury of executive opinion. This is based on the inputs and decisions of high-level experts or management.

2. Delphi method. Decision makers, staff, and respondents all meet to develop the forecast. Every shareholder in the process provides input.

3. Sales force composite. Each sales person provides an individual estimate which is reviewed for realism by management, and then combined for a big picture view.

4. Consumer market survey. This is surveying the prospective customer base to determine demand for existing products and can also be used for new products.

KAHE

As these methods are based mostly on instinct, experience and human input, be cautious of excessive optimism.

Quantitative methods are in two categories. Time-series models predict by assuming the future is a function of the past. Associative models uses similar historical data inputs and then includes other external variables such as advertising budget, housing, competitor's prices and more.

Time Series Models	Associative Model
Naïve method	Linear regression
Moving averages	
Exponential smoothing	
Trend projection	

	Qualitative Methods	Quantitative Methods
1. Characteristics	Based on human judgment, opinions; subjective and nonmathematical.	Based on mathematics; quantitative in nature.
2. Strengths	Can incorporate latest changes in the environment and "inside information."	Consistent and objective; able to consider much information and data at one time.
3. Weaknesses	Can bias the forecast and reduce forecast accuracy.	Often quantifiable data are not available. Only as good as the data on which they are based.

SIMPLE MOVING AVERAGE

This method is appropriate when there is not a significant trend (fast up or down trend) or seasonal characteristics. It is useful only to smooth out randomness of the data. This method is very simple to compute and requires one decision: the number of time periods to consider ***n***. The larger the number of time periods considered, the smoother the forecast.

$$\boldsymbol{w} = 1/\boldsymbol{n}$$

$$F_t = \boldsymbol{w}\,(A_{t-1} + A_{t-2} + \ldots\ldots + A_{t-\boldsymbol{n}})$$

Where

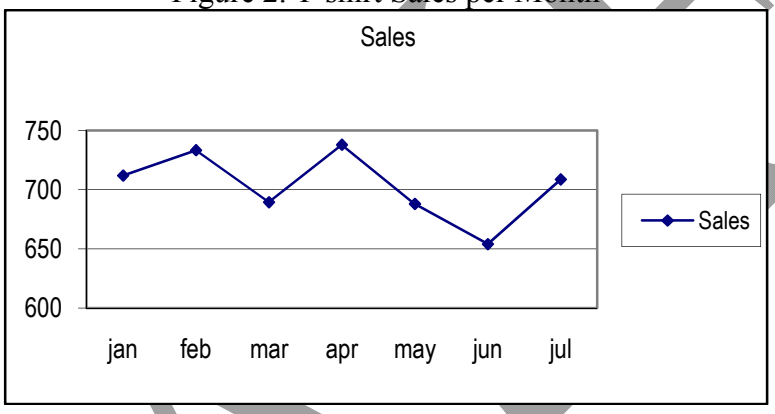
F_t = Forecast for the coming period t

A_x= Actual Demand for period x

Example

A small retail store owner wants to know how many T-shirts will be sold per month. The owner has tracked T-shirt sales for the last 7 months and needs a forecast for August. The data is shown in Figure 2 and the forecasts are shown in the table below.

Figure 2. T-shirt Sales per Month



Month	**Period**	**Sales**	**n** = 2	**n** = 3	**n** = 4
January	1	712			
Februar y	2	733			
March	3	689			
April	4	738			
May	5	688			
June	6	654			
July	7	709			
August	8		1/2(709) + 1/2(654) = **681.33**	1/3(709) + 1/3(654) + 1/3(688) = **683.55**	1/4(709) + 1/4(654) + 1/4(688) + 1/4(738) = **697/16**

Weighted Moving Average

This forecasting method is similar to the Simple Moving Average, but it allows the decision-maker to place more emphasis on recent (or past) data. The computations are also simple and require two

decisions: the number of time periods to consider ***n***, and the weight for each period x, w_x. Note that the sum of all weights must be equal to 1. While there are no rules to select weights, typically a larger weight is given to more recent data.

w = forecaster's decision (0 to 1)

$F_t = w_1 A_{t-1} + w_2 A_{t-2} + \ldots.. + w_n A_{t-n}$

Where

F_t = Forecast for the coming period t

A_x= Actual Demand for period x

w_1 = Weight for the actual demand period t - 1

w_2 = Weight for Actual Demand period t - 2

w_n = Weight for Actual Demand period t - n

sum all w's must be equal to 1

Example

Using the data from the above example and investigating three cases; n = 2, and $w_1 = 0.7$, $w_2 = 0.3$, n = 3, and $w_1 = 0.7$, $w_2 = 0.2$, $w_3 = 0.1$, and n = 4, and $w_1 = 0.7$, $w_2 = 0.1$, $w_3 = 0.1$, $w_4 = 0.1$ we get the following forecasts.

Month	**Period**	**Sales**	**n** = 2, $w_1 = 0.7$, $w_2 = 0.3$	**n** = 3, $w_1 = 0.7$, $w_2 = 0.2$, $w_3 = 0.1$	**n** = 4, $w_1 = 0.7$, $w_2 = 0.1$, $w_3 = 0.1$, $w_4 = 0.1$
January	1	712			
February	2	733			
March	3	689			

KAHE

April	4	738			
May	5	688			
June	6	654			
July	7	709			
August	8		0.7(709) + 0.3(654) = **692.26**	0.7(709) + 0.2(654) + 0.1(688) = **695.66**	0.7(709) + 0.1(654) + 0.1(688) + 0.01(738) = **704.06**

Exponential Smoothing

Exponential smoothing is another forecasting technique that is also simple to compute. In this case, past data and forecasts are used in the generation of a forecast for the next period. This method is widely used in practice, but it has some of the same problems as simple moving average (not useful when there are significant trends and seasonal effects). The computations are simple and require one decision and a forecast number for the period before the forecast period in question: the smoothing constant α. Note that the smoothing constant, α, has to be greater than 0 and less than 1. The smaller the α, the less reactive the forecasts will be.

$$F_t = F_{t-1} + \alpha(A_{t-1} - F_{t-1})$$

Where

F_t = Forecast for the coming period t

A_x= Actual Demand for period x

α = Smoothing Constant

Example

Using the data from the above example and investigating three cases; F_1 =700, α = 0.8, F_1 =700, α = 0.4, and F_1 =730, α = 0.8 we get the following forecasts.

Month	**Period**	**Sales**	F_1 =*700,* α = 0.8	F_1 =*700,* α = 0.4	F_1 =*730,* α = 0.8
January	1	712	*700*	*700*	*730*
February	2	733	*700* + 0.8(712 - *700*) = ***709.6***	*700* + 0.4(712 - *700*) = 704.8	*730* + 0.8(712 - *730*) = 715.6
March	3	689	***709.6*** + 0.8(733 - ***709.6***) = ***728.6***	***704.8*** + 0.4(733 - ***704.8***) = ***716.2***	***715.6*** + 0.8(733 - ***715.6***) = ***729.8***
April	4	738	697.3	705.5	697.5
May	5	688	729.9	718.5	729.9
June	6	654	696.4	706.3	696.4
July	7	709	662.5	685.4	662.5
August	8		**699.4**	**694.7**	**699.4**

Linear Regression

This is a mathematical tool used for many purposes and you probably remember it from the introductory statistics class. This technique is especially good for the forecasting of products with a clear trend (growing or decreasing).

Linear regression is based on the linear relationship between time (for example days, weeks, or months) and the variable to be forecasted (T-shirt sales for example). This relationship is formulated in the familiar Y = *m*X + *b* format, where Y is the variable to be predicted, X is the time factor, *m* is the slope of the line, and *b* is the constant. This text will not present the details of how this equation is formulated/calculated given this is covered in other courses and texts and in practice, the regression equation can be easily computed using spreadsheet software such as Excel or statistical software such as SPSS.

To forecast using regression analysis it is necessary to enter the data into the software and obtain the regression equation. At this time it is important to examine the resulting r value; a high r value means the regression equation is a good predictor of the data. If the r^2 value is low, the data may be graphed and analyzed to remove outliers, or it may be determined that linear regression is not the best technique. The equation will then be used to predict the period of interest.

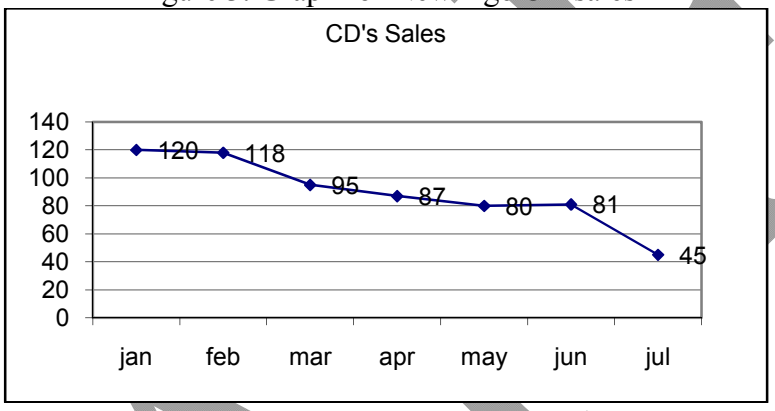
Example

The data from the T-shirt example does not show a trend, does applying the linear regression method is not a good option. However, sales for New Age CD's seemed to have a trend (sales are decreasing). The data is shown in Figure 3.

The data was entered in Excel and using the data analysis tool, the following regression equation was obtained: sales = 134.28 - 11.21 * (period), thus sales for August are forecasted by

$$F_8 = 134.28 - 11.21 * (8) = 44.6$$

Figure 3. Graph for New Age CD sales



It is important to note that the r^2 value for this equation was 0.90, which is good. Other examples and the use of Microsoft ® Excel will be presented during class.

FORECASTING ERRORS

As discussed in the previous sections, there are many methods to develop quantitative forecasts. For the T-shirt example, we have at least six possible forecasts for the month of August. The question now is, what method is the best and what are the best parameters? While it will be impossible for anyone to evaluate all the possible options (for example all the possible set of weights in a weighted moving average), the evaluation of forecasting methods is based on comparing a few pre-selected options for a specific data set.

The evaluation process is based on the average error of a method given historical data. Therefore, we look at multiple data points, determine what the forecasting method would have calculated and

determine the error. IF the forecasting method does not work for past data, we can guess it will not work in generating forecasts.

For each data point (where there is historical data and a forecast value) and forecasting method we calculate an absolute deviation.

$$D_t = \text{Absolute value of } (F_t - A_t)$$

The mean absolute deviation (MAD) is the average measure of error, and the basis to make a decision regarding what is the best forecasting method. The MAD is calculated by:

$$\text{MAD} = \text{SUM}_{1..g} (D_t) / g$$

Where

g = number of periods where there is a forecast and actual data.

Example

The owner of the store wants to know which is the most accurate forecast for the month of August, and which method should they use to forecast T-shirt sales every month. To determine this we calculate the forecasts for all possible periods. Lets evaluate the simple moving average forecasts under our three parameters.

Month	**(Period)**	**Sales**	**n** = 2	**n** = 3	**n** = 4	D_t	D_t	D_t
January	1	712						
February	2	733						
March	3	689	722.7			33.3		
April	4	738	711.4	711.6		26.6	26.4	
May	5	688	713.7	720.3	718.2	25.7	32.3	30.2
June	6	654	713.0	705.1	712.2	59.0	51.1	58.2
July	7	709	671.0	693.3	692.4	37.7	15.3	16.3
August			***681.3***	***683.6***	***697.2***			
					MAD	*36.4*	*31.3*	*34.9*

Using 3 periods (n=3) results in the lowest MAD, thus 683.6 is the so far the best estimate for August (and the best forecasting method for T-shirt Sales). Let's now look at the weighted moving average forecasts. Option 1 = (n = 2, w1 = 0.7, w2 = 0.3); Option 2 = (n = 3, w1 = 0.7, w2 = 0.2, w3 = 0.1) and Option 3 = (n = 4, w1 = 0.7, w2 = 0.1, w3 = 0.1, w4 = 0.1).

Month	**(Period)**	**Sales**	Option 1	Option 2	Option 3	D_t	D_t	D_t
January	1	712						
February	2	733						
March	3	689	727.0			37.5		
April	4	738	702.6	700.5		35.4	37.5	
May	5	688	723.4	727.8	730.1	35.4	39.8	42.1
June	6	654	703.0	698.1	697.7	49.0	44.1	43.7
July	7	709	664.2	669.2	669.3	44.5	39.5	39.3
August			***692.3***	***695.7***	***704.1***			
					MAD	*40.4*	*40.2*	*41.7*

The three options of the weighted moving average resulted in MAD's that were higher than 31.3, thus the simple moving average with 3 periods (n = 3) is best estimate for August. Let's now look at exponential smoothing.

Month	**(Period)**	**Sales**	F_1 =700, $\alpha = 0.8$	F_1 =700, $\alpha = 0.4$	F_1 =730, $\alpha = 0.8$	D_t	D_t	D_t
January	1	712	*700*	*700*	*730*			
February	2	733	709.6	704.8	715.6	23.8	28.6	17.8
March	3	689	728.6	716.2	729.8	39.2	26.8	40.4
April	4	738	697.3	705.5	697.5	40.7	32.5	40.5
May	5	688	729.9	718.5	729.9	41.9	30.5	41.9
June	6	654	696.4	706.3	696.4	42.4	52.3	42.4
July	7	709	662.5	685.4	662.5	46.2	23.3	46.2
August			***699.4***	***694.7***	***699.4***			
					MAD	*39.0*	*32.3*	*38.2*

The second option of the exponential smoothing method resulted in a lowest MAD for this method, but still, the simple moving average with three months results in the lowest MAD

(31.3). Therefore the forecast for August is 683.6 and simple moving average with **n** = 3 is selected as the forecasting method. If we had used a linear regression equation, the process would have included a MAD analysis for the regression forecasts.

TRACKING SIGNAL

- Ratio of cumulative error to MAD
- Tracks period-by-period whether there is a systematic bias in the forecast
  - Bias = tendency for forecast to be persistently above or below actual values
  - Zero is ideal value for TS_t.
  - If $TS_t > 4$ or $TS_t < -4$ then there appears to be bias in the forecast, and corrective action should be taken.

$$\text{Tracking Signal}_t = \frac{\sum(\text{Actual}_t - \text{Forecast}_t)}{\text{MAD}_t}$$

SELECTION OF FORECASTING TECHNIQUES:

- No single technique works in every situation
- Two most important factors
  - Cost
  - Accuracy

(a) The characteristics of the decision making situation:

- Time Horizon
- Level of Detail
- Number of items
- Control Vs planning

(b) The characteristics of forecasting methods:

- Time Horizon (Number of period for which forecasting required)
- The pattern of Data (Horizontal, Seasonal, trend)
- Time of model (Causal, Time series, statistical)
- Cost

- ❖ Accuracy
- ❖ Ease of Application

(c) Present Situation

- ❖ The item that is being forecast
- ❖ Amount of Historical data available
- ❖ Time allowed for preparing forecast

(d) Other factors include the availability of:

- Historical data
- Computers
- Time needed to gather and analyze the data
- Forecast horizon

OBJECTIVES OF DEMAND FORECASTING

I. Short range Objectives:

(1) Formulation of Production strategy & Policy: To bridge the gap between demand & supply of a product offered by the firm and to ensure:

(a) Estimating the requirement of Materials

(b) Optimum utilization of plant & equipments

(c) Planning the availability of labor on regular basis

(1) Formulation of Pricing Policy: Demand forecast enable management to formulate a suitable mechanism for fixing the prices for products to be sold.

(2) Planning & control of sales: Demand forecasts facilities territory design and determination of sales quotas to be assigned to sales people.

(3) Financing Planning: Demand forecasts facilitate estimating cash inflows and cash outflows for the products for which forecasts are made.

II. Medium or Long range Objectives:

(1) Long range planning for production capacity

(2) Labour requirements

(3) Restructuring the capital structure.

KAHE

Forecast accuracy in the supply chain is typically measured using the Mean Absolute Percent Error or MAPE. Statistically MAPE is defined as the average of percentage errors, where is the actual value and the **forecast**, is also known as WAPE, Weighted Absolute Percent Error.

Part A (ONE Mark)

Multiple Choice Questions

Part B (2 Marks)

1. Define Forecasting.
2. List the factors affecting forecasting?
3. What are the types of forecasting techniques?
4. List the Quantitative forecasting techniques.
5. List the Qualitative forecasting techniques.
6. What is Delphi method?
7. What is forecast error?
8. What is MAD?

Part C (Each Question Carries 6 Marks)

1. What are factors affecting forecasting?
2. List and explain the types of forecasting in decision making.
3. Discuss the application of forecasting.
4. Explain the types of forecsting techniques?
5. Enumerate the quantitative type of forecasting techniques.
6. Elucidate the qualitative type of forecasting techniques.

KAHE

Part D Case Study (Carries 11 Marks)

Sabre Enterprise is growing organization specializing in manufacture of spare parts for plant and machines. Sabre enterprise started their business as vendor for machining Cast Iron castings. Every day metal scrap / rejected material is collected in bin and stored in a compartment at scrap yard. Other scrap like paper waste, waste packing box etc are dumped in the scrap yard as a separate compartment. Once in four months scrap buyer used to visit the factory and collect the scrap.

However Sabre expanded its activities from CI Castings machining to manufacturing spares from a variety of material like brass, gunmetal, mild steel, Cast Iron etc. The total scrap generated is about 10 tons per year. Now the scrap is being segregated as ferrous and nonferrous and nonmetallic scrap and stored in scrap in scrap yard. Method of disposing scrap through scrap dealer remains unchanged. Storekeeper coordinates scrap disposal activities. The price of scrap keeps fluctuating in the market due to a member of environmental factors.

a) Sabre has new Materials Manager who feels that existing system of scrap disposal needs to be changed. What should he do?

b) Explain, Ferrous and Non Ferrous type of material with examples.

Part D Case Study (Carries 11 Marks)

Renuka Thomas, president of Renuka Machines Manufacturing Corporation (RMMC), is concerned about company's choice of supplier for cleaning brushes, which are used in the company's data processing equipment. Renuka occasionally plays Tennis with Sheela George, President of George Machine Company (GMC), one of the Company's suppliers of cleaning brushes. Recently, Sheela complained to Renuka that her company has been having difficulty in getting traditional share of Renuka's brush business. On the last buy, Sheela's company failed to get any business, even though Sheela believed she was the low bidder. Renuka tells Sheela that normally she does not get into the details of procurement, but she promises to ask her purchasing manager Dannis Chako to investigate. The next day morning Renuka calls Dannis Chako and tells him of Sheela's complaint. He said, he does not want to influence the company's procurement policies, but he does not feel that Renuka should investigate to make sure that Sheela's firm was treated fairly.

Purchasing Manager Dannis discovers that Sheela George Machine Company was indeed low bidder on the last buying. Quotation for on order of 20,000 units were as under:

Sheela George Machine Company	Rs. 2.22
Data Matics Electronics Company	Rs. 2.23
Royal Tools and Machine Company	Rs. 2.25

Royal and Data Matics each got orders for 10,000 pieces. Royal has done considerable development work on brushes, while Sheela and Data Matics have done very little. The quality and delivery records of the three suppliers on the last ten orders for the brush are shown below. Renuka Machine's mfg. quality control development has set an acceptable quality level of 3 percent on the brush:

Supplier	Quality Ordered	Quantity Defective	Delivery
Royal	4,000	122	One week early
Data Matics	4,000	92	One week late
Sheela	3,000	120	On time
Sheela	6,000	162	Two week late
Royal	4,000	38	On time
Data Matics	5,000	29	One week early
Sheela	2,000	88	1000 pieces on time, 1000 pieces four weeks late
Data Matics	6,000	98	Two weeks late
Royal	4,000	45	One week early
Sheela	5,000	162	One week late

KAHE

Questions:

a) Is Dannic Chaco justified in eliminating Sheela Machine Company as a supplier of brushes?

b) In what respect is the complaint from Sheela Machine Company Justified?

c) Prepare a report for Renuka Thomas explaining the decision to eliminate Sheela Machine Company as a supplier, use quantitative data as much as possible to support your answer?

KAHE

KARPAGAM ACADEMY OF HIGHER EDUCATION						
Department of Management						
Unit 4- Forecasting-Multiple Choice Questions- Each Question Carry ONE Mark						
S.NO	**Question**	**Option 1**	**Option 2**	**Option 3**	**Option 4**	**Answer**
1	Which exponential smoothing factor would produce the most smoothing?	1	0.3	0.1	0	0
2	Which one of the following is a qualitative forecasting technique?	Delphi	naive	moving average	exponential smoothing	Delphi
3	Which term is most closely associated with simple exponential smoothing?	seasonal relative	moving average	trend	predictor variable	moving average
4	Which is not a typical approach for improving forecasts?	Search for a better technique.	Shorten product development time.	Shorten lead times.	Build flexibility into the system.	Shorten lead times.
5	Which would not generally be considered a feature common to all forecasts?	Assumption of a stable underlying causal system.	Actual results will differ somewhat from predicted values.	Historical data are available on which to base the forecast.	Forecasts for groups of items tend to be more accurate than forecasts for individual items.	Historical data are available on which to base the forecast.
6	If an analyst wants to make a moving average more responsive to change, the analyst should:	increase the number of data points in the average.	decrease the number of data points in the average.	increase the value of the smoothing constant.	decrease the value of the smoothing constant.	decrease the number of data points in the average.
7	What is the MAD for this set of data? –1 +3 0 –2 +3	1	1.8	2.5	3	1.8

8	What is the MSE for this set of data? –1 +3 0 –2 +3	1.8	5.75	9	2.3	5.75
9	Which term is most closely associated with a tracking signal?	MBA	MSE	MAD	MAPE	MAD
10	Which of the following would be considered a reason for using a sales force composite forecast?	Salespeople often communicate with each other	They are not likely to be affected by recent events	They are very aware of the importance of forecast accuracy	They are often aware of customers' future plans	They are often aware of customers' future plans
11	The previous period's forecast was for 100 units, and the actual demand in the previous period was for 110 units. Exponential smoothing, with alpha equal to .4, is used to forecast demand. What will the forecast for the next period be?	102 units	104 units	106 units	108 units	104 units
12	One feature common to good forecasting is that a good forecast's……. outweigh(s) its…….....	time horizon; applicability	accuracy; variability	variability; reliability	benefits; costs	benefits; costs
13	Which of the following is not typically accounted for in time-series forecasting?	trend variation	random variation	seasonal variation	cyclical variation	random variation
14	Demand for next year is forecasted to be 800 units per quarter. The first quarter seasonal relative is .8, the second quarter seasonal relative is 1.2, and the third quarter seasonal relative is 1.3. What will be the demand forecast for quarter 4?	650 units	560 units	640 units	1,040 units	560 units

15	In monitoring forecasts, bias is commonly assessed with ……., while nonrandomness is commonly assessed with ……..	MSE; MAD	control charts; MAD	MAPE; MAD	tracking signals; control charts	tracking signals; control charts
16	Which approach is not used for job shop sequencing?	shortest processing time	assignment method	critical ratio	earliest due date	assignment method
17	Which rule minimizes lateness?	FCFS	SPT	critical ratio	EDD	EDD
18	The following are all qualitative forecasting methods except:……	Panel consensus	Delphi method	Exponential forecasting	Historical analogy	Exponential forecasting
19	Which of the following is true regarding forward scheduling?	end items or finished product	final operations first beginning with the due date	start items or component part	jobs as soon as the requirements are known	jobs as soon as the requirements are known
20	Which of the following best describes how short term schedules are prepared?	From master schedules which are derived from aggregate plans	Directly from the capacity plans	From inventory records for items that have been uses	Directly from the aggregate plans	From master schedules which are derived from aggregate plans
21	Which scheduling technique should be employed when due dates are important for a job order?	forward scheduling	backward scheduling	dispatching	loading	backward scheduling
22	The forecasting time horizon that would typically be easiest to predict for would be the	medium-range	intermediate range	short-range	long-range	short-range
23	A forecast that projects a company's sales is a(n)……	economic forecast	technological forecast	demand forecast	associative model	demand forecast

24	Quantitative methods of forecasting include	exponential smoothing	sales force composite.	consumer market survey.	jury of executive opinion.	exponential smoothing.
25	The method that considers several variables that are related to the variable being predicted is……	exponential smoothing	multiple regression	weighted moving average	jury of executive opinion	multiple regression
26	The forecasting model that is based upon salesperson's estimates of expected sales is…….	sales force composite	jury of executive opinion	consumer market survey	delphi method	sales force composite
27	Decomposing a time series refers to breaking down past data into the components of…….	trends, cycles, seasonal and random variations.	long-term, short-term, and medium-term variations.	constants and variations.	strategy, tactical, and operational variations.	trends, cycles, seasonal and random variations.
28	With regard to a regression-based forecast, the standard error of the estimate gives a measure of……..	the time period for which the forecast is valid.	the time required to derive the forecast equation.	the variability around the regression line.	the maximum error of the forecast.	the variability around the regression line.
29	When using exponential smoothing, the smoothing constant?	is typically between .75 and .95 for most business applications.	indicates the accuracy of the previous forecast.	can be determined using MAD.	should be chosen to maximize positive bias.	can be determined using MAD.
30	A tracking signal……	cannot be used with exponential smoothing.	must be either 1, 0, or -1 for the first predicted value	that is negative indicates that demand is greater than the forecast.	is computed as the mean absolute deviation (MAD) divided by the running sum of the forecast errors (RSFE)	must be either 1, 0, or -1 for the first predicted value
31	If demand is 106 during January, 120 in February, 134 in March, and 142 in April, what is the 3-month simple moving average for May?	132	126	142	138	132

32	Given last period's forecast of 65, and last period's demand of 62, what is the simple exponential smoothing forecast with an alpha of 0.4 for the next period?	63.2	63.8	65	62	63.8
33	A forecasting technique consistently produces a negative tracking signal. This means that	the MAPE will also consistently be negative.	the forecasting technique consistently under predicts.	the forecast technique consistently over predicts.	the MSE will also consistently be negative.	the forecast technique consistently over predicts.
34	A regression model is used to forecast sales based on advertising dollars spent. The regression line is y=500+35x and the coefficient of determination is .90. Which is the best statement about this forecasting model?	Even if no money is spent on advertising, the company realizes $35 of sales.	The coefficient of correlation between sales and advertising is 0.81.	The correlation between sales and advertising is positive.	For every Rs.35 spent on advertising, sales increase by Rs1.	The correlation between sales and advertising is positive.
35	Linear regression is most similar to……	the weighted moving average method of forecasting.	the simple moving average method of forecasting.	the naïve method of forecasting.	the trend projection method of forecasting.	the trend projection method of forecasting.
36	Time series patterns that repeat themselves after a period of days or weeks are called……..	trend.	random variation.	cycles.	seasonality.	seasonality.
37	Which of the following is NOT a time-series model?	naïve approach	moving averages	exponential smoothing	linear regression	linear regression
38	Operations generated forecasts often not to do with……..	Inventory requirements	Resource needs	Time requirements	Sales	Sales

39	Which of the following is not true for forecasting?	Forecasts are rarely perfect	The underlying casual system will remain same in the future	Forecast for group of items is accurate than individual item	Short range forecasts are less accurate than long range forecasts	Short range forecasts are less accurate than long range forecasts
40	Which of the following is not a forecasting technique?	Judgemental	Time series	Time horizon	Associative	Time horizon
41	In which of the following forecasting technique, subjective inputs obtained from various sources are analyzed?	Judgemental forecast	Time series forecast	Associative model	delphi method.	Judgemental forecast
42	In which of the following forecasting technique, data obtained from past experience is analyzed?	Judgemental forecast	Time series forecast	Associative model	delphi method	Time series forecast
43	A……..approach actually schedules, in detail, each resource using the setup and runtime required for each order.	Infinite loading	Finite loading	Forward scheduling	Backward scheduling	Finite loading
44	The objectives of work-center scheduling include(s):	Meeting due dates	Minimizing lead times	Minimizing finish goods inventory	A and B	A and B
45	Which of the following is not a priority rule for job sequencing?	Shortest processing time	Minimum slack time remaining	Last come, randomly served	Critical ratio	Last come, randomly served

46	The first hour principle is best used when……..:	Scheduling two jobs on one machine	Scheduling n jobs on two machines	Applying input/output control	Scheduling personnel in the service industry with changing hourly requirements	Scheduling personnel in the service industry with changing hourly requirements
47	The assignment method is appropriate in solving problems that have the following characteristics:	There are 'n' things to be distributed to 'n' destinations	Though each destination may handle all the things, the final assignment has each thing assigned to one and only one destination	Only one criterion should be used (minimum cost, maximum profit, for example)	A and C	A and C
48	The major functions of shop-floor control are:	Assign priority of each shop order	Provide actual output data for capacity control purposes	Maintain work-in-process quantity information	A, B, and C	A, B, and C
49	The basic tools for shop-floor control include:	Dispatch list	Various status and exception reports	An input/output control report	A, B, and C	A, B, and C
50	Which of the following is not a principle of work-center scheduling?	Obtain feedback each day on jobs that are completed at each work center	Reschedule every day	Schedule jobs as strings, with process steps back-to-back	There is direct equivalence between work flow and cash flow	Obtain feedback each day on jobs that are completed at each work center

51	In scheduling personnel for services, which of following is not an issue?	Consecutive days off	Johnson's rule	Continuous shifts	Expected customer demand	Johnson's rule
52	Johnson's rule is used for:	Scheduling job shops	Minimizing total time to complete all jobs	Scheduling two machine flow shops	B and C	B and C
53	Which phrase most closely describes the Delphi forecasting technique?	consumer survey	random individual opinions	group of experts' opinions	historic data	group of experts' opinions
54	Which of the following statements are true about time-series forecasting?	Time series analysis is based on the idea that the history of occurrences over time can	Time series analysis tries to understand the system underlying and surrounding the	Under time series methods, demand is divided into the time-based components	Time series methods are useful for long-range forecasts when the demand pattern is erratic.	Time series analysis is based on the idea that the history of occurrences over time can be used to predict the future.
55	Under exponential smoothing, if we want our forecast to be very responsive to recent demand, the value of alpha should be:	large	small	moderate	zero	large
56	Which of the following would not be classified as a time series technique?	Simple moving average	Exponential smoothing	Box Jenkins technique	Regression model	Regression model

57	Given that the previous forecast of 65 turned out to be four units less than the actual demand and the next forecast is 66, what would be the value of alpha if the simple exponential smoothing forecast	0.02	0.4	0.04	0.25	0.25
58	Which of the following would not be classified as a component of demand?	Trend	Seasonality	Cycle	Causal variation	Causal variation
59	A _____ model is usually more accurate than a _____ model for medium-to-long-range forecasts.	Time-series decomposition, causal regression	Causal regression, time-series decomposition	Time-series decomposition, simple exponential smoothing	Simple exponential smoothing, time-series decomposition	Causal regression, time-series decomposition
60	An accuracy measure that may be used to indicate any positive or negative bias in the forecast is:	Tracking signal	Mean absolute deviation	Mean squared error	Standard error	Tracking signal

UNIT-V

SYLLABUS

TQM, JIT and Supply Chain- Total Quality Management: Introduction, Meaning and Dimensions of Quality, Quality Control Techniques, Quality Based Strategy, Total Quality Management (TQM), Towards TQM – ISO 9000 as a Platform, Total Productive Maintenance (TPM) - Statistical Process Control (SPC) (Problems) Just-In-Time : Introduction, Characteristics of JIT, Key Processes to Eliminate Waste, Implementation of JIT, Pre-requisites for implementation, JIT Inventory and Supply Chains - Supply Chain Management, Managing supply chain, Supply chain integration.

INTRODUCTION

Quality is the ability of a product or service to consistently meet or exceed customer expectations.

Quality management can be considered to have three main components: quality control, quality assurance and quality improvement. Quality management is focused not only on product/service quality, but also the means to achieve it. Quality management therefore uses quality assurance and control of processes as well as products to achieve more consistent quality.

Quality control is a process employed to ensure a certain level of quality in a product or service. It may include whatever actions a business deems necessary to provide for the control and verification of certain characteristics of a product or service. The basic goal of quality control is to ensure that the products, services, or processes provided meet specific requirements and are dependable, satisfactory, and fiscally sound.

Essentially, quality control involves the examination of a product, service, or process for certain minimum levels of quality. The goal of a quality control team is to identify products or services that do not meet a company's specified standards of quality. If a problem is identified, the job of a quality control team or professional may involve stopping production temporarily. Depending on the particular service or product, as well as the type of problem identified, production or implementation may not cease entirely.

Usually, it is not the job of a quality control team or professional to correct quality issues. Typically, other individuals are involved in the process of discovering the cause of quality issues and fixing them. Once such problems are overcome, the product, service, or process continues production or implementation as usual.

Quality control can cover not just products, services, and processes, but also people. Employees are an important part of any company. If a company has employees that don't have adequate skills or training, have trouble understanding directions, or are misinformed, quality may be severely diminished. When quality control is considered in terms of human beings, it concerns correctable issues. However, it should not be confused with human resource issues.

Often, quality control is confused with quality assurance. Though the two are very similar, there are some basic differences. Quality control is concerned with the product, while quality assurance is process–oriented. Even with such a clear-cut difference defined, identifying the differences between the two can be hard. Basically, quality control involves evaluating a product, activity, process, or service. By contrast, quality assurance is designed to make sure processes are sufficient to meet objectives. Simply put, quality assurance ensures a product or service is manufactured, implemented, created, or produced in the right way; while quality control evaluates whether or not the end result is satisfactory.

Quality assurance, or **QA** for short, refers to a program for the systematic monitoring and evaluation of the various aspects of a project, service, or facility to ensure that standards of quality are being met.

It is important to realize also that quality is determined by the program sponsor. QA cannot absolutely guarantee the production of *quality* products, unfortunately, but makes this more likely.

Two key principles characterise QA: "fit for purpose" (the product should be suitable for the intended purpose) and "right first time" (mistakes should be eliminated). QA includes regulation of the quality of raw materials, assemblies, products and components; services related to production; and management, production and inspection processes. It is important to realize also that *quality* is

determined by the intended users, clients or customers, not by society in general: it is not the same as 'expensive' or 'high quality'. Even goods with low prices can be considered quality items if they meet a market need. QA is more than just testing the quality of aspects of a product, service or facility, it analyzes the quality to make sure it conforms to specific requirements and comply with established plans.

Quality Improvement Organizations monitor the appropriateness, effectiveness, and quality of care provided.

Difference between Quality Control and Quality Assurance:

Quality Control (QC) refers to quality related activities associated with the creation of project deliverables. Quality control is used to verify that deliverables are of acceptable quality and that they are complete and correct. Examples of quality control activities include inspection, deliverable peer reviews and the testing process.

Quality control is about adherence to requirements. Quality assurance is generic and does not concern the specific requirements of the product being developed.

Quality Assurance (QA) refers to the process used to create the deliverables, and can be performed by a manager, client, or even a third-party reviewer. Examples of quality assurance include process checklists, project audits and methodology and standards development.

Quality assurance activities are determined before production work begins and these activities are performed while the product is being developed. In contrast, Quality control activities are performed **after** the product is developed.

Evolution of Quality Management

- 1924 - Statistical process control charts
- 1930 - Tables for acceptance sampling

- 1940's - Statistical sampling techniques
- 1950's - Quality assurance/TQC
- 1960's - Zero defects
- 1970's - Quality assurance in services

Dimensions of Quality

- *Performance* - main characteristics of the product/service
- *Aesthetics* - appearance, feel, smell, taste
- *Special Features* - extra characteristics
- *Conformance* - how well product/service conforms to customer's expectations
- *Reliability* - consistency of performance
- *Durability* - useful life of the product/service
- *Perceived Quality* - indirect evaluation of quality (e.g. reputation)
- *Serviceability - service after sale*

Service Quality: - The service quality is described by the following dimensions:

- Tangibles – the physical appearance of facilities, equipment, personnel and communication materials.
- Convenience – the availability and accessibility of the service.
- Reliability – the ability to perform a service dependably, consistently and accurately.
- Responsiveness – the willingness of service providers to help customers in unusual situations and to deal with the problems.
- Time – the speed with which service is delivered.
- Assurance – the knowledge exhibited by personnel who come into contact with a customer and their ability to convey trust and confidence.
- Courtesy – the way customers are treated by employees who came into contact with them.

Determinants of Quality:- The degree to which a product or service successfully satisfies its intended purpose has four primary determinants as given below:

1. Design

2. How well it conforms to its design.
3. Ease of use
4. Service after delivery.

The Consequences of Poor Quality:- The quality of the product or service provided by on organization affects the existence of the organization. Some of the ways that quality affects an organization are,

- Loss of business: Poor design or defective products or services can result in loss of business.
- Liability: Organisations must pay special attention to their potential liability due to damages or injuries resulting form either faulty design or poor workmanship.
- Productivity: Productivity and quality are closely related. Poor quality can adversely affect productivity during the manufacturing process and similarly, poor service can mean having to redo the service and reduce the service productivity.
- Costs: Cost to remedy a problem is a major consideration in quality management. The earlier a problem is identified in the process, the cheaper is the cost to fix it.

Responsibility for Quality:- All the members of an organization have the responsibility for quality, but certain areas of the organization are involved in activities that make them key areas of responsibility. They include top management, design department, procurement division, production department, quality assurance systems, packaging and shipping activities, marketing and sales departments and customer service department.

Poor quality increases the cost in an organization. The analyses of the costs of quality reveals the following classification of cost.

Costs of Quality:- Appraisal cost, prevention cost and Failure cost.

Appraisal Costs are the Costs of activities designed to ensure quality or uncover defects

Prevention Costs are the cost related to all the TQ training, TQ planning, customer assessment, process control, and quality improvement costs to prevent defects from occurring.

Failure Costs - costs incurred by defective parts/products or faulty services. It can be classified as Internal failure cost, External failure cost , Appraisal costs and prevention costs.

•Internal Failure Costs are the Costs incurred to fix problems that are detected before the product/service is delivered to the customer.

•External Failure Costs are the Costs incurred to fix problems that are detected after the product/service is delivered to the customer.

TOTAL QUALITY MANAGEMENT

Although quality and quality management does not have a formal definition, most agree that it is an integration of all functions of a business to achieve high quality of products through continuous improvement efforts of all employees. Quality revolves around the concept of meeting or exceeding customer expectation applied to the product and service. Achieving high quality is an ever changing, or continuous, process therefore quality management emphasizes the ideas of working constantly toward improved quality. It involves every aspect of the company: processes, environment and people. The whole workforce from the CEO to the line worker must be involved in a shared commitment to improving quality.

Therefore, in brief, quality and total quality management (TQM) in particular can be defined as directing (managing) the whole (total) production process to produce an excellent (quality) product or service. It differs from other management techniques in the attitude of management toward the product and toward the worker. Older management methods focused on the volume of production and the cost of the product. Quality was controlled by using a detection method (post production inspection), problems were solved by management and management's role was defined as planning, assigning work, controlling the production. Quality management, in contrast, is focused on the customer and meeting the customer's needs. Quality is controlled by prevention, i.e., quality is built in at every stage. Teams solve problems and everyone is responsible for the quality of the product. Management's role is to delegate, coach, facilitate and mentor. The major quality management principles are: quality, teamwork, and proactive management philosophies for process improvement.

ORIGINS

Quality management in is not derived from a single idea or person. It is a collection of ideas, and has been called by various names and acronyms: TQM, total quality management; CQU, continuous quality improvement; SQC, statistical quality control; TQC, total quality control, etc. However each of these ideas encompasses the underlying idea of productivity initiatives that increase profit by improving the product.

QUALITY GURUS:

The Quality Gurus—Dr. W. Edwards Deming, Dr. Joseph Juran, Philip Crosby, Armand V. Feigenbaum, Dr. H. James Harrington, Dr. Kaoru Ishikawa, Dr. Walter A. Shewhart, Shigeo Shingo, Frederick Taylor, and Dr. Genichi Taguchi—have made a significant impact on the world through their contributions to improving not only businesses, but all organizations including state and national governments, military organizations, educational institutions, healthcare organizations, and many other establishments and organizations.

DR. W. EDWARDS DEMING (1900–1993)

Dr. W. Edward Deming is best known for reminding management that most problems are systemic and that it is management's responsibility to improve the systems so that workers (management and non-management) can do their jobs more effectively. Deming argued that higher quality leads to higher productivity, which, in turn, leads to long-term competitive strength. The theory is that improvements in quality lead to lower costs and higher productivity because they result in less rework, fewer mistakes, fewer delays, and better use of time and materials. With better quality and lower prices, a firm can achieve a greater market share and thus stay in business, providing more and more jobs.

In emphasizing management's responsibility, Deming noted that workers are responsible for 10 to 20 percent of the quality problems in a factory, and that the remaining 80 to 90 percent is under management's control. Workers are responsible for communicating to management the information

they possess regarding the system. Deming's approach requires an organization-wide cultural transformation.

Deming's philosophy is summarized in his famous fourteen points, and it serves as a framework for quality and productivity improvement. Instead of relying on inspection at the end of the process to find flaws, Deming advocated a statistical analysis of the manufacturing process and emphasized cooperation of workers and management to achieve high-quality products.

Deming's quality methods centered on systematically tallying product defects, analyzing their causes, correcting the causes, and recording the effects of the corrections on subsequent product quality as defects were prevented. He taught that it is less costly in the long-run to get things done right the first time then fix them later.

DEMING'S FOURTEEN POINTS

Deming formulated the following Fourteen Points to cure (eliminate) the Seven Deadly Diseases and help organizations to survive and flourish in the long term:

1. Create constancy of purpose toward improvement of product and service. Develop a plan to be competitive and stay in business. Everyone in the organization, from top management to shop floor workers, should learn the new philosophy.

2. Adopt the new philosophy. Commonly accepted levels of delays, mistakes, defective materials, and defective workmanship are now intolerable. We must prevent mistakes.

3. Cease dependence on mass inspection. Instead, design and build in quality. The purpose of inspection is not to send the product for rework because it does not add value. Instead of leaving the problems for someone else down the production line, workers must take responsibility for their work. Quality has to be designed and built into the product; it cannot

be inspected into it. Inspection should be used as an information-gathering device, not as a means of "assuring" quality or blaming workers.

4. Don't award business on price tag alone (but also on quality, value, speed and long term relationship). Minimize total cost. Many companies and organizations award contracts to the lowest bidder as long as they meet certain requirements. However, low bids do not guarantee quality; and unless the quality aspect is considered, the effective price per unit that a company pays its vendors may be understated and, in some cases, unknown. Deming urged businesses to move toward single-sourcing, to establish long-term relationships with a few suppliers (one supplier per purchased part, for example) leading to loyalty and opportunities for mutual improvement. Using multiple suppliers has been long justified for reasons such as providing protection against strikes or natural disasters or making the suppliers compete against each other on cost. However, this approach has ignored "hidden" costs such as increased travel to visit suppliers, loss of volume discounts, increased set-up charges resulting in higher unit costs, and increased inventory and administrative expenses. Also constantly changing suppliers solely on the base of price increases the variation in the material supplied to production, since each supplier's process is different.

5. Continuously improve the system of production and service. Management's job is to continuously improve the system with input from workers and management. Deming was a disciple of Walter A. Shewhart, the developer of control charts and the continuous cycle of process improvement known as the Shewhart cycle. Deming popularized the Shewhart Cycle as the Plan-Do-Check-Act (PDCA) or Plan-Do-Study-Act (PDSA) cycle; therefore, it is also often referred to as the Deming cycle. In the planning stage, opportunities for improvement are recognized and operationally defined. In the doing stage, the theory and course of action developed in the previous stage is tested on a small scale through conducting trial runs in a laboratory or prototype setting. The results of the testing phase are analyzed in the check/study stage using statistical methods. In the action stage, a decision is made regarding the implementation of the proposed plan. If the results were positive in the pilot stage, then the plan will be implemented. Otherwise alternative plans are developed. After full scale

implementation, customer and process feedback will again be obtained and the process of continuous improvement continues.

6. Institute training on the job. When training is an integral part of the system, operators are better able to prevent defects. Deming understood that employees are the fundamental asset of every company, and they must know and buy into a company's goals. Training enables employees to understand their responsibilities in meeting customers' needs.

7. Institute leadership (modern methods of supervision). The best supervisors are leaders and coaches, not dictators. Deming high-lighted the key role of supervisors who serve as a vital link between managers and workers. Supervisors first have to be trained in the quality management before they can communicate management's commitment to quality improvement and serve as role models and leaders.

8. Drive out fear. Create a fear-free environment where everyone can contribute and work effectively. There is an economic loss associated with fear in an organization. Employees try to please their superiors. Also, because they feel that they might lose their jobs, they are hesitant to ask questions about their jobs, production methods, and process parameters. If a supervisor or manager gives the impression that asking such questions is a waste of time, then employees will be more concerned about pleasing their supervisors than meeting long-term goals of the organization. Therefore, creating an environment of trust is a key task of management.

9. Break down barriers between areas. People should work cooperatively with mutual trust, respect, and appreciation for the needs of others in their work. Internal and external organizational barriers impede the flow of information, prevent entities from perceiving organizational goals, and foster the pursuit of subunit goals that are not necessarily consistent with the organizational goals. Barriers between organizational levels and departments are internal barriers. External barriers are between the company and its suppliers, customers,

investors, and community. Barriers can be eliminated through better communication, cross-functional teams, and changing attitudes and cultures.

10. Eliminate slogans aimed solely at the work force. Most problems are system-related and require managerial involvement to rectify or change. Slogans don't help. Deming believed that people want to do work right the first time. It is the system that 80 to 90 percent of the time prevents people from doing their work right the first time.

11. Eliminate numerical goals, work standards, and quotas. Objectives set for others can force sub-optimization or defective output in order to achieve them. Instead, learn the capabilities of processes and how to improve them. Numerical goals set arbitrarily by management, especially if they are not accompanied by feasible courses of action, have a demoralizing effect. Goals should be set in a participative style together with methods for accomplishment. Deming argued that the quota or work standard system is a short-term solution and that quotas emphasize quantity over quality. They do not provide data about the process that can be used to meet the quota, and they fail to distinguish between special and common causes when seeking improvements to the process.

12. Remove barriers that hinder workers (and hinder pride in workmanship). The direct effect of pride in workmanship is increased motivation and a greater ability for employees to see themselves as part of the same team. This pride can be diminished by several factors: (1) management may be insensitive to workers' problems; (2) they may not communicate the company's goals to all levels; and (3) they may blame employees for failing to meet company goals when the real fault lies with the management.

13. Institute a vigorous program of education and self improvement. Deming's philosophy is based on long-term, continuous process improvement that cannot be carried out without properly trained and motivated employees. This point addresses the need for ongoing and continuous education and self-improvement for the entire organization. This educational investment serves the following objectives: (1) it leads to better motivated employees; (2) it

communicates the company goals to the employees; (3) it keeps the employees up-to-date on the latest techniques and promotes teamwork; (4) training and retraining provides a mechanism to ensure adequate performance as the job responsibilities change; and (5) through increasing job loyalty, it reduces the number of people who "job-hop."

14. Take action to accomplish the transformation. Create a structure in top management that will promote the previous thirteen points. It is the top management's responsibility to create and maintain a structure for the dissemination of the concepts outlined in the first thirteen points. Deming felt that people at all levels in the organization should learn and apply his Fourteen Points if statistical process control is to be a successful approach to process improvement and if organizations are to be transformed. However, he encouraged top management to learn them first. He believed that these points represent an all-or-nothing commitment and that they cannot be implemented selectively.

THE DEMING CYCLE

Known as the Deming Plan-Do-Check-Act (PDCA) Cycle, this concept was invented by Shewhart and popularized by Deming. This approach is a cyclic process for planning and testing improvement activities prior to full-scale implementation and/or prior to formalizing the improvement. When an improvement idea is identified, it is often wise to test it on a small scale prior to full implementation to validate its benefit. Additionally, by introducing a change on a small scale, employees have time to accept it and are more likely to support it. The Deming PDCA Cycle provides opportunities for continuous evaluation and improvement.

The steps in the Deming PDCA or PDSA Cycle as shown in Figure 1 are as follows:

1. Plan a change or test (P).
2. Do it (D). Carry out the change or test, preferably on a small scale.
3. Check it (C). Observe the effects of the change or test. Study it (S).
4. Act on what was learned (A).
5. Repeat Step 1, with new knowledge.
6. Repeat Step 2, and onward. Continuously evaluate and improve.

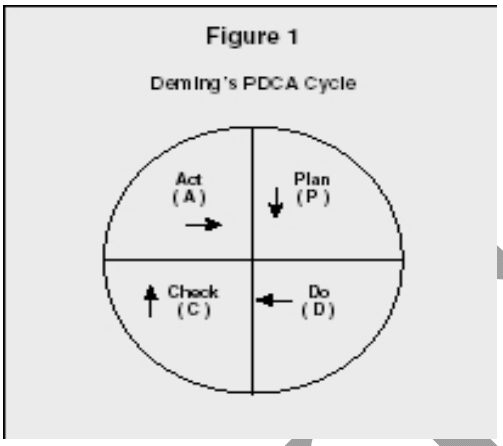


Figure - Deming's PDCA Cycle

Deming was trained as a mathematical physicist, and he utilized mathematical concepts and tools (Statistical Process Control) to reduce variation and prevent defects. However, one of his greatest contributions might have been in recognizing the importance of organizational culture and employee attitudes in creating a successful organization. In many ways, his philosophies paralleled the development of the resource-based view of organizations that emphasized that employee knowledge and skills and organizational culture are very difficult to imitate or replicate, and they can serve as a basis of sustainable competitive advantage.

DR. JOSEPH JURAN (B. 1904)

Dr. Juran was born on December 24, 1904 in Braila, Romania. He moved to the United States in 1912 at the age of 8. Juran's teaching and consulting career spanned more than seventy years, known as one of the foremost experts on quality in the world.

SELECTED JURAN QUALITY THEORIES

Juran's concepts can be used to establish a traditional quality system, as well as to support Strategic Quality Management. Among other things, Juran's philosophy includes the Quality Trilogy and the Quality Planning Roadmap.

JURAN'S QUALITY TRILOGY.

The Quality Trilogy emphasizes the roles of quality planning, quality control, and quality improvement. Quality planning's purpose is to provide operators with the ability to produce goods and services that can meet customers' needs. In the quality planning stage, an organization must determine who the customers are and what they need, develop the product or service features that meet customers' needs, develop processes which are able to deliver those products and services, and transfer the plans to the operating forces. If quality planning is deficient, then chronic waste occurs.

Quality control is used to prevent things from getting worse. Quality control is the inspection part of the Quality Trilogy where operators compare actual performance with plans and resolve the differences. Chronic waste should be considered an opportunity for quality improvement, the third element of the Trilogy. Quality improvement encompasses improvement of fitness-for-use and error reduction, seeks a new level of performance that is superior to any previous level, and is attained by applying breakthrough thinking.

While up-front quality planning is what organizations should be doing, it is normal for organizations to focus their first quality efforts on quality control. In this aspect of the Quality Trilogy, activities include inspection to determine percent defective (or first pass yield) and deviations from quality standards. Activities can then focus on another part of the trilogy, quality improvement, and make it an integral part of daily work for individuals and teams.

The Quality Trilogy is depicted below in Figure 2.

KAHE

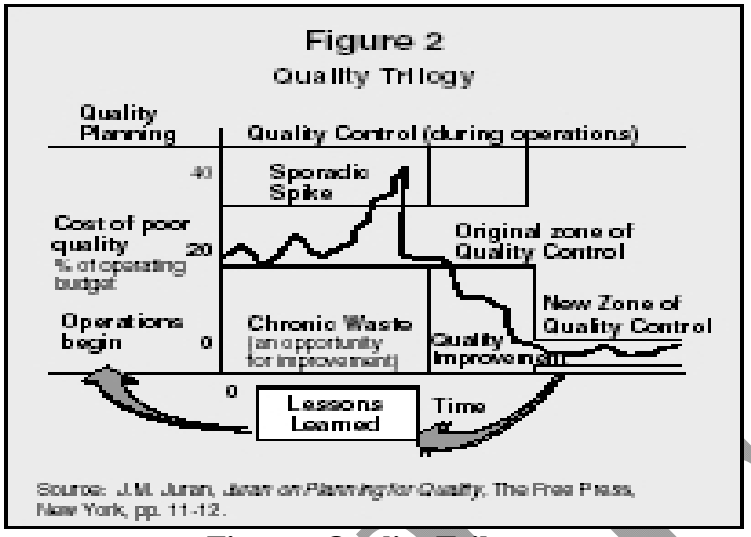


Figure - Quality Trilogy

Quality planning must be integrated into every aspect of the organization's work, such as strategic plans; product, service and process designs; operations; and delivery to the customer.

JURAN'S QUALITY PLANNING ROAD MAP.

Juran's Quality Planning Road Map can be used by individuals and teams throughout the world as a checklist for understanding customer requirements, establishing measurements based on customer needs, optimizing product design, and developing a process that is capable of meeting customer requirements. The Quality Planning Roadmap is used for Product and Process Development and is shown in Figure 3.

Juran's Quality Trilogy and Quality Roadmap are not enough. An infrastructure for Quality must be developed, and teams must work on improvement projects. The infrastructure should include a quality steering team with top management leading the effort, quality should become an integral part of the strategic plan, and all people should be involved. As people identify areas with improvement potential, they should team together to improve processes and produce quality products and services.

Under the "Big Q" concept, all people and departments are responsible for quality. In the old era under the concept of "little q," the quality department was responsible for quality. Big "Q" allows workers to regain pride in workmanship by assuming responsibility for quality.

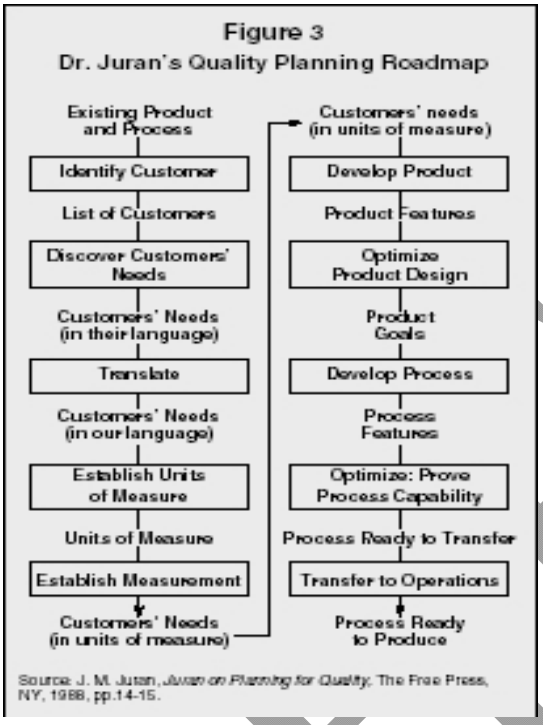


Figure Dr. Juran's Quality Planning Roadmap

PHILIP CROSBY (1926–2001)

Attention to customer requirements and preventing defects is evident in Crosby's definitions of quality and "non-quality" as follows: "Quality is conformance to requirements; non-quality is nonconformance."

CROSBY'S COST OF QUALITY.

In his book *Quality Is Free,* Crosby makes the point that it costs money to achieve quality, but it costs more money when quality is not achieved. When an organization designs and builds an item right the first time (or provides a service without errors), quality is free. It does not cost anything above what would have already been spent. When an organization has to rework or scrap an item because of poor quality, it costs more. Crosby discusses Cost of Quality and Cost of Nonconformance or Cost of Nonquality. The intention is spend more money on preventing defects and less on inspection and rework.

CROSBY'S FOUR ABSOLUTES OF QUALITY.

Crosby espoused his basic theories about quality in four Absolutes of Quality Management as follows:

1. Quality means conformance to requirements, not goodness.
2. The system for causing quality is prevention, not appraisal.
3. The performance standard must be zero defects, not "that's close enough."
4. The measurement of quality is the price of nonconformance, not indexes.

To support his Four Absolutes of Quality Management, Crosby developed the Quality Management Maturity Grid and Fourteen Steps of Quality Improvement. Crosby sees the Quality Management Maturity Grid as a first step in moving an organization towards quality management.

Crosby's Absolutes of Quality Management are further delineated in his Fourteen Steps of Quality Improvement as shown below:

Step 1. Management Commitment

Step 2. Quality Improvement Teams

Step 3. Quality Measurement

Step 4. Cost of Quality Evaluation

Step 5. Quality Awareness

Step 6. Corrective Action

Step 7. Zero-Defects Planning

Step 8. Supervisory Training

Step 9. Zero Defects

Step 10. Goal Setting

Step 11. Error Cause Removal

Step 12. Recognition

Step 13. Quality Councils

Step 14. Do It All Over Again

ARMAND V. FEIGENBAUM

Feigenbaum was still a doctoral student at the Massachusetts Institute of Technology when he completed the first edition of *Total Quality Control* (1951). An engineer at General Electric during

World War II, Feigenbaum used statistical techniques to determine what was wrong with early jet airplane engines. For ten years he served as manager of worldwide manufacturing operations and quality control at GE. Feigenbaum serves as president of General Systems Company, Inc., Pittsfield, Massachusetts, an international engineering firm that designs and installs integrated operational systems for major corporations in the United States and abroad.

Feigenbaum was the founding chairman of the International Academy for Quality and is a past president of the American Society for Quality Control, which presented him its Edwards Medal and Lancaster Award for his contributions to quality and productivity. His Total Quality Control concepts have had a very positive impact on quality and productivity for many organizations throughout the industrialized world.

DR. KAORU ISHIKAWA (1915–1989)

A professor of engineering at the University of Tokyo and a student of Dr. W. Edwards Deming, Ishikawa was active in the quality movement in Japan, and was a member of the Union of Japanese Scientists and Engineers. He was awarded the Deming Prize, the Nihon Keizai Press Prize, and the Industrial Standardization Prize for his writings on quality control, and the Grant Award from the American Society for Quality Control for his educational program on quality control.

Ishikawa's book, *Guide to Quality Control* (1982), is considered a classic because of its in-depth explanations of quality tools and related statistics. The tool for which he is best known is the cause and effect diagram. Ishikawa is considered the Father of the Quality Circle Movement. Ishikawa believed that quality improvement initiatives must be organization-wide in order to be successful and sustainable over the long term. He promoted the use of Quality Circles to: (1) Support improvement; (2) Respect human relations in the workplace; (3) Increase job satisfaction; and (4) More fully recognize employee capabilities and utilize their ideas. Quality Circles are effective when management understands statistical techniques and act on recommendations from members of the Quality Circles.

DR. WALTER A. SHEWHART (1891–1967)

A statistician who worked at Western Electric, Bell Laboratories, Dr. Walter A. Shewhart used statistics to explain process variability. It was Dr. W. Edward Deming who publicized the usefulness of control charts, as well as the Shewhart Cycle. However, Deming rightfully credited Shewhart with

the development of theories of process control as well as the Shewhart transformation process on which the Deming PDCA (Plan-Do-Check or Study-Act) Cycle is based. Shewhart's theories were first published in his book *Economic Control of Quality of Manufactured Product* (1931).

SHIGEO SHINGO (1919–1990)

One of the world's leading experts on improving the manufacturing process, Shigeo Shingo created, with Taiichi Ohno, many of the features of just-in-time (JIT) manufacturing methods, systems, and processes, which constitute the Toyota Production System. Shingo's greatness seems to be based on his ability to understand exactly why products are manufactured the way they are, and then transform that understanding into a workable system for low-cost, high quality production.

Rather than focusing on theory, Shingo focused on practical concepts that made an immediate difference. Specific concepts attributed to Shingo are:

- Poka Yoke requires stopping processes as soon as a defect occurs, identifying the source of the defect, and preventing it from happening again.
- Mistake Proofing is a component of Poka Yoke. Literally, this means making it impossible to make mistakes (i.e., preventing errors at the source).
- SMED (Single Minute Exchange of Die) is a system for quick changeovers between products. The intent is to simplify materials, machinery, processes and skills in order to dramatically reduce changeover times from hours to minutes. As a result products could be produced in small batches or even single units with minimal disruption.
- Just-in-Time (JIT) Production is about supplying customers with what they want when they want it. The aim of JIT is to minimize inventories by producing only what is required when it is required. Orders are "pulled" through the system when triggered by customer orders, not pushed through the system in order to achieve economies of scale with the production of larger batches.

FREDERICK TAYLOR (1856–1915)

An industrial (efficiency) engineer, manager, and consultant, Frederick Taylor is known as the Father of Scientific Management. In 1911, he published *The Principles of Scientific Management.* Taylor believed in task specialization and is noted for his time and motion studies. Some of his ideas

are the predecessors for modern industrial engineering tools and concepts that are used in cycle time reduction.

While quality experts would agree that Taylor's concepts increase productivity, some argue that his concepts are focused on productivity, not process improvement and as a result could cause less emphasis on quality. Dr. Joseph Juran said that Taylor's concepts made the United States the world leader in productivity. However, the Taylor system required separation of planning work from executing the work. This separation was based on the idea that engineers should do the planning because supervisors and workers were not educated. Today, the emphasis is on transferring planning to the people doing the work.

DR. GENICHI TAGUCHI (B. 1924)

Dr. Genichi Taguchi was a Japanese engineer and statistician who defined what product specification means and how this can be translated into cost effective production. Taguchi's contributions are in robust design in the area of product development. The Taguchi Loss Function, The Taguchi Method (Design of Experiments), and other methodologies have made major contributions in the reduction of variation and greatly improved engineering quality and productivity. By consciously considering the noise factors (environmental variation during the product's usage, manufacturing variation, and component deterioration) and the cost of failure in the field, Taguchi methodologies help ensure customer satisfaction.

Robust Design focuses on improving the fundamental function of the product or process, thus facilitating flexible designs and concurrent engineering. Taguchi product development includes three stages: (1) system design (the non-statistical stage for engineering, marketing, customer and other knowledge); (2) parameter stage (determining how the product should perform against defined parameters; and (3) tolerance design (finding the balance between manufacturing cost and loss).

IMPLEMENTING TQM

Although different authorities on total quality management emphasize different techniques and use different terminology, all share three common ideas: quality, teamwork and process improvement. Joseph Jablonskiin his book, In *Implementing TQM,* has identified three characteristics: (1) participative management; (2) continuous process improvement; and (3) utilization of teams.

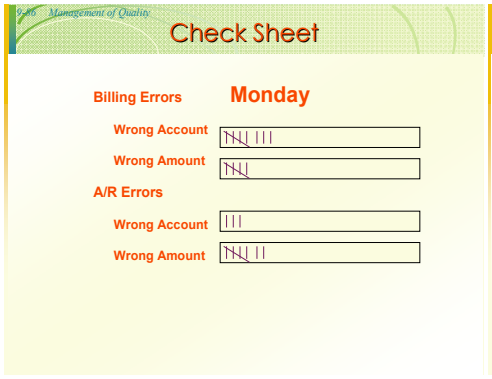
Participative management is the opposite of the hierarchical management style of the early twentieth century businesses. It involves all employees in the management process and decision making by having managers set policies and make key decisions based upon the advice and ideas of subordinates. This method provides management with more information from the front line and motivates the workers as they have some control of the decisions. Continuous process improvement is one of Deming's major ideas and involves small steps toward the ultimate goal. This involves patience on the part of management. Teamwork refers to cross-functional teams of workers that share in problem solving. Jablonski went on to list six attributes necessary for success: (1) customer focus; (2) process focus; (3) prevention versus inspection; (4) employee empowerment and compensation; (5) fact-based decision making; and (6) receptiveness to feedback. TQM emphasizes a decentralized structure to encourage leadership and creativity. The purpose of this change in structure is to change the behavior of the employees. However, successful companies have more functional integration and fewer layers of hierarchy.

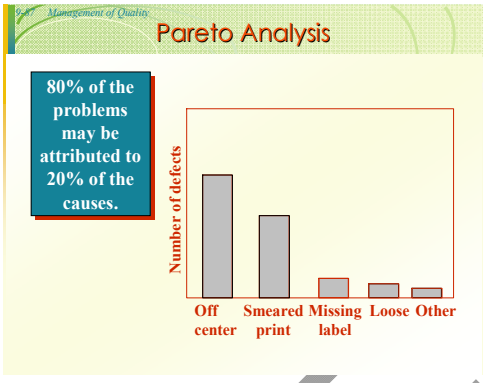
BASIC QUALITY TOOLS OF TQM:

- Flowcharts
- Check sheets
- Histograms
- Pareto Charts
- Scatter diagrams
- Control charts
- Cause-and-effect diagrams
- Run charts

Check Sheet Pareto Analysis

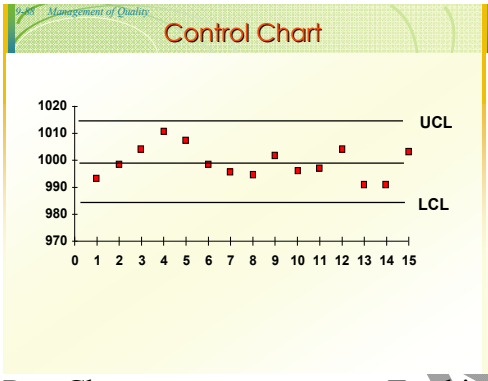
KAHE

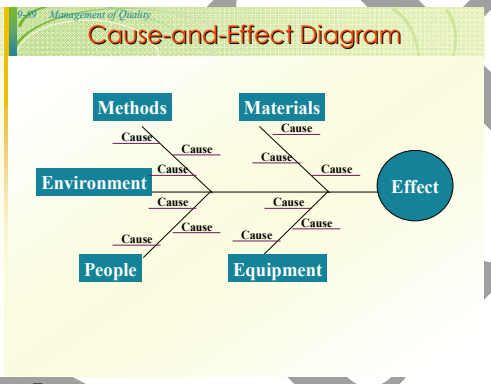




Control Chart

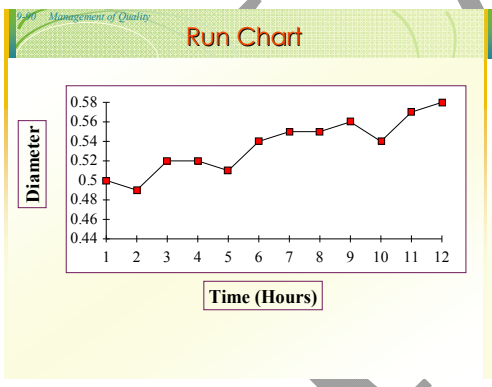
Cause-and-Effect Diagram

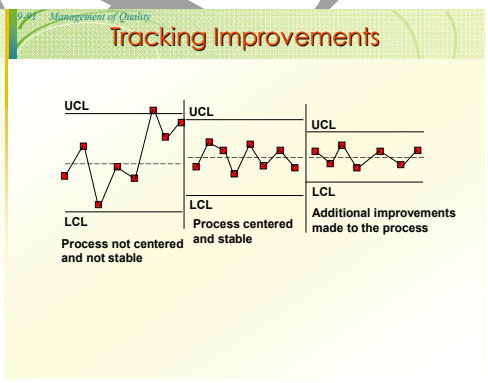




Run Chart

Tracking Improvements





QUALITY CIRCLES

Ross defined a quality circle as follows: "A quality circle is a small group of employees doing similar or related work who meet regularly to identify, analyze, and solve product-quality and production problems and to improve general operations. The circle is a relatively autonomous unit (ideally about ten workers), usually led by a supervisor or a senior worker and organized as a work unit."

Under ideal circumstances these voluntary groups of problem solvers focus on measurable indicators of quality that impact the company's costs, productivity, or other business interests. Such indicators are usually industry- or process-specific. So, for example, quality circles at a manufacturing company might focus on finding ways to minimize product defects, as measured in the amount of product with a particular defect per thousand or million; meanwhile, those at an insurance company might seek methods to reduce the frequency of billing errors.

The principles of quality circles emphasized the importance of preventing defects from occurring rather than relying on product inspection following a production process. Quality circles also attempted to minimize the scrap and downtime that resulted from part and product defects. Deming's idea that improving quality could increase productivity led to the development in Japan of the Total Quality Control (TQC) concept, in which quality and productivity are viewed as two sides of a coin. TQC also required that a manufacturer's suppliers make use of quality circles.

Quality circles often rely on visual representations such as scatter diagrams, flow charts, and cause-and-effect diagrams. In one common format, various aspects of the production process were categorized by materials, manpower, methods, and machines. The reliance on statistical representations of the production process and statistical production controls was another of Deming's legacies in Japan.

Quality circles in Japan were part of a system of relatively cooperative labor-management relations, involving company unions and lifetime employment guarantees for many full-time permanent employees. Consistent with this decentralized, enterprise-oriented system, quality circles provided a means by which production workers were encouraged to participate in company matters and by

which management could benefit from production workers' intimate knowledge of the production process.

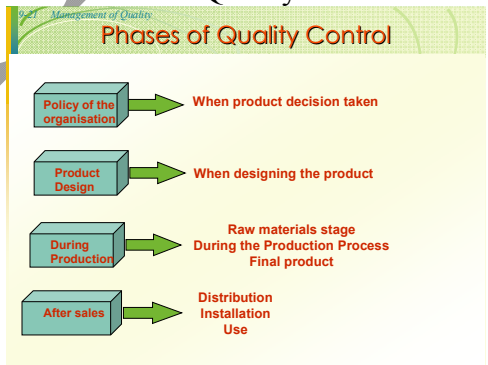
STATISTICAL QUALITY CONTROL

The American Society for Quality Control (ASQC), in its *Glossary and Tables for Statistical Quality Control,* defines quality control as the operational techniques and the activities which sustain a quality of product or service that will satisfy given needs. This requires integrating several related steps including proper specification of the product, proper design of the product to meet the requirements; proper production processes that meet the specification, timely inspection to determine the degree of conformance to the specification and review of usage to provide for revision of specification, if necessary.

These steps are required for a firm to design, produce, market, and profit from a quality product. Control charts are one technique used in implementing, sustaining, and improving quality control. Statistical process studies are also an important tool in improving quality by reducing process variation.

On an international level, the ISO 9000 series of quality standards was first published in 1987. These standards reflect the importance of quality and reliability as critical factors for achieving and maintaining worldwide competitive advantage. Another example is the international environment management standard, ISO 14001. Companies worldwide use this standard as a blueprint to develop and refine internal environmental management systems.

Phases of Quality Control :



KAHE

Inspection

- The process of examining the object for identification or checking it for verification of quality and quantity in any of its characteristics.

Objectives:

- To safeguard the quality
- To locate defective items
- To reduce risks(Producer's and Consumer's risk)
- To detect sources of weakness and trouble.

Steps in Inspection

- Determine the characteristics to be inspected.
- Determine when and where inspection to be done.
- How many items are to be inspected.
- Determine the sampling scheme and the specification limits.

Inspection

- How Much/How Often
- Where/When
- Centralized vs. On-site

Where to Inspect in the Process

- Raw materials and purchased parts
- Finished products
- Before a costly operation
- Before an irreversible process
- Before a covering process

Acceptance Sampling: The process of accepting or rejecting a lot based on the sample characteristics is known as Acceptance Sampling.

KAHE

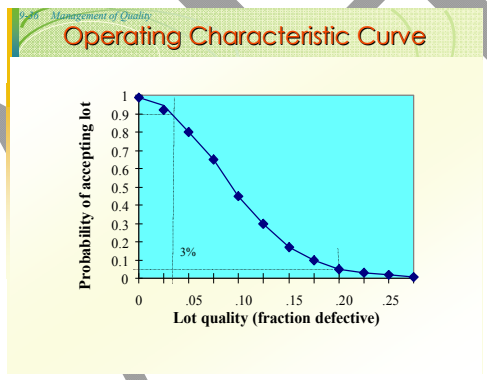
Limitations of Acceptance sampling: Producer's risk & Consumer's risk

•*Consumer's risk*: The probability of accepting a bad lot because of good sample is known as Consumer's risk.

•*Producer's risk*:The probability of rejecting a good lot because of bad sample is known as Producer's risk.

Operating Characteristic Curve:

OC curve is a probability curve which shows the probability that the given plan will accept lot of various quality levels. The curve always pertains to a specific plan, an 'n' & 'c' combination. It indicates what % of lots of any quality may be accepted.



•Acceptance quality level (AQL): the percentage of defects at which consumers are willing to accept lots as "good"

•Lot tolerance percent defective (LTPD): the upper limit on the percentage of defects that a consumer is willing to accept

•Consumer's risk: the probability that a lot contained defectives exceeding the LTPD will be accepted

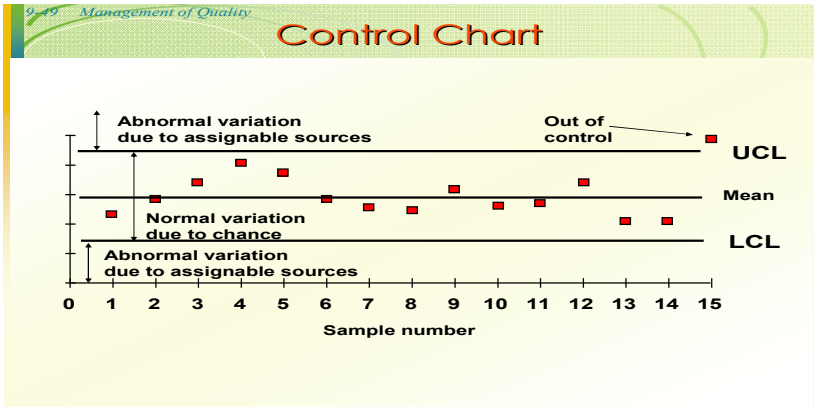
•Producer's risk: the probability that a lot containing the acceptable quality level will be rejected

Quality Control Chart:

•*Purpose:* to monitor process output to see if it is random

•A time ordered plot representative sample statistics obtained from an on going process (e.g. sample means)

•Upper and lower control limits define the range of acceptable variation



Statistical process control (SPC) is the application of statistical methods to the monitoring and control of a process to ensure that it operates at its full potential to produce conforming product. Under SPC, a process behaves predictably to produce as much conforming product as possible with the least possible waste. While SPC has been applied most frequently to controlling manufacturing lines, it applies equally well to any process with a measurable output. Key tools in SPC are control charts, a focus on continuous improvement and designed experiments.

Much of the power of SPC lies in the ability to examine a process and the sources of variation in that process using tools that give weight to objective analysis over subjective opinions and that allow the strength of each source to be determined numerically. Variations in the process that may affect the quality of the end product or service can be detected and corrected, thus reducing waste as well as the likelihood that problems will be passed on to the customer. With its emphasis on early detection and prevention of problems, SPC has a distinct advantage over other quality methods, such as inspection, that apply resources to detecting and correcting problems after they have occurred.

In addition to reducing waste, SPC can lead to a reduction in the time required to produce the product or service from end to end. This is partially due to a diminished likelihood that the final product will have to be reworked, but it may also result from using SPC data to identify bottlenecks,

wait times, and other sources of delays within the process. Process cycle time reductions coupled with improvements in yield have made SPC a valuable tool from both a cost reduction and a customer satisfaction standpoint.

Statistical Process Control uses statistical tools to observe the performance of the production process in order to predict significant deviations that may later result in rejected product.

Statistical Process Control Process:

- Define
- Measure
- Compare
- Evaluate
- Correct
- Monitor results

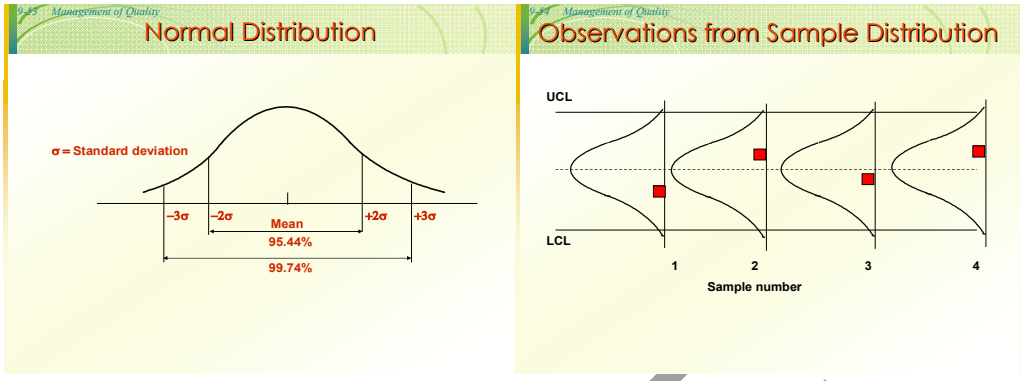
Two kinds of variation occur in all manufacturing processes: both these types of process variation cause subsequent variation in the final product. The first is known as natural or common cause variation and consists of the variation inherent in the process as it is designed. Common cause variation may include variations in temperature, properties of raw materials, strength of an electrical current etc. The second kind of variation is known as special cause variation, or assignable-cause variation, and happens less frequently than the first. With sufficient investigation, a specific cause, such as abnormal raw material or incorrect set-up parameters, can be found for special cause variations.

Statistical Process Control: Variations and Control

- *Random variation*: Natural variations in the output of a process, created by countless minor factors
- *Assignable variation*: A variation whose source can be identified

Normal Distribution

KAHE



Observations from Sample Distribution

Statistical Process Control may be broadly broken down into three sets of activities: understanding the process; understanding the causes of variation; and elimination of the sources of special cause variation.

In understanding a process, the process is typically mapped out and the process is monitored using control charts. Control charts are used to identify variation that may be due to special causes, and to free the user from concern over variation due to common causes. This is a continuous, ongoing activity. When a process is stable and does not trigger any of the detection rules for a control chart, a process capability analysis may also be performed to predict the ability of the current process to produce conforming (i.e. within specification) product in the future.

Quality Control Charts for Variables

- Mean control charts known as X bar charts
- Used to monitor the central tendency of a process.

X – chart

UCL = $X + 3\sigma / \sqrt{n}$
CL = X
LCL = $X - 3\sigma / \sqrt{n}$
where $\sigma / \sqrt{n}$ is the standard error.
X = average of the mean. n = sample size, σ = standard deviation

X – chart

UCL = X + 3 R/ d2
CL = X
LCL = X - 3 R/d2
Where, X = average of the mean. , n = sample size, R = Average of the range,
d2 = constant for different values of "n".

X – chart

UCL = X + A2R
CL = X
LCL = X – A2R
Where, X = average of the mean, n = sample size, R = Average of the range
A2 = constant for different values of "n".

R – chart

- Range control charts known as R charts
- Used to monitor the process dispersion

(σ) standard deviation is known.

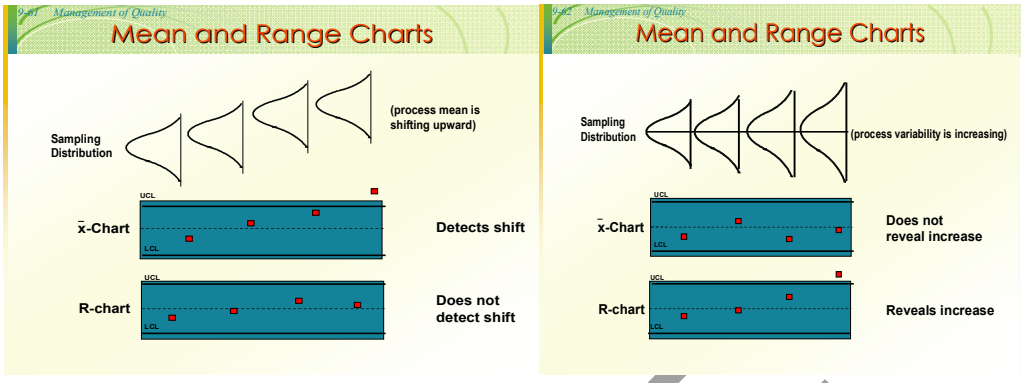
UCL = d2σ + 3d3 σ
CL = d2σ
LCL = d2σ - 3d3 σ
Where, n = sample size, σ = standard deviation, d2 & d3 are constant for different values of 'n' .

R - chart
(σ) standard deviation is not known.

UCL = R+ 3d3/d2R = R (1+3d3/d2) = RD4
CL = R
LCL = R- 3d3/d2R = R (1-3d3/d2) = RD3
Where, n = sample size, R = Average of the range
D3 & D4 are constant for different values of 'n' ,

Mean and Range Charts

KAHE



Control Chart for Attributes

•p-Chart - Control chart used to monitor the proportion of defectives in a process
•np-Chart - Control chart used to monitor the proportion of number of defectives in a process

Use of p-Charts
•When observations can be placed into two categories.
•Good or bad, Pass or fail, Operate or don't operate
•When the data consists of multiple samples of several observations each we use 'np'chart.

p – chart

UCL = $p + 3 \sqrt{pq/n}$
CL = p
LCL = $p - 3 \sqrt{pq/n}$
Where p = proportionate number of defectives in the lot, n = sample size, q=(1-p).

np – chart

UCL = $np + 3 \sqrt{npq}$
CL = np
LCL = $np - 3 \sqrt{npq}$
Where p = proportionate number of defectives in the lot, n = sample size, q=(1-p).

•**c-Chart** - Control chart used to monitor the number of defects per unit

Use of c-Charts
•Use only when the number of occurrences per unit of measure can be counted; non-occurrences cannot be counted.
•Scratches, chips, dents, or errors per item
•Cracks or faults per unit of distance
•Breaks or Tears per unit of area
•Bacteria or pollutants per unit of volume

KAHE

•Calls, complaints, failures per unit of time

c – chart

UCL = c + 3 √ c
CL = c
LCL = c - 3 √c
Where c = average number of defects in the lot.

When excessive variation is identified by the control chart detection rules, or the process capability is found lacking, additional effort is exerted to determine causes of that variance. The tools used include Ishikawa diagrams, designed experiments and Pareto charts. Designed experiments are critical to this phase of SPC, as they are the only means of objectively quantifying the relative importance of the many potential causes of variation.

Once the causes of variation have been quantified, effort is spent in eliminating those causes that are both statistically and practically significant (i.e. a cause that has only a small but statistically significant effect may not be considered cost-effective to fix; however, a cause that is not statistically significant can never be considered practically significant). Generally, this includes development of standard work, error-proofing and training. Additional process changes may be required to reduce variation or align the process with the desired target, especially if there is a problem with process capability.

SUMMARY

For quality control to occur, the top management of any company must have totally committed itself to TQC, and then CWQC. Sustaining and improving the quality of manufacturing or service processes require such tools as control charts, process capability studies, experimental designs, business ethics, organizational change and development, and excellent employee relations. Finally, to compete internationally a company has to adopt international quality standards.

ISO 9000

The ISO 9000 Series Standards for Quality Management and Assurance were issued by the **International Organization for Standardization (ISO)** in 1987. They reflect an important trend in business practice. Early in the 20th century, quality was viewed by businesses as an additional cost of production. However, as businesses realized that high quality leads to more efficient and less expensive production processes, the pursuit of quality became a desirable goal. Businesses began to implement quality control programs, and they began to require such programs of their suppliers. Quality control programs proliferated at the same time that businesses were being globalized. This led to the realization that international quality assurance standards were needed to avoid the need to comply with multiple, conflicting systems. The ISO responded to the need for harmonization by publishing the ISO 9000 series standards.

The ISO 9000 series is a set of standards for quality management and quality assurance. The standards apply to processes and systems used to produce products; they do not apply to the products themselves. Further, the standards provide a general framework for any industry; they are not industry-specific. A company that has a quality management system (QMS) that is "certified to" ISO 9000 has demonstrated that it has a documented QMS in place and that it is applied consistently. The ISO 9000 series emphasizes prevention of problems and meeting customers' needs. ISO 9000 standards apply to all companies large or small, whether in services or manufacturing.

KAHE

BACKGROUND

International standardization began early in the 20th century with the creation of the International Electrotechnical Commission (IEC) in 1906 and the establishment of the International Federation of National Standardizing Associations (ISA) in 1926. The ISA focused primarily on mechanical engineering.

The idea of quality assurance dates back to World War II. To deal with quality problems related to manufacturing of defense equipment, the U.S. Department of Defense instituted one of the first formal quality control programs in the world. The United Kingdom, influenced by the United States, developed its own quality standards for its defense industry. U.S. and U.K. standards later spread to other countries and formed the basis for a set of quality assurance standards adopted by other members of the North Atlantic Treaty Organization (NATO). Those standards were called the Allied Quality Assurance Publication (AQAP). After World War II, the U.S. government continued to develop quality standards. These standards were conveyed to defense contractors who were expected to implement them to ensure quality defense equipment.

The idea of industry standards continued to spread and develop throughout the world. At the close of World War II, in 1947, the International Organization for Standardization (ISO) was created with headquarters in Geneva, Switzerland. The ISO published its first standards in 1951, and by 1998 it had published over 10,060 standards. ISO Standards cover a multitude of topics including, but not limited to, paper sizes, a uniform system of measurement, symbols for automobile controls, film speed codes, and an internationally standardized freight container.

In 1979, the British Standards Institute (BSI) submitted a proposal to the ISO calling for the development of international quality assurance and quality management standards. Twenty member nations of the ISO participated on the ISO/TC 176, the technical committee that drafted the standards, with another 14 nations serving as observers. In 1987, eight years after the BSI proposal, the ISO published its first quality assurance standards, called the ISO 9000 Series. Since then more standards have been added to the series.

WHO HAS ADOPTED THE STANDARDS?

ISO 9000 series standards have been adopted by at least 90 countries around the world. In 1992, the European Union established the European Council for Standardization (CEN). The Council's mission is to set a single set of standards for manufacturers to simplify trade among its 15 member states. The CEN, in turn, adopted the ISO 9000 series provisions verbatim as EN 29000. Within the

EU, products such as medical devices, industrial safety equipment, telecommunications equipment, and construction-related products require ISO 9000 series certification. As a result, study of the ISO 9000 series standards is a standard part of the curriculum in European trade schools.

The American National Standards Institute (ANSI), working with the American Society for Quality Control (ASQC), has adopted the ISO 9000 series for use by businesses in the United States as ANSI/ASQU Q-90. The Q-90 series includes five books, each of which corresponds to one of five parts of the ISO 9000 Series. (The five parts are ISO 9000 through ISO 9004). The standards are available for purchase through ANSI or the ASQC. It should be noted, however, that the ANSI/ASQU harmonized variant of ISO 9000 is not sponsored by the U.S. government.

MAJOR PROVISIONS OF THE STANDARDS

The ISO 9000 Series standards are created as generic standards in order to allow them to be applied to every industry. They help businesses plan, control, and document issues related to quality. They are based on the assumption that if a quality management system is properly designed, then quality assurance programs will also be properly designed. However, it is important to note that the ISO 9000 standards relate to the quality of production processes only. They do not include provisions for evaluating the quality of the product. This means that three companies following ISO 9000 standards, each producing the same product, could produce three products of varying qualities. This fact has been the basis for criticism of the ISO 9000 series standards.

There are more than five standards in the ISO 9000 series, but five contain most of the crucial provisions. They include ISO 9000, ISO 9001, ISO 9002, ISO 9003, and ISO 9004. In addition, ISO 8402 is often grouped with the ISO 9000 series. ISO 8402, which covers vocabulary, was passed in 1986 in anticipation of the ISO 9000 series. ISO 9000 and ISO 9004 provide guidelines. To develop a quality system, a company must choose to become certified to one of three standards: ISO 9001, ISO 9002, or ISO 9003. Below is a summary of each of the six standards.

1. ISO 8402 "Quality Vocabulary." This standard provides definitions of quality assurance terms. It is useful in choosing terminology when drafting quality control manuals.
2. ISO 9000 "Quality Management and Quality Assurance Standards—Guidelines for Selection and Use." This standard provides an overview of the other ISO 9000 series standards. It includes guidelines for choosing the applicable ISO 9000 standards, and describes the purpose and application of quality assurance programs. ISO 9000 provides quality management guidelines for all industries.
3. ISO 90001 "Quality Systems—Model for Quality Assurance in Design/Development, Production, Installation, and Servicing." This standard sets out 20 element requirements and is the most comprehensive of the five ISO 9000 series standards. Although it is designed to apply to all industries, it is particularly useful in manufacturing and related industries in which a company designs, produces, installs, and services its own products.
4. ISO 9002 "Quality Systems—Model for Quality Assurance in Production and Installation." This standard includes 18 element requirements. It is used primarily by companies responsible for production and installation of their own products, but not the design. These standards apply to suppliers and subcontractors for ISO 9001-certified companies.
5. ISO 9003 "Quality Systems—Model for Quality Assurance in Final Inspection and Test." This standard includes 12 element requirements. It is the least complex of the five ISO 9000 series standards. Its primary users are companies that perform tests on and do final production inspections such as calibration. In general, a company that does not add any value to the manufacturing process should use ISO 9003.
6. ISO 90004 "Quality Management and Quality System Elements—Guidelines." This standard is similar to the ISO 9000 standard in that it provides guidelines for implementation of other standards within the ISO 9000 series. It is used for auditing purposes, and it contains guidelines that assist a company as it develops its own quality systems.

KAHE

REVISIONS:

To better serve certain industries, the original 1987 standards have been modified; a major set of revisions was published in 1994. In fact, ISO 9000 includes a provision allowing the quality provisions found in ISO 9001, 9002, and 9003 to be customized to make the system applicable to certain products or services. Areas in which customized standards have been developed include, for example, ISO 9004-2, which applies to service industries; and ISO 9000-3, which covers the development and supply of computer software. Subsequently revisions have been made in 1997, 2000 and recently in 2008.

ISO 9001:2008 Quality management systems — Requirements is a document of approximately 30 pages which is available from the national standards organization in each country.

- *Requirements* for ISO 9001:2008
  - 1: *Scope*
  - 2: *Normative Reference*
  - 3: *Terms and definitions* (specific to ISO 9001, not specified in ISO 9000)
  - 4: *Quality Management System*
  - 5: *Management Responsibility*
  - 6: *Resource Management*
  - 7: *Product Realization*

The standard specifies six compulsory documents:

- Control of Documents (4.2.3)
- Control of Records (4.2.4)
- Internal Audits (8.2.2)
- Control of Nonconforming Product / Service (8.3)
- Corrective Action (8.5.2)
- Preventive Action (8.5.3)

In addition to these, ISO 9001:2008 requires a Quality Policy and Quality Manual (which may or may not include the above documents).

Summary of ISO 9001:2008

- The quality policy is a formal statement from management, closely linked to the business and marketing plan and to customer needs. The quality policy is understood and followed at all levels and by all employees. Each employee needs measurable objectives to work towards.
- Decisions about the quality system are made based on recorded data and the system is regularly audited and evaluated for conformance and effectiveness.
- Records should show how and where raw materials and products were processed, to allow products and problems to be traced to the source.
- You need to determine customer requirements and create systems for communicating with customers about product information, inquiries, contracts, orders, feedback and complaints.
- When developing new products, you need to plan the stages of development, with appropriate testing at each stage. You need to test and document whether the product meets design requirements, regulatory requirements and user needs.
- You need to regularly review performance through internal audits and meetings. Determine whether the quality system is working and what improvements can be made. Deal with past problems and potential problems. Keep records of these activities and the resulting decisions, and monitor their effectiveness (note: you need a documented procedure for internal audits).
- You need documented procedures for dealing with actual and potential nonconformances (problems involving suppliers or customers, or internal problems). Make sure no one uses bad product, determine what to do with bad product, deal with the root cause of the problem seeking and keep records to use as a tool to improve the system.

1987 version

ISO 9000:1987 had the same structure as the UK Standard BS 5750, with three 'models' for quality management systems, the selection of which was based on the scope of activities of the organization:

- ISO 9001:1987 *Model for quality assurance in design, development, production, installation, and servicing* was for companies and organizations whose activities included the creation of new products.
- ISO 9002:1987 *Model for quality assurance in production, installation, and servicing* had basically the same material as ISO 9001 but without covering the creation of new products.
- ISO 9003:1987 *Model for quality assurance in final inspection and test* covered only the final inspection of finished product, with no concern for how the product was produced.

ISO 9000:1987 was also influenced by existing U.S. and other Defense Standards ("MIL SPECS"), and so was well-suited to manufacturing. The emphasis tended to be placed on conformance with procedures rather than the overall process of management—which was likely the actual intent.

1994 version

ISO 9000:1994 emphasized quality assurance via preventive actions, instead of just checking final product, and continued to require evidence of compliance with documented procedures. As with the first edition, the down-side was that companies tended to implement its requirements by creating shelf-loads of procedure manuals, and becoming burdened with an ISO bureaucracy. In some companies, adapting and improving processes could actually be impeded by the quality system.

2000 version

ISO 9001:2000 combines the three standards 9001, 9002, and 9003 into one, called 9001. Design and development procedures are required only if a company does in fact engage in the creation of new products. The 2000 version sought to make a radical change in thinking by actually placing the concept of process management front and center ("Process management" was the monitoring and optimizing of a company's tasks and activities, instead of just inspecting the final product). The 2000 version also demands involvement by upper executives, in order to integrate quality into the business system and avoid delegation of quality functions to junior administrators. Another goal is to improve effectiveness via process performance metrics — numerical measurement of the effectiveness of

tasks and activities. Expectations of continual process improvement and tracking customer satisfaction were made explicit.

The ISO 9000 standard is continually being revised by standing technical committees and advisory groups, who receive feedback from those professionals who are implementing the standard.

ISO 9001:2008 only introduces clarifications to the existing requirements of ISO 9001:2000 and some changes intended to improve consistency with ISO 14001:2004. There are no new requirements. Explanation of changes in ISO 9001:2008. A quality management system being upgraded just needs to be checked to see if it is following the clarifications introduced in the amended version.

Certification

ISO does not itself certify organizations. Many countries have formed accreditation bodies to authorize certification bodies, which audit organizations applying for ISO 9001 compliance certification. Although commonly referred to as ISO 9000:2000 certification, the actual standard to which an organization's quality management can be certified is ISO 9001:2008. Both the accreditation bodies and the certification bodies charge fees for their services. The various accreditation bodies have mutual agreements with each other to ensure that certificates issued by one of the Accredited Certification Bodies (CB) are accepted worldwide.

The applying organization is assessed based on an extensive sample of its sites, functions, products, services and processes; a list of problems ("action requests" or "non-compliance") is made known to the management. If there are no major problems on this list, or after it receives a satisfactory improvement plan from the management showing how any problems will be resolved, the certification body will issue an ISO 9001 certificate for each geographical site it has visited.

An ISO certificate is not a once-and-for-all award, but must be renewed at regular intervals recommended by the certification body, usually around three years. In contrast to the Capability Maturity Model there are no grades of competence within ISO 9001. Marlin (USF)

Auditing

Two types of auditing are required to become registered to the standard: auditing by an external certification body (external audit) and audits by internal staff trained for this process (internal audits). The aim is a continual process of review and assessment, to verify that the system is working as it's supposed to, find out where it can improve and to correct or prevent problems identified. It is considered healthier for internal auditors to audit outside their usual management line, so as to bring a degree of independence to their judgments.

Under the 1994 standard, the auditing process could be adequately addressed by performing "compliance auditing":

- Tell me what you do *(describe the business process)*
- Show me where it says that *(reference the procedure manuals)*
- Prove that this is what happened *(exhibit evidence in documented records)*

The 2000 standard uses a different approach. Auditors are expected to go beyond mere auditing for rote "compliance" by focusing on risk, status and importance. This means they are expected to make more judgments on what is effective, rather than merely adhering to what is formally prescribed. The difference from the previous standard can be explained thus:

> Under the 1994 version, the question was broadly "Are you doing what the manual says you should be doing?", whereas under the 2000 version, the question is more "Will this process help you achieve your stated objectives? Is it a good process or is there a way to do it better?"

Industry-specific interpretations

The ISO 9001 standard is generalized and abstract. Its parts must be carefully interpreted, to make sense within a particular organization. Developing software is not like making cheese or offering counseling services; yet the ISO 9001 guidelines, because they are business management guidelines, can be applied to each of these. Diverse organizations—police departments (US), professional soccer teams (Mexico) and city councils (UK)—have successfully implemented ISO 9001:2000 systems.

KAHE

Over time, various industry sectors have wanted to standardize their interpretations of the guidelines within their own marketplace. This is partly to ensure that their versions of ISO 9000 have their specific requirements, but also to try and ensure that more appropriately trained and experienced auditors are sent to assess them.

- The **TickIT** guidelines are an interpretation of ISO 9000 produced by the UK Board of Trade to suit the processes of the information technology industry, especially software development.
- **AS9000** is the Aerospace Basic Quality System Standard, an interpretation developed by major aerospace manufacturers. Those major manufacturers include AlliedSignal, Allison Engine, Boeing, General Electric Aircraft Engines, Lockheed-Martin, McDonnell Douglas, Northrop Grumman, Pratt & Whitney, Rockwell-Collins, Sikorsky Aircraft, and Sundstrand. The current version is **AS9100**.
- **PS 9000** is an application of the standard for Pharmaceutical Packaging Materials. The Pharmaceutical Quality Group (PQG) of the Institute of Quality Assurance (IQA) has developed PS 9000:2001. It aims to provide a widely accepted baseline GMP framework of best practice within the pharmaceutical packaging supply industry. It applies ISO 9001: 2000 to pharmaceutical printed and contact packaging materials.
- **QS 9000** is an interpretation agreed upon by major automotive manufacturers (GM, Ford, Chrysler). It includes techniques such as FMEA and APQP. QS 9000 is now replaced by ISO/TS 16949.
- **ISO/TS 16949:2009** is an interpretation agreed upon by major automotive manufacturers (American and European manufacturers); the latest version is based on ISO 9001:2008. The emphasis on a process approach is stronger than in ISO 9001:2008. ISO/TS 16949:2009 contains the full text of ISO 9001:2008 and automotive industry-specific requirements.
- **TL 9000** is the Telecom Quality Management and Measurement System Standard, an interpretation developed by the telecom consortium, QUEST Forum. The current version is 4.0 and unlike ISO 9001 or the above sector standards, TL 9000 includes standardized product measurements that can be benchmarked. In 1998 QUEST Forum developed the TL

9000 Quality Management System to meet the supply chain quality requirements of the worldwide telecommunications industry.

- **ISO 13485:2003** is the medical industry's equivalent of ISO 9001:2000. Whereas the standards it replaces were interpretations of how to apply ISO 9001 and ISO 9002 to medical devices, ISO 13485:2003 is a stand-alone standard. Compliance with ISO 13485 does not necessarily mean compliance with ISO 9001:2000.
- **ISO/TS 29001** is quality management system requirements for the design, development, production, installation and service of products for the petroleum, petrochemical and natural gas industries. It is equivalent to API Spec Q1 without the Monogram annex.

DEVELOPING A QUALITY ASSURANCE SYSTEM

Implementation of ISO 9000 series standards and certification to them is a lengthy and detailed procedure, but this section will provide a brief overview of the process. A series of six steps lead to the development of an internal quality assurance system. That system must include but is not limited to, a quality systems manual.

It is a misperception that preparation of the manual creates mountains of paperwork; the ISO quality manual is typically about 20-35 pages long. It is a major tool in developing and implementing an internal quality assurance system. The manual is to be used for training new personnel as well as in the day-to-day operations of the company.

The process of developing a system can be described in six steps.

1. Management must decide which ISO standards apply to their company and which element requirements must be implemented.
2. All personnel directly involved in the ISO 9000 implementation process must be trained. In turn, staff must develop policies and objectives necessary to meet the element requirements of the applicable ISO series 9000 standards.
3. Procedures and documentation must be developed to carry out the policies and objectives that have been laid out. Examples of documentation include organization charts, quality plans, log books, inspection and test reports, purchase orders, and corrective action reports.
4. Each employee is interviewed on how he she does his or her job, and a description of procedures is created for each job. The description must include safety procedures.

5. Industry-wide standards and specifications must be documented.
6. The company must establish an internal audit system. The system must be used to continually check whether the quality system is functioning properly.

The quality system process is an organization-wide process. There is no such thing as a partial quality assurance system; it is either for all of a company or none of it. The documentation gathered through these steps is used as a basis to develop the company's quality management system; and the system is described in the quality management manual.

After the quality assurance system has been developed, the next step is for the company to perform a preliminary internal assessment to measure how closely it conforms to the relevant standard.

INTERNAL BENEFITS.

Whether certification is required or not, ISO 9000 series certification provides a variety of internal benefits. First, ISO 9000 certification leads to better documentation of company processes. This, in turn, leads to more efficient production processes and less waste. Both save money for a company.

Second, managers and other employees become more aware of quality. They begin to view operations through a "quality of management" lens. This leads to a more efficient company that can be more competitive in the marketplace.

Third, employee morale improves. When employees feel that they are part of the process, they accept responsibility for quality. This creates an incentive for workers to do a better job and makes the company more efficient.

Fourth, cooperation and communication are improved. Documenting procedures facilitates communication and promotes cooperation.

Fifth, production processes can be made more efficient. When there is better coordination of processes, there is less "down time," and resources are shared among departments more efficiently.

Sixth, fewer defective products are produced. Better quality results in fewer defects, less scrap, and, therefore, lower production costs. Finally, documentation of safety standards results in fewer accidents. In turn, there is less downtime for employees. The ultimate results are more efficient workers and lower costs of production.

EXTERNAL BENEFITS.

Similarly, there are many potential external benefits. The first is that company prestige increases. Companies following ISO 9000 series standards are perceived as "good corporate citizens" that produce higher quality products. Thus, they gain prestige that can help retain old customers and attract new ones.

Second, it improves customer satisfaction. Higher quality means higher customer satisfaction. Further, the manufacturer of a product is certified, a customer may feel better about the product even if it is, in fact, of no higher quality than that of a non-certified manufacturer.

Third, it creates a higher level of trust. Customers perceive a certified company as being more trust worthy than a non-certified company.

Fourth, it reduces the need for customer audits. With certification, a company has already been audited. Therefore, customers will not feel a need to audit every time they want to do business with a company. This can result in major savings. For example, it is reported that in some industry segments in the United States, a facility may be subject to dozens of audits per year; in some cases it may be as many as 30 per month.

Fifth, it can help a company increase its market share. Certified companies gain access to markets that require ISO certification, and they can deepen penetration of existing markets. Finally, the

company can respond more quickly to market needs. With better quality procedures, it is easier to develop and market new product lines. Being the first to reach a market results in higher profits for the company.

COSTS AND PROBLEMS RELATED TO ISO 9000

There are costs in time and money for companies becoming certified to an ISO 9000 series standard. For example, an ISO program may take three months to over one year to implement, and it requires continual efforts to review progress and pursue improvement. Further, it costs money to develop a certification program and attain certification. There may be benefits in terms of increased sales resulting from public perception that the firm produces quality goods, but sometimes non-ISO certified companies may be able to produce a similar product more cheaply.
ISO certification does not mean that a firm's product is better than that of a non-ISO certified firm. For example, ISO 9000 series certification does not prevent design defects. To reiterate, the ISO series 9000 standards are process standards; they are not product standards.

The quality of an audit performed for ISO certification purposes depends on the qualifications and honesty of the auditor, and whether the auditor is acting in a first, second, or third party capacity. In addition, there are numerous problems inherent in the third party certification process.

First, the ISO does not have standard procedures for certification. As a result, various countries have developed different certification procedures. For example, in the United States, the national body of accreditation is the Registrar Accreditation Board (RAB). At present, the European Union (EU) does not regulate registrars. Instead, they are accredited through national certification boards. This divergence contributes to a lack of understanding of the certification process. Without an international certification procedure, companies and members of the public are uninformed about what is involved in certification. And, of course, standards for certification are not uniform.

Second, certification is not always recognized across borders of countries. Therefore, a registrar should be chosen in view of the company's customer base. One practice that facilitates operations of

companies in various countries is that some U.S. registrars have signed memoranda with registrars in Europe. As a result of such agreements, a company can become ISO-certified in several countries through the completion of a single certification process.

Third, there is no centralized record of registrations. This makes proof of certification difficult, and potential customers must rely on documents in the possession of the certified firm or the auditing firm hired by the firm.

Fourth, certification is costly. It costs from Rs.5,00,000 to Rs.10,00,000 or more, and may take six to 18 months to perform, depending on the size of the company. This can be prohibitive for small companies and for companies with severely limited resources. Such companies tend to come, in disproportionate percentages, from developing countries as compared to companies from industrialized countries.

Another set of objections to the ISO 9000 series standards is based on the assertion that the standards function as a non-tariff barrier to trade. The adoption of ISO 9000 series by the EU is viewed by some commentators as a trade barrier to companies from outside the EU. In other cases, it has been asserted that, as ISO 9000 certification becomes a *de facto* requirement for doing business, it operates as a non-tariff barrier to trade with respect to struggling companies from developing countries. This argument is based on the premise that ISO certification is an expense that is beyond the means of firms with extremely limited funds.

The ISO 9000 series standards involve potentially high economic stakes. Therefore, there must be continuing, careful surveillance by various industries throughout the world, as standards are developed and refined, and, especially, as variants on the ISO 9000 system are developed.

CONCLUSION

Certification of businesses to the ISO 9000 series standards is increasing rapidly around the world. Many companies see implementation of the standards as an investment in the future. They are

convinced that the program will pay for itself as it results in lower production costs and greater efficiency in operation as well as access to new markets and new customers. In many industries, certification has almost become a necessity for doing business. And in some countries, such as in the EU, certification is mandatory in certain industries.

Yet, the ISO 9000 series standards are process standards, not product standards. Their widespread use throughout the world is creating desirable harmonization in terms of providing goods to the public. But the ISO 9000 series standards do not guarantee quality products from the companies that participate in the program.

ISO 14000

The ISO 14000 Series International Environmental Management Standards are receiving significant attention from business managers and their legal and economic advisers, and it is said that the standards may be a "watershed in the annals of environmental regulation." Business managers view ISO 14000 as a market-driven approach to environmental protection that provides an alternative to "command and control" regulation by government. Therefore, the standards are of significant interest to business organizations and their legal representatives; environmental groups and their members; and governments, their agencies, and their officials.

The ISO 14000 standards were issued in September 1996 by the International Organization for Standardization (ISO), a major, private organization involved in standardization of industrial management practices. Although the ISO 14000 standards are the product of a nongovernmental organization and compliance with the standards is voluntary, one of the primary purposes of the standards is to ensure that businesses comply with applicable environmental law. Businesses view implementation of ISO 14000 as a means to self-regulate, thereby minimizing their exposure to surveillance and sanctions by the U.S. Environmental Protection Agency (EPA) and its state-level counterparts. Part II of this article explores reasons for the development of ISO 14000. Part III describes the provisions of ISO 14000, and Part IV describes the perspectives of various parties on the utility of ISO 14000. Finally, Part V surveys the overall strengths and limitations of ISO 14000.

REASONS FOR DEVELOPMENT OF ISO 14000

Several converging factors relating to the developing global marketplace led to the development of the ISO 14000 Series International Environmental Management Standards. As industrialization has spread to countries throughout the world, citizens and their governments have voiced their concerns about the effects of that industrialization on the environment. As a result of such concerns, the concept of sustainable development was developed. Its pursuit has been adopted as a goal by governments and business groups around the world.

Sustainable development was articulated as a goal and defined in 1987 by the World Commission on the Environment and Development (World Commission), a body established by the United Nations. In *Our Common Future,* the World Commission defined sustainable development as development which 'meets the needs of the present without compromising the ability of future generations to meet their own needs."

For more than a decade, sustainable development has been at the center of discussion of environmental issues, especially with respect to the effects of increased trade on the environment. Sustainable development was the focus of discussion at the United Nations Conference on the Environment and Development held in Rio de Janeiro in 1992, and it was listed as one of ten goals in the Environmental Side Agreement to the North American Free Trade Agreement (NAFTA), which took effect on January 1, 1994. And in 1996, the ISO incorporated the attainment of sustainable development as a major goal in its new ISO 14000 Series International Environmental Management Standards.

Another impetus for ISO 14000 was the desire of businesses to self-regulate and minimize their exposure to government regulation. Such regulations can be burdensome. For example, in the United States, environmental regulations fill more than 20,000 pages of the *Federal Register,* and there are thousands of additional environmental regulations at the state and local levels.

A third impetus for the ISO 14000 Series Standards came from the United Nations Conference on the Environment and Development (UNCED), which was held in Rio de Janeiro in 1992 and attended by representatives of more than 100 nations. In response to documents issued by UNCED, the international business community adopted a "Business Charter for Sustainable Development." The document includes 16 proposals that set out basic elements for any environmental management system (EMS).

A fourth source of inspiration for development of the standards comes from environmental management programs proposed by groups of concerned citizens around the world. For example, in response to a major oil spill off the coast of Alaska by a ship called the *Exxon Valdez,* a group of environmentalists, investors, government agencies, and economists formed the Coalition for Environmentally Responsible Economies (CERES). The CERES group issued a set of principles that was first known as the Valdez Principles and was later renamed the CERES Principles. The CERES Principles give guidelines designed to lead to an international standard for EMS. CERES has been recognized as a direct impetus for the ISO 14000 series and similar programs.

A fifth impetus for the ISO 14000 series is the need for harmonization among various environmental management and auditing programs. Such harmonization is needed within the United States. For example, the EPA has designed several different environmental management programs, including the XL Program, the Star Track Programs, and the Environmental Leadership Program (ELP). ELP is a voluntary program in which a participating business creates its own EMS according to EPA guidelines. The incentive for participation is that the EPA may treat the company leniently in instances of noncompliance, and, upon certain conditions, the EPA refrains from conducting routine enforcement inspections at the company's facilities. Various state-level counterparts to the EPA have developed similar programs.

In addition, there are industry-specific environmental review programs such as the Chemical Manufacturers Association's (CMA's) Responsible Care program (also known as CARE). All members of the CMA are required to participate in the program, which sets out conformance

standards in the areas of pollution prevention, emergency response, and employee health and safety protection and awareness.

ISO 14000 PROVISIONS.

The initial standards in the 14000 series include numbers 14000, 14001, 14004, 14010, 14011, and 14012. They were developed by ISO Technical Committee (TC) 207 Environmental Management and were adopted by the ISO in 1996.

A company must fulfill the following three requirements to comply with ISO 14000:

1. It must create an environmental management system (EMS).
2. It must demonstrate its compliance with the environmental statutes and regulations of countries in which it does business.
3. It must demonstrate its commitment to continuous improvement in environmental protection and pollution prevention.

ISO 14000 sets up criteria pursuant to which a company's EMS may be certified. The EMS is a set of procedures for assessing compliance with applicable environmental laws. It must also include procedures for assessing the company's own procedures for identifying and resolving environmental problems, and for engaging the company's workforce in a commitment to improved environmental performance.

ISO 14001 describes two types of documents (guidance documents and specification documents), and it sets out standards used to evaluate a company's EMS. For example, the EMS must include an accurate summary of the laws and legal standards with which the company must comply. Applicable laws include federal, state, and local laws. Applicable legal standards include permit stipulations and provisions of administrative or court-certified consent judgments.

To be certified to ISO 14001, the EMS must include five elements. First, it must establish an environmental policy. Second, it must set environmental goals and establish plans to comply with

legal requirements. Third, it must provide for implementation and operation of the policy including training of personnel, communication, and document control. Fourth, it must set up monitoring and measurement devices and an audit procedure to ensure continuing improvement. Finally, it must provide for management review to take place on a regular, planned basis.

The EMS must be certified by a registrar who has been qualified under ISO 13012, which is a standard that predates the ISO 14000 series. If a company chooses not to undergo third-party EMS certification, it may decide to use ISO 14001 as a basis for self-declaration. It is important to note that ISO 14001 is the only standard in the ISO 14000 series that leads to certification. The others support 14001 or provide guidance only.

The ISO 14004 standard gives advice only; compliance with its provisions is not required. It includes five principles, each of which corresponds to one of the five areas of ISO 14001 listed above. First, the company should define its environmental policy and take steps to ensure its commitment to the EMS. Second, the company should develop a written plan to implement its environmental policies. Third, it should provide support mechanisms to implement its environmental policies. Fourth, the company should monitor and evaluate its environmental performance. Fifth, the company should review and revise its EMS periodically with the objective of improving its overall environmental performance.

ISO 14010, 14011, and 14012 are auditing standards. ISO 14010 gives general principles of environmental auditing, and ISO 14011 provides guidelines for auditing of an EMS. ISO 14012 gives guidelines for establishing qualifications for environmental auditors called "registrars."

PLANS FOR ADDITIONAL ISO 14000 STANDARDS.

The ISO is considering various proposals for additions to the ISO 14000 series standards. (Documents providing proposals are designated by the prefix "CD.") CD 14021 gives terms and definitions for use in self-declaration through environmental labeling. The proposed standard has two goals. First, it establishes guidelines for environmental claims made in connection with the

supply of services and goods. Second, it defines specific terms used in environmental claims and provides rules for their use.

Several draft documents address other concerns. CD 14024 provides guidelines, practices, and certification procedures related to environmental labeling. CD 14040 deals with life-cycle assessment of a product. CD 14050 provides a comprehensive set of definitions of terms used in environmental management.

In addition, an ISO working group is reviewing the needs and concerns of small and medium sized enterprises (SMEs). The group is preparing CD 14002 Environmental Management Systems—Guidelines on Special Considerations Affecting Small and Medium Size Enterprises.

DISTINGUISHING ISO 14000 FROM ISO 9000

It is important to note that the ISO issued a separate set of management standards in 1987 called the ISO 9000 series. It is a series of standards designed to lead to quality in design, development, production, inspection, testing, installation, and servicing of products. In short, the standards are designed to promote quality management practices.

The ISO 9000 series and the ISO 14000 standards are process standards, not performance standards. Both series promote management systems that focus on prevention rather than corrective action. But the ISO 14000 series can be distinguished from the 9000 series in at least four major aspects. First, the 9000 series is designed to help an organization maintain quality as it designs, produces, and delivers a product or service to a customer. Thus, it focuses on the customer-supplier relationship. The ISO 14000 series is of concern to various groups of interested parties or "stakeholders." It concerns businesses and their customers as well as government, environmental organizations, consumer groups, and others. Second, the ISO 14000 series involves more strategic planning; it prompts businesses to pursue continuous improvement in their environmental performance. Third, the subject of the 14000 series (environmental protection) is heavily regulated by government through thousands of statutes and regulations. Noncompliance with environmental law can result in

substantial fines or even imprisonment of business managers. Thus, a major goal of the ISO 14000 series is to ensure that businesses are in compliance with their own national and local applicable environmental laws and regulations. Quality of management is less directly tied to law. Fourth, the ISO 14000 series covers a broad area (the environment) and takes a holistic approach to that area, focusing on the business organization's activities and how they affect the land, water, and air. The quality of management area covered by ISO 9000 is more limited.

Certification to ISO 9000 is not a precondition to ISO 14000 certification, but coordination of the two sets of standards has been addressed by the U.S. Technical Advisory Group, which provides advice to the ISO's Technical Committee charged with formulation of the ISO 14000 standards.
Many organizations that are already registered to ISO 9000, however, have decided to seek ISO 14000 registration, also. As they do so, they are seeking ways to integrate ISO 14000 systems into their existing ISO 9000 systems.

PERSPECTIVES OF BUSINESS ON THE ISO 14000 STANDARDS

The benefits and detriments of the ISO 14000 standards depend on the perspectives of the speaker. Therefore, this section looks at the ISO 14000 standards from the perspectives of business organizations, governments, and environmentalists.

BENEFITS TO THE INDIVIDUAL BUSINESS.

ISO 14001 certification may bring various rewards to a company, most of which can ultimately provide a financial advantage to the company. Seven potential rewards are explored below, but this list could be expanded.

First, many firms are hoping that, in return for obtaining ISO 14001 certification (and the actions required to do so), regulatory agencies such as the EPA will give them more favorable treatment. For example, businesses are hoping for less stringent filing, or less monitoring, or even less severe sanctions for violations of environmental laws.

Many state regulatory agencies have suggested that the ISO 14001 certificate may be classified as a voluntary audit program that will, in turn, qualify a business for leniency in filing or monitoring requirements or even, less severe sanctions for violations of environmental regulations.

In a state that has not adopted legislation or policies to provide regulatory relief to businesses that implement an EMS, a business can at least benefit from an enhanced relationship with environmental regulatory agencies and regulated businesses. A cordial and cooperative relationship between the business and regulators can be valuable in many instances.

A second benefit to businesses that choose to become certified to ISO 14001 is that substantial numbers of citizens can be influenced in their buying decisions. Obtaining ISO 14000 certification is a way for companies to demonstrate their environmental stewardship and accountability to the public.

Third, ISO 14000 certification can attract investors to the business organization. A growing number of individual investors as well as investment managers and managers of mutual funds search for environmentally responsible businesses.

Fourth, the company may save money on insurance premiums. For example, some insurance companies give reduced rates on insurance to cover accidental pollution releases if the insured company has successfully implemented an EMS.

Fifth, actions taken in the process of implementing the EMS are likely to reduce the likelihood of toxic spills endangering employees and members of the community.

Sixth, financial institutions are sensitive to environmental risks and their impact on collateral. ISO 14001 may help a corporation obtain loans and protect it from allegations of investor fraud.
Seventh, by implementing an EMS, a company may realize internal cost savings as a result of waste reduction, use of fewer toxic chemicals, reduced energy use, and recycling.

LIMITATIONS OF ISO 14000.

A limitation of the ISO 14000 series is that participants are self-selecting. Because participation is voluntary, it covers only a limited segment of the business community.

A second major limitation of the ISO 14000 series is that it depends on self-enforcement. Thomas Ott, corporate manager for environment, safety, and industrial hygiene with Motorola Corporation, is the U.S. chairperson of the ISO's working group on environmental auditing. He observed, "Having a certificate doesn't mean you have a clean company.… The bad guys who pollute today will still do it, and they'll have a certificate." The successful implementation of an EMS within an individual company will depend substantially on the leadership of the managers of the company. The organization must show its commitment through its statement of policy in the EMS, articulation of goals, and communication of the policy and goals to its personnel. Further, the company must allocate adequate funds for implementation of its goals and for training of personnel.

A related limitation is that the quality of the environmental audit depends on the qualifications and integrity of the registrar who performs the audit. As increased numbers of companies seek certification to ISO 14001, increased numbers of auditors will be needed for initial audits and continuing, periodic audits. Certification of registrars depends on the accrediting body or bodies of individual countries. For example, in the United States, the American National Standards Institute operates as a partner with the U.S. Registrar Accreditation Board (RAB). RAB is a nonprofit organization that accredits ISO 9000 registrars, and many of those same registrars are beginning to provide ISO 14000 audit services. Even with the services of an accreditation board, a company must choose its auditors and other consultants carefully.

A fourth limitation is that certification to ISO 14000 series standards does not serve as a substitute for conformance to environmental management standards that have been adopted by other organizations. For example, the CMA's Responsible Care (RC) program is not as broad as ISO 14001; an organization meeting RC requirements must do more before it can also be certified to ISO 14001. Because membership in the CMA requires conformance with RC, a chemical company may

not wish to undergo the number of audits (and costs) involved in conformance with RC and certification to ISO 14001.

CONCLUSION

The effects of ISO 14000 around the world will vary depending on the needs and perspectives of participating companies, their governments, and individual citizens. In developing countries, adoption of ISO 14000 is likely to lag because of limited resources of developing businesses and their governments. ISO 14000 may even act as a non-tariff barrier to trade for those companies.
The perspectives of companies from developed, industrialized countries such as the United States and the members of the EU are different. Overall, the ISO 14000 series can provide a useful supplement to governmental environmental regulation in such countries. It will cause companies to engage in self-examination and self-correction of many environmental problems. That, in turn, may free government environmental enforcement personnel to concentrate on companies that are not in compliance with environmental law.

Even in industrialized countries with highly developed regulatory systems, however, ISO 14000's reach is limited. It is a voluntary program and, as such, can provide only a supplement to governmental environmental regulation. The effectiveness of ISO in promoting environmental stewardship within individual companies depends on the leadership of the company's managers and the creation of a corporate culture in which environmental management permeates the daily operations of the business in all areas. Further, a company must hire well-qualified consultants and registrars (auditors) as it formulates and implements its EMS. In the end, the success of the ISO 14000 series program depends on qualified, committed people and the allocation of sufficient resources to accomplish the goals identified in the company's EMS.

TOTAL PRODUCTIVE MAINTENANCE

In industry, total productive maintenance (TPM) is a system of maintaining and improving the integrity of production and quality systems through the machines, equipment, processes, and employees that add business value to an organization.

What is TPM?

TPM (Total Productive Maintenance) is a holistic approach to equipment maintenance that strives to achieve perfect production:

- No Breakdowns
- No Small Stops or Slow Running
- No Defects

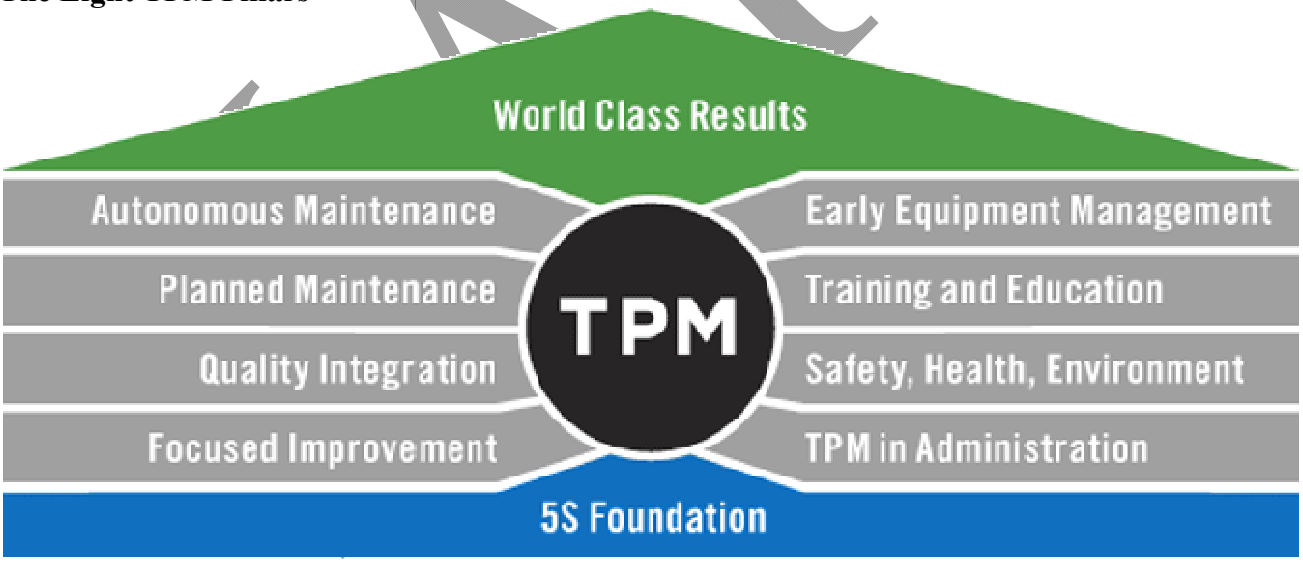
In addition it values a safe working environment:

No Accidents

TPM emphasizes proactive and preventative maintenance to maximize the operational efficiency of equipment. It blurs the distinction between the roles of production and maintenance by placing a strong emphasis on empowering operators to help maintain their equipment.

The implementation of a TPM program creates a shared responsibility for equipment that encourages greater involvement by plant floor workers. In the right environment this can be very effective in improving productivity (increasing up time, reducing cycle times, and eliminating defects).

The Eight TPM Pillars



TPM Pillar 1: Autonomous Maintenance (Jishu Hozen)

Jishu Hozen or Autonomous Maintenance places the responsibility of basic maintenance activities on the hands of the operators and leaves the maintenance staff with more time to attend to more complex maintenance tasks.

Maintenance activities that are carried out by shop floor workers include basic cleaning of machines, lubricating, oiling, and tightening of nuts and bolts, inspection, diagnosis of potential problems and other actions that increase the productive life of machines or equipment.

By carrying out these maintenance activities, the workers become more responsible towards their work and downtime is reduced because there is no need of waiting for maintenance staff as they can correct simple problems that may occur from time to time.

Maintenance staff on the other hand will be more concerned with issues that require a higher technical ability such as replacement and servicing of internal parts. They will also carry out scheduled or planned maintenance which means production will not be interrupted unnecessarily.

Autonomous maintenance has benefits to both the workers and the organization as a whole:

Operators become more responsible and concerned about the condition of equipment they use on a daily basis

Skill levels of workers increase as they gain an understanding of the general working of equipment thus achieving the multi-skilling objective of a lean organization.

Machines operate at their optimal level because basic maintenance such as cleaning and lubrication is carried out more regularly.

Problems are identified and corrected before they go out of control leading to major breakdown of equipment.

Engineering staff are freed-up to carry out higher-level maintenance activities on sensitive and critical equipment thus reducing the overall system downtime.

By carrying out the simple activities in this TPM pillar, capital investments are drastically reduced because the organization has reliable equipment and does not have to replace machines as often. This is because the lifespan of machines is drastically increased as forced deterioration is checked through constant monitoring and maintenance.

TPM Pillar 2: Planned Maintenance

Planned maintenance is the scheduling of maintenance activities based on observed behaviour of machines such as failure rates and breakdowns. By scheduling these activities around such metrics, the cycle of breakdowns and failure is broken thus contributing to a longer service life of machines.

Because there is a specific time for maintaining equipment, production is rarely interrupted as these activities are scheduled around the time when they are idle or are producing very little. In fact, production functions can build up some inventory to allow for the planned maintenance to be carried out as they have prior information of when these activities are scheduled.

This is in contrast to reactive maintenance that waits for problems to occur which has a negative impact on productivity due to machine downtime. Production will never be sure when they will be able to get back to work because the problems are not clear and technicians will just be doing exploratory work to find causes.

There are many obvious benefits of taking the planned maintenance approach as compared to being reactive when technical issues arise:

By constantly scheduling maintenance activities, the number of breakdowns gradually decrease and this then increases the capacity for productive activities

Production functions can continue with their activities uninterrupted because they know exactly when maintenance will take place.

Maintenance is done when the production floor is not very busy

Capital investments in machinery are reduced as the equipment is utilized to its fullest potential

Expensive machine parts do not have to be kept in inventory as there is better control of the various categories of parts.

Pillar 3: Quality Maintenance

This TPM pillar addresses the issue of quality by ensuring equipment is able to detect and prevent errors during production. By detecting errors, processes become reliable enough to produce the right specification the first time.

The quality aspect of maintenance is very important because it helps in preventing defects from moving down the value chain which only leads to a lot of rework.

Using lean tools such autonomation (jidoka) and andon, machines detect and report any abnormal conditions, thereby releasing the operators from the tedious monitoring that is common in non-lean operations.

The quality maintenance pillar of TPM also ingrains in the workforce the habit of finding the root cause of problems instead of rushing to solutions that are not permanent. This is done through tools such as 5 Whys root-cause-analysis and Ishakawa diagrams which are structured ways of getting to the real reasons why problems occur.

Quality maintenance offers a number of advantages including:

Targeted improvement activities address quality issues that arise from time to time in the workplace by coming up with permanent countermeasures

Defects are minimized or completely eliminated

Cost of poor quality is reduced by getting quality right the first time. This happens because errors are caught before they move down the value stream which reduces the amount of rework that has to be done to correct them

Pillar 4: Focused Improvement (Kobetsu Kaizen)

In this pillar, cross-functional teams are assembled with the main working on problematic equipment and coming up with improvement suggestions.

The use of cross-functional teams is important so as to have a large and varied number of employees involved so as to bring in different experience as well as viewpoints to the table.

These teams are better placed to come up with solutions to the issues that arise concerning crucial machines. The kaizen projects for maintenance also serve as training sessions on the total productive maintenance tool which results in the organization having a large pool of skilled personnel.

Once a focussed improvement team for maintenance has been identified and trained, they choose at least one piece of equipment as a pilot for their activities. Problems relating to the equipment are identified and improvement goals set in a three to five day in-house kaizen event.

During the events, the participants map the current state of affairs as a baseline performance measure on which they will compare any future performance after improvement.

The teams work together to make sure that any solutions that they come up with are implemented and any follow-up activities are completed within the agreed timelines.

The focussed improvement pillar of TPM is therefore advantageous as quick gains are made which helps in promoting the lean methodology to workers who may not have bought in to the program.

The organization is able to build-up a large base of employees that are conversant with the right tools for solving problems and getting to the root cause.

Pillar 5: Early Equipment Maintenance

The fifth TPM pillar of Early Management uses the experience gathered from previous maintenance improvement activities to ensure that new machinery reaches its optimal performance much early than usual.

Working with a myriad of stake-holders including suppliers, the company is able to hit the ground running with highly reliable and productive equipment.

Such an approach has a positive impact on profitability of the company as maintenance costs are dramatically reduced.

The productivity as well as output quality of the machines is also guaranteed from the very first day when the equipment is commissioned.

Using the input from the people who use these machines on a daily basis, suppliers of the equipment can improve the maintainability and operability in the next iteration of their products.

Among the factors that should be considered when designing new equipment include:

- Ease of cleaning and inspection
- Ease of lubrication
- Accessibility of equipment parts
- Improving operability of machines through ergonomically placing controls in such a way that they are comfortable to use by operators
- Making it easier for changeover to take place through simplification of procedures or eliminating the unnecessary ones
- Feedback mechanisms that prevent out-of-spec situations as well as clear indications of the correct specifications for quality products
- Increased safety features

Though the machines may be designed and manufactured with all the above considerations in mind, it is still possible that there will be bugs that will need to be removed before full commissioning.

Early management is a system that addresses these concerns and uses input from the staff who will be using the equipment before installation.

Pillar 6: Education and Training

This pillar is concerned with filling the knowledge gap that exists in an organization when it comes to total productive maintenance.

Lack of knowledge in the tools can stand in the way of proper implementation leading to mediocre results at best and failure at worst.

Without proper training, tools such as TPM can be misunderstood by the staff which can result in disastrous results for the company.

Ensuring that employees are trained gives the organization a reliable pool of knowledgeable staff that can drive the initiative competently.

TPM education and training pillar is a company-wide initiative that does not leave out any employee cadre. In fact, all levels in the organization – from the operators to senior managers – get involved in the TPM training as well projects.

Through training, operators' skills levels are raised to the point where they are able to carry-out basic maintenance activities that were previously the preserve of maintenance staff.

The technical staffs are then taught higher level skills such as preventive maintenance and analytical skills to help become more proactive to problem solving.

At the managerial level, managers also learn the TPM skills so as to become competent mentors to their juniors as well as be involved in coaching programs.

Pillar 7: Health, Safety & Environment

That workers must be able to perform their functions in a safe environment devoid of health risks cannot be gainsaid.

The health, safety and environment pillar of total productive maintenance ensures that all workers are provided with an environment that is safe and that all conditions that are harmful to their well-being are eliminated.

While the goal of any organization is to produce value for the customer in an efficient and productive manner, this should be done in a way that is does not put to risk the safety of workers. It is therefore important that any solutions which are put in place should consider the well-being of the worker above all else.

When workers are in a safe environment, their attitude towards work changes dramatically with a resultant increase in important metrics such as productivity. This is because injuries or fatalities reduce when there is a concerted effort to make the workplace an accident-free environment.

The cross-functional teams will work towards making machines safe to use by the operators by putting in place such features as guards, works standards, use of personal protective equipment and first-aid kits in the work-area. Each of these measures are aimed at improving the safety of the machines so as to have a more productive work-force.

Pillar 8: TPM in Office Functions

Taking TPM to the administrative functions is the next logical step in the total productive maintenance program so as to have the whole organization speaking from the same page.

As these are supportive functions, making them understand and apply the principles of lean in their own operations makes it easy for them to provide efficient service to the main value-creating processes.

In addition, spreading the initiative into other functions removes the silo mentality and encourages horizontal cooperation within the workforce. The organization will also benefit by having a larger pool of workers who understand the principles of TPM and can easily be called upon to play a positive role in its implementation.

The TPM principles can also be applied as stand-alone techniques to improve the efficiency of these supportive functions. For example, if the administrative functions are able to improve their order processing procedures, then material will get to the shop-floor in a flawless manner which will have a positive effect on the workflow.

If suppliers are paid on time, they will have the ability to provide the services that they have been contracted to give without any problem.

As we conclude with this pillar, it is important to note that each has its role in the greater scheme of things and should be employed at the appropriate time.

While each TPM pillar has can be applied as a stand-alone component, the aim should be to sequentially implement each of the pillars so as to have get the full benefits of a complete system.

KAHE

The Role of OEE in Total Productive Maintenance:

OEE is a supportive metric that measures how productive a process is against the expected productivity of that process and is a strong component of the TPM program that must be measured at regular intervals.

It is composed of three important metrics that tie in well with the overall objectives of a TPM program as set-out in the introductory part of this article.

The three components of overall equipment effectiveness metric are:

- **Availability-** which is a measure of the percentage of time that a piece of equipment or a process is available for productive work. The goal of this metric to ensure that there are no break-downs and downtime beyond the already planned downtime.
- **Performance** measures how well a process performed against the set targets and exposes any speed losses that may arise during the running of a production process
- **Quality** is a measure of the percentage of good parts that come out of a process against all the parts produced. It is concerned with the defect-rate and the ability of a process to produce good quality the first time without the need for rework

OEE is an important metric as it ties-in well with the objectives of a TPM program that aims at having zero-defects, zero-breakdowns and zero-stops in the production process. A more detailed account of the OEE metric can be found in our page on overall equipment effectiveness.

The tracking of OEE is important because by doing so, one will be able to tell whether the TPM program is working as intended as well as the effect of any improvement activities.

Collection of OEE data is therefore an integral part of the TPM program and can be done either manually or automatically.

Each data collection technique has its advantages but one will notice that an automated OEE data collection strategy can provide even greater benefits.

KAHE

For example, for processes with extremely short cycles, it would be better to employ automatic data collection mechanisms such as computerized metering. This will free up the operator to do their main task as well improve on the accuracy of the data collection activity.

TPM IMPLEMENTATION STEPS

TPM Step one - Piloting

The first step in implementing the program should start with the identification of a pilot area. The importance of this approach is that the program will gain more acceptance and momentum when staff realise the benefits that accrue from its implementation.

Several considerations must be taken into account when choosing the pilot area and these include:

Is it easy to get the "low hanging fruit"? Getting quick gains helps in achieving buy-in from staff who may be reluctant to implement the program because of fear of the unknown. Choosing a simple machine will be good as a starting point as any mistake during the learning process will not lead to any significant damage to the system.

The effect of the improvement on the system will not be as strong as using critical equipment and you will not be able to use the TPM methodology to the fullest. Though this may appear as a disadvantage, it is the safest approach given the critical nature of capital equipment to the organization

Another approach will be to pilot the TPM project on a bottleneck or highly critical equipment. While this approach will have a significant effect on the process if it succeeds, there is the risk that it can cause disruption of the normal processes if done in the wrong way

Choosing the pilot equipment for the TPM project should therefore be a balance between the perceived benefits and the cost of failure. It is always better to start with less critical equipment and then move to the more critical machines as the teams mature and gain competence in the TPM methodology.

To get more acceptance across the organization, it is best practice to begin the TPM journey with the widest base of employees. This gives it the necessary momentum to sustain it into the future as well as to build the right culture that eventually becomes the DNA of the organization.

TPM Step Two – Restore Equipment Back to Basic Condition

Machines and equipment are returned to their basic condition through a thorough 5S program coupled with autonomous maintenance as discussed above. In the 5S project, both operators and technical staff work together to clean and organize the machines by taking into consideration the following points:

Record the current state of the machines by noting any abnormalities such as dust, exposed wires, oily surfaces and poorly organized work area. It is good practice to take "before" photos of the work area as it is so as to serve as a comparison with the state after improvement

Remove any unwanted material from within the vicinity of the machines and put them away in a "red tag" area for decisions to be made on their disposal at a later date

Use visual shadow boards to store the remaining tools, spares and other parts so as to provide an organized way of knowing where everything is or should be. Yellow marking can also be used to mark the position of machines so that it will be easy to know when they are moved

Carryout thorough cleaning of machines and surrounding spaces so as to get rid of dirt and expose any abnormalities that may be hidden from sight.

Record the new state of the machines using photos and use it for training purposes as well as for selling the benefits of the program to present and future staff

Create one-point-lessons for training purpose as well as checklist so as to ensure that the new standards are followed by members of staff

Audit the machines and work area regularly to get a clear picture on whether the agreed standards are being adhered to by the workers. The audits also help you get enough feedback on what needs to be changed or improved upon – an important principle of kaizen continuous improvement methodology

Once the 5S program has been carried-out satisfactorily, the operators and maintenance staff will then begin an autonomous maintenance project.

There should be an agreement as to the technical tasks that can be safely transferred to the operators and if there is need for basic training to bring them up to speed, it should be done before the start of autonomous maintenance.

An autonomous maintenance program will achieve a lot if done correctly and normally takes the following format:

KAHE

Create a machine map with inspection points clearly indicated for ease of reference

Make obscure inspection points more visible by using transparent covers where possible (safety and functionality should be considered)

Visualize the ideal settings of gauges and meters by marking the machines – for example, a pressure gauge can be marked green to show the acceptable reading and red to indicate out-of-spec conditions

Mark the lubrication points and make the lubricating of machines easier through adjustments such as extension of oiling nozzles. This will reduce the downtime associated with such activities as they can now be done with minimal interruption of the production process

Put in place standards for reporting of abnormalities by the operators and encourage a culture of always addressing problems before they get out of control

Create autonomous maintenance standards and checklists that will be used by the operators to check for most important tasks that need to done on machines such as lubrication and inspection points

TPM Step Three – OEE Tracking

On completion of the preparatory steps of 5S and autonomous maintenance, the next logical step is to track the Overall Equipment Effectiveness. This data collection is important so as to identify the biggest causes of downtime on critical machines.

Downtime can be caused by a variety of reasons and it is important for these reasons to be accurately categorized which will help in pinpointing which are the ones that need to be urgently addressed.

While it is quite straight-forward to know which are the causes of downtime, sometimes it will not be easy for operators to immediately or allocate a cause to a breakdown.

In this case, operators can introduce a new category of "not known" to their causes for downtime. This is makes it easy for operators to record data that they are not sure about instead of leaving the data collection form blank.

Data collection must be done over decently long period of time (at least a month) for it to be meaningful enough to be analyzed and for decisions to be made based on the data.

Accuracy is also an important factor during data collection and all efforts should be made to ensure that all shifts give real data.

To achieve this, there has to real time review of data with the aim of correcting any inaccuracies that may arise during its collection.

TPM Step Four – Reduce Major Losses

Using the Kaizen pillar of TPM, major losses are tackled in a systematic process based on the data already collected in the data-collection step.

Addressing the major losses based on the data involves:

- Selecting a cross-functional team from a wide section of the workforce and should comprise of all cadres including operators, technical staff as well supervisors. Another consideration when assembling a cross-functional team is the level of experience and expertise of the team members.
- Data analysis of the major losses as collected from the OEE data. This analysis should look at the main reasons for the losses using tools such as pareto diagrams which rank the causes according to the degree of occurrence
- Root cause analysis of why the losses occurred in the first place. This is done by asking why five or more times until you get to the true cause of the problem. It is only after a thorough root cause analysis has been done should countermeasures be suggested and implemented
- Implementation of suggested solutions within a specified time frame
- Verify effectiveness of the implemented solutions through audits

TPM Step Five – Planned Maintenance

Planned maintenance is a very advanced part of the TPM implementation journey because it happens only after other components have matured enough to be left on their own and any benefits accruing from the programs have been exhausted.

At the heart of this TPM step is to understand the machine parts the wear out the most and reasons for this wearing out. Countermeasures to these causes are then put in place and this includes the use of parts that do not wear out as quickly as the ones replaced.

Documentation of the frequency of failure for machine parts must also be carried out so as to have a clear picture of all the parts that need replacement and how regularly they need replacement.

KAHE

With both the data on the frequency of wearing out and that of failure, a schedule for replacement of these parts is created. This will include the purchasing of the parts in advance and scheduling the downtime in such a way that it has the least effect on production processes.

Replacement data should be collected on an on-going basis to fine-tune the part replacement schedule. This fine-tuning should also take into consideration the parts that require replacement off-schedule and analysis should be done to find out whether there are any emerging issues with the equipment that had not been recognized earlier.

Other TPM Actions

- The other pillars of TPM will be implemented depending on the situation that the organization is facing at the moment and do not necessary have to be implemented all at once.
- For example, early equipment management applies to situations where there has been purchase of new equipment.
- Similarly, a quality maintenance project will be more likely to be implemented when there are major customer issues concerning quality.
- It would also be initiated when there are major deviations of the agreed quality standards within the facility.
- In the same vein, the TPM in the office and Safety, Health & Environment programs will be implemented when there are serious issues concerning them.
- If the accidents within the workplace are way above the standards, there will be more focus on creating safe working conditions.
- These additional steps should be taken one at a time depending on priority and urgency because it not about only implementing a set of programs but it is based more on necessity.

JUST-IN-TIME (JIT)

Introduction

Just-in-time (JIT) is easy to grasp conceptually, everything happens *just-in-time*. For example consider my journey to work this morning, I could have left my house, *just-in-time* to catch a bus to the train station, *just-in-time* to catch the train, *just-in-time* to arrive at my office, *just-in-time* to pick

up my lecture notes, *just-in-time* to walk into this lecture theatre to start the lecture. Conceptually there is no problem about this, however achieving it in practice is likely to be difficult!

So too in a manufacturing operation component parts could conceptually arrive *just-in-time* to be picked up by a worker and used. So we would at a stroke eliminate any inventory of parts, they would simply arrive *just-in-time*! Similarly we could produce finished goods *just-in-time* to be handed to a customer who wants them. So, at a conceptual extreme, JIT has no need for inventory or stock, either of raw materials or work in progress or finished goods.

Obviously any sensible person will appreciate that achieving the conceptual extreme outlined above might well be difficult, or impossible, or extremely expensive, in real-life. However that extreme does illustrate that, perhaps, we could move an existing system towards a system with more of a JIT element than it currently contains. For example, consider a manufacturing process - whilst we might not be able to have a JIT process in terms of handing finished goods to customers, so we would still need some inventory of finished goods, perhaps it might be possible to arrange raw material deliveries so that, for example, materials needed for one day's production arrive at the start of the day and are consumed during the day - effectively reducing/eliminating raw material inventory.

Adopting a JIT system is also sometimes referred to as adopting a **lean production system**.

Ohno regarded waste as a general term including time and resources as well as materials. He identified a **number of sources of was**te that he felt should be eliminated:

- overproduction - waste from producing more than is needed
- time spent waiting - waste such as that associated with a worker being idle whilst waiting for another worker to pass him an item he needs (e.g. such as may occur in a sequential line production process)
- transportation/movement - waste such as that associated with transporting/moving items around a factory
- processing time - waste such as that associated with spending more time than is necessary processing an item on a machine
- inventory - waste associated with keeping stocks
- defects - waste associated with defective items

Japanese terms

There are a number of Japanese terms (words) associated with JIT that you may encounter. I have listed some below for you:

- Andon - trouble lights which immediately signal to the production line that there is a problem to be resolved (typically the line is stopped until the problem is resolved)
- Jikoda - autonomation - enabling machines to be autonomous and able to automatically detect defects
- Muda - waste
- Mura - unevenness
- Muri - excess
- Poka-yoke - "foolproof" machines and methods so as to prevent production mistakes
- Shojinka - a workforce flexible enough to cope with changes in production and using different machines
- Soikufu - thinking creatively, having inventive ideas

JIT philosophy

- elimination of waste in its many forms
- belief that ordering/holding costs can be reduced
- continuous improvement, always striving to improve

Elements of JIT

- regular meetings of the workforce (e.g. daily/weekly)
- discuss work practices, confront and solve problems
- an emphasis on consultation and cooperation (i.e. involving the workforce) rather than confrontation
- modify machinery, e.g. to reduce setup time
- reduce buffer stock
- expose problems, rather than have them covered up
- reveal bad practices
- take away the "security blanket" of stock

Benefits

The benefits of JIT are:

- better quality products

KAHE

- quality the responsibility of every worker, not just quality control inspectors
- reduced scrap and rework
- reduced cycle times
- lower setup times
- smoother production flow
- less inventory, of raw materials, work-in-progress and finished goods
- cost savings
- higher productivity
- higher worker participation
- more skilled workforce, able and willing to switch roles
- reduced space requirements
- improved relationships with suppliers

Characteristics of JIT:

1. People Involvement
2. Team work
3. Discipline
4. TQM
5. Pull method of material flow
6. Small lot sizes
7. Short setup time
8. Standardized components and work methods
9. Close supplier ties
10. Flexible work force
11. Product focus
12. Automated Production

Principles of JIT

1. The elimination of waste: Waste in a system can perpetuate errors and problems and so the first principle is to eliminate the waste, highlight the problem and then resolve them.

KAHE

2. Total Quality Control: It leads to the elimination of waste by eliminating defects. However, within the JIT environment, the aim is not to detect defects but to prevent them occurring in the first place by tracing any problem back to their source.
3. Total Employee involvement: This principle requires that management provide leadership which leads to employees willing to be involved in what is happening. Give opportunity and encouragement which includes providing education and training, using teams at work.

Push/Pull Production:

1. Produce on Demand (Pull System)
2. Produce to forecasts of demand or make to stock (Push System)

KANBAN:--

- KANBAN is Japanese word for card.
- It is a Pull system
- KANBAN system is a kind of production system.
- It operates based on the information contained in cards- "KANBANS"

  (1) Withdrawal KANBAN (2) Production order KANBAN
- Production process- Preceding process & Succeeding process.
- Withdrawal KANBAN- Infortmation on how much materials (raw materials/semi finished goods) the succeeding process should withdarw.
- Production order KANBAN- Information on how much quantity the preceding process should produce.
- It prevent ***over production*** by ensuring that each stage of a process produces only as much as the next stage needs.
- Problems easily identified & make corrective action.

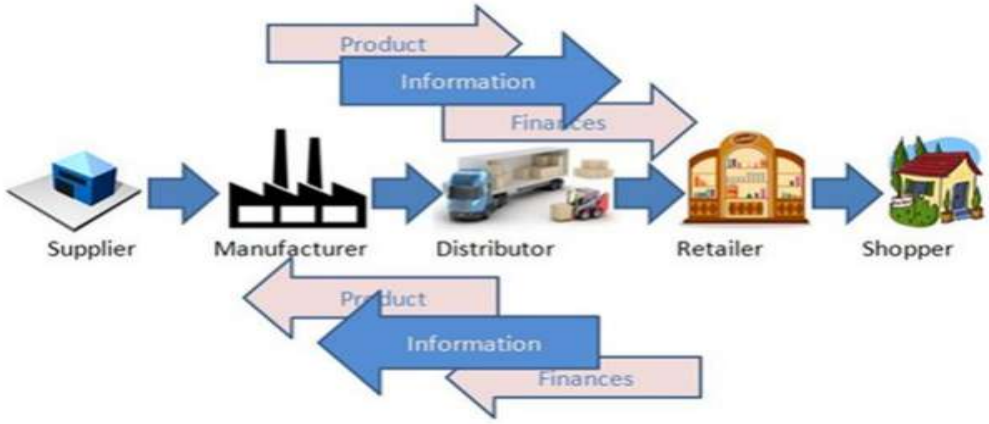
Six Rules for an Effective Kanban System

1. Customer (downstream) processes withdraw items in the precise amounts specified by the KANBAN.
2. Supplier (upstream) produces items in the precise amounts and sequences specified by the KANBAN.
3. No items are made or moved without a KANBAN.

4. A KANBAN should accompany each item, every time.
5. Defects and incorrect amounts are never sent to the next downstream process.
6. The number of KANBANS is reduced carefully to lower inventories and to reveal problems.

SUPPLY CHAIN MANAGEMENT

Supply Chain Management can be defined as the management of flow of products and services, which begins from the origin of products and ends at the product's consumption. It also comprises movement and storage of raw materials that are involved in work in progress, inventory and fully furnished goods. The main objective of supply chain management is to monitor and relate production, distribution, and shipment of products and services. This can be done by companies with a very good and tight hold over internal inventories, production, distribution, internal productions and sales.



In the above figure, we can see the flow of goods, services and information from the producer to the consumer. The picture depicts the movement of a product from the producer to the manufacturer, who forwards it to the distributor for shipment. The distributor in turn ships it to the wholesaler or retailer, who further distributes the products to various shops from where the customers can easily get the product. Supply chain management basically merges the supply and demand management. It uses different strategies and approaches to view the entire chain and work efficiently at each and every step involved in the chain. Every unit that participates in the process must aim to minimize the costs and help the companies to improve their long term performance, while also creating value for its stakeholders and customers. This process can also minimize the rates by eradicating the unnecessary expenses, movements and handling. Here we need to note that supply chain management and supply

chain event management are two different topics to consider. The Supply Chain Event Management considers the factors that may interrupt the flow of an effective supply chain; possible scenarios are considered and accordingly, solutions are devised for them.

Supply Chain Management Goals

Every firm strives to match supply with demand in a timely fashion with the most efficient use of resources. Here are some of the important goals of supply chain management:

- Supply chain partners work collaboratively at different levels to maximize resource productivity, construct standardized processes, remove duplicate efforts and minimize inventory levels.
- Minimization of supply chain expenses is very essential, especially when there are economic uncertainties in companies regarding their wish to conserve capital.
- Cost efficient and cheap products are necessary, but supply chain managers need to concentrate on value creation for their customers.
- Exceeding the customers' expectations on a regular basis is the best way to satisfy them. Increased expectations of clients for higher product variety, customized goods, off-season availability of inventory and rapid fulfillment at a cost comparable to in-store offerings should be matched.
- To meet consumer expectations, merchants need to leverage inventory as a shared resource and utilize the distributed order management technology to complete orders from the optimal node in the supply chain.
- Lastly, supply chain management aims at contributing to the financial success of an enterprise. In addition to all the points highlighted above, it aims at leading enterprises using the supply chain to improve differentiation, increase sales, and penetrate new markets. The objective is to drive competitive benefit and shareholder value.

SCM Integration

Supply chain integration can be defined as a close calibration and collaboration within a supply chain, mostly with the application of shared management information systems. A supply chain is made from all parties that participate in the completion of a purchase, like the resources, raw materials, manufacturing of the product, shipping of completed products and facilitating services. There are different levels of supply chain integration. We will understand this with

the help of an example of a computer manufacturing company. The initial step in integration shall include choosing precise merchants to supply certain inputs and ensuring compliance for them for supplying certain amount of inputs within the year at a set cost. This assures that the company has the appropriate materials required to produce the expected output of computers during the year. In the meanwhile, this computer company may sign a bond with a large supplier of circuit boards; the bond expects it to deliver a precise quantity at precise times within a year and fix a price that will be effective during the bond year. If we move to a higher level, the next step would be to integrate the companies more closely. The circuit board supplier may construct a plant close to the assembly plant and may also share production software. Hence, the circuit board company would be able to see how many boards are required in the upcoming month and can construct them in time, as the company requires them in order to meet its sales demand. Further higher level is referred as vertical integration. This level starts when the supply chain of a company is actually owned by the company itself. Here, a computer company may buy the circuit board company just to ensure a devoted supply of elements.

Push System

- In a push-based supply chain, the goods are pushed with the help of a medium, from the source point, e.g., the production site, to the retailer, e.g., the destination site. The production level is set in accordance with the previous ordering patterns by the manufacturer. A push-based supply chain is time consuming when it has to respond to fluctuations in demand, which can result in overstocking or bottlenecks and delays, unacceptable service levels and product obsolescence. This system is based on the deliberation of customer's demand. It tries to push as many products into the market as possible. As a result, the production is time consuming because the producer and the retailer struggle to react to the changes in the market. Forecast or prediction plays an important role in the push system. Optimum level of products can be produced through long term prediction. This deliberative nature of the push system leads to high production cost, high inventory cost as well as high shipment cost due to the company's desire to halt products at every stage. Thus, in the push view of supply chain integration, the manager of a firm may sometimes fail to satisfy or cope with the fluctuating demand pattern. This system leads to high inventory and high size of batches.

Pull System

- The pull-based supply chain is based on demand-driven techniques; the procurement, production and distribution are demand-driven rather than predicting. This system doesn't always follow the make-to-order production. For example, Toyota Motors Manufacturing produces products yet do not religiously produce to order. They follow the supermarket model. According to this model, limited inventory is kept and piled up as it is consumed. Talking about Toyota, Kanban cards are used to hint at the requirement of piling up inventory. In this system, the demand is real and the company responds to the customer demands. It assists the company in producing the exact amount of products demanded by the clients. The major drawback in this system is that in case the demand exceeds than the amount of products manufactured, then the company fails to meet the customer demand, which in turn leads to loss of opportunity cost. Basically in the pull system, the total time allotted for manufacturing of products is not sufficient. The production unit and distribution unit of the company rely on the demand. From this point of view, we can say that the company has a reactive supply chain. Thus, it has less inventories as well as variability. It minimizes the lead time in the complete process. The biggest drawback in pull based supply chain integration is that it can't minimize the price by ranking up the production and operations.

Differences in Push and Pull System:

- The major differences between push and pull view in supply chain are as follows:
- In the push system, the implementation begins in anticipation of customer order whereas in the pull system, the implementation starts as a result of customer's order.
- In the push system, there is an uncertainty in demand whereas in pull system, the demand remains certain.
- The push system is a speculative process whereas the pull system is a reactive process. The level of complexity is high in the push system whereas it is low in the pull system.
- The push based system concentrates on resources allocation whereas the pull system stresses on responsiveness.
- The push system has a long lead time whereas the pull system has a short lead time. The push system assists in supply chain planning whereas the pull system facilitates in order completion.

Demand-Driven Strategies

- The demand-driven strategies were first developed to understand the impact of inactivity and collection, as information fertilizes the supply chain from the source of demand to the suppliers. Within a mentioned supply lead time, normally the manufacturers manufacture sufficient goods to satisfy the needs of their clients predicted. But this is only somewhat accurate at the granular level at which inventory decisions are made. Anyways, when the actual demand varies from the demand predicted, the first thing to be done is to adjust the supply levels needed in accordance with each step of the supply chain. But because of time delay between changing demands and its detection at several at points along the supply chain, its impact is amplified, resulting in inventory shortages or excesses. The inventory levels of the companies are disturbed because of the overcompensation done by the companies either by slowing down or speeding up production. These fluctuations prove to be a costly and inefficient affair for all participants. Basically, the demand-driven strategies or the demand-driven supply chain is completely based on the demand as well as the supply part of marketing. So it can be uniquely organized in terms of the demand side and supply side initiatives. The demand-side initiatives concentrate on efficient methods to acquire the demand signal closer to the source, observe the demand to sense the latest and most accurate demand signal and shape the demand by implementing and following promotional and pricing strategies to gear up demand in accordance with business objectives. On the other hand, the supply side initiatives mostly need to do with reducing reliance on the prediction by developing into an agile supply chain accompanied by faster response when absolute demand is known. All the strategies discussed above are addressed under the demand-driven strategy, but we a company following all of them is rare. In fact, we can conclude that companies concentrate on different markets on the basis of features of the market and industry.

KAHE

Part B- 2 Marks

1. Define Quality Control.
2. What is acceptance sampling?
3. What is ISO 14000?
4. Define TQM.
5. Define the Concept of Six Sigma?
6. What is Quality Assurance?
7. Define the concept of Operating Characteristic curve.
8. What is Type I and Type II error?
9. What is Quality Circle?
10. What do you mean by ISO?

Part C- 5 Marks

1. Explain the concept of SQC and the various QC charts in detail.
2. Explain the concept of TQM with the contributions of Quality guru's in detail.
3. Explain the importance of ISO in today's competitive environment.
4. Explain the concept of Six Sigma and its implementation procedure in detail.
5. What is Statistical Process Control? What are the type I and type II errors?
6. Elucidate the various types of certification in ISO 9000?
7. Explain the Taguchi's concept of cost of variability.
8. Why is an ISO 9000 certification important to a firm? What are the advantages to the firm? Explain.
9. Are Quality and creative product design inimical to each other? Discuss.
10. The following data are obtained from an automatic filling process of certain chemical delivered into each container. The specification of the mass delivered is 50±4 grams. Samples of 5 are taken from 10 successive samples are shown in Table 3.5

	Samples									
Observation	1	2	3	4	5	6	7	8	9	10

KAHE

	51	52	51	48	53	51	52	54	53	50
	50	53	52	49	49	49	53	52	53	52
	52	52	52	52	49	49	47	51	52	52
	49	54	51	49	54	50	52	53	54	53

—

(a) Determine the control limits for X and R Charts.

(b) Plot the Charts and Comment on the process.

(c) Does it appear that the machine is capable of meeting the specification requirements?

KAHE

Part D Case Study 10 Marks

Harley-Davidson Motorcycle Company was established in the year 1903. It soon became a leading manufacturer of motorbikes in the US and the neighboring countries After World War II, Harley- had a monopoly in the motorbikes market due to the closure of its main rivals. It was easy, therefore, for the company to increase its market share and production, but the quality of the product became a secondary consideration. The problems for Harley-Davidson started only when Honda entered the US market and started to cut into its market share. Using the total quality management. Principles of Edward Deming, Honda's products were Davidson increasingly better in terms of quality at a time when Harley-Davidson's products were low on the quality front. By 1981, Honda almost pushed Harley- Davidson to the verge of closure.

The management of Harley-Davidson was wondering how Honda was able to manufacture motorbikes much better in quality and at a much lesser cost compared to its products. Initially it attributed this to the cheap Japanese labour, huge advertising budgets, and dumping practices on part of Honda. Over a period of time/ Harley officials found the three real reasons for Honda's success— *kaizen,* Just-in-Time (JIT)/ and extensive use of statistical methods to measure quality. Using JIT, Honda was turning its inventory 20-30 times a year compared to Harley-Davidson and other American companies at that time/ who were turning their inventory only four times a year. Harley

had by now understood how fewer inventory turns affect product cost and quality. Earlier in 1978, it had tried to implement the *quality circles* concept in its organization, but could not sustain it for a long time, in complete contrast to *kaizen's* continuous improvement concept evolved and successfully implemented by Japanese companies.

The top management of Harley-Davidson was very conscious of *employee involvement* programmes having had a bad experience with *quality circles.* They did not want to thrust upon their workers various types of programmes for inventory reduction, quality improvement, work methods improvement/ cost reduction/ etc. simultaneously leading to confusion**.** Instead, they focused on a single most important agenda—quality. They felt that this umbrella term contained in an implicit way all the other improvement programmes. This simple goal of achieving quality in all the spheres of activity was something which every worker could relate to easily. Improving quality in everything you do gives a sense of pride and commitment. Harley-Davidson's managers were so focused on their goal of quality that they were not opposed to making investments in order to improve the quality of their product, if new equipment could increase productivity and quality in addition to fostering a climate of continuous improvement, the company would go for it even without financial justification. Another important decision on the part of Harley-Davidson officials was not to send rigid rules and regulations to their multiple facilities with diverse manufacturing environments. It was felt that doing so will kilt employee participation in the quality initiative. The management provided the plant managers only with the direction in which the company was willing to go and told them the principles and concepts to be applied, but gave them the freedom to do it in their own way. This was a drastic shift from the white-collar and blue-collar discrimination existing in American companies at that time.

A typical example of this radical change in the thinking of top management can be demonstrated with an example of the company's plant at York. The company wanted to have the paint facility enclosed at the plant to keep it cleaner and have proper lighting. The employees made the designs of the enclosures themselves and asked the management if they could choose the colour of its walls. The usual response would have been that we have to follow the standard colour scheme, but the management responded with consent to the workers' request. This resulted in a clear demonstration of the management's commitment to change and the workers reciprocated in the same way.

Harley-Davidson started the employee involvement group (EIG) in order to solve quality problems- It was the same *quality circles* programme which was a disaster earlier. This time the company gave workers the liberty to choose a suitable name for the concept. The employees at the Milwaukee engine plant opted for ‘quality circles', while the York assembly plant workers decided to call this as 'employee involvement groups'. Now, the company has a full-fledged employee involvement programme, in which the company formally trains employees in problem solving, though participation is voluntary. Harley-Davidson does not quantify the cost benefits as a result of these EIGs**,** as it does not want to shift the company's focus from quality to cost reduction. Harley's turnaround has been highlighted in a big way in terms of its financial recovery and manufacturing improvements, though what is not reported is the vision of Harley-Davidson in promoting employee involvement (Nimwegen & Kleiner 2000).

1. Is it right on the part of Harley-Davidson to focus only on quality improvement by even overlooking cost considerations?
2. Up to what extent has Harley-Davidson been? Successful in the international and domestic US market compared to Honda according to you?
3. Is the EIG a unique innovation of Harley-Davidson?

KAHE

KARPAGAM ACADEMY OF HIGHER EDUCATION						
Department of Management						
Unit 5- TQM , JIT and Supply Chain-Multiple Choice Questions- Each Question Carry ONE Mark						
S.NO	**Question**	**Option 1**	**Option 2**	**Option 3**	**Option 4**	**Answer**
1	The major decision areas in supply chain management are……..	location, production, distribution, inventory	planning, production, distribution, inventory	location, production, scheduling, inventory	location, production, distribution, marketing	location, production, distribution, inventory
2	A part or small selection from the population is…….	Sampling	Parameter	Sample	Universe	Sample
3	Features, service, response and aesthetics are……..	Quality costs	Dimensions of quality	Quality functions	Quality planning statement	Dimensions of quality
4	Planning, preparation, training costs are	Prevention costs	Appraisal cost	Internal cost	External cost	Prevention costs
5	Quality costs include	Cost of prevention, apprisal, internal and external failure cost	Cost of approval	Cost of external and internal failures	Prevention cost	Cost of prevention, apprisal, internal and external failure cost
6	The word aesthetics means…….	Quality of the product	Exterior finish of the product	Life of the product	Failure of the product	Exterior finish of the product

7	Who is not related to triple role concept?	Customer	Supplier	Processor	Manager	Manager
8	-------- was awarded annually to firms that distinguish themselves with quality.	Juran prize	Deming prize	Kaizen prize	Keller prize	Deming prize
9	Cost of down time, cost of appraisal and rework are……..	Cost of prevention	Cost of appraisal	Cost of internal failures	Cost of external failure	Cost of internal failures
10	Cost of warranty claims and commissioning failures are coming under…….	Cost of prevention	Cost of appraisal	Cost of internal failures	Cost of external failure	Cost of external failure
11	Most commonly used analysis technical for quality is……..	Trend analysis	Pareto analysis	Economic analysis	Juran Triology	Trend analysis & pareto analysis
12	Widely used quality definition is……	Quality is conformance to requirements	Quality is fitness for use	Quality is in its essence ,a way of managing the organization	Quality is correcting and preventing loss	Quality is conformance to requirements

13	Strategic planning sets the…….	Short term direction	Medium term direction	Long term direction	Over all objective	Long term direction
14	Durability, reliability, aesthetics are called……	Quality planning	Dimensions of quality	Quality costs	Price	Dimensions of quality
15	The meaning of down time is……..	Not able to do the work because of the machine breakdown	Time wasted while waiting for the people	Lead time	Working time	Not able to do the work
16	Non measurable attributes are……..	Skills	Product	Productivity	Quantity	Skills
17	Which of the following is NOT consistent with the concept of TQM?	organizational leadership	quality control departments	continuous improvements	customer focus	quality control departments
18	Training ,planning , auditing are coming under……	Conformance quality costs	Non-conformance quality costs	Quality planning	Dimensions of quality	Conformance quality costs

19	Waiting ,downtime are called……	Conformance quality costs	Non-conformance quality costs	Optimum cost	Total cost	Non-conformance quality costs
20	Quality is a judgment by a……..	Customers	Suppliers	Distributors	Agents	Customers
21	Conformance quality costs include…….	Training	Waiting	Inspection	Training and inspection	Trainint and inspection
22	Which of the following is a conformance quality costs?	Scrap	Documentation	Rework	Waiting	Documentation
23	Which of the following is a non-conformance quality costs?	Training	Inspection	Down time	Documentation	Down time
24	How many analysis techniques are there for quality costs?	5	4	3	2	2

25	Non-conformance quality costs include……..	Rework	Inspection	Scrap	Rework and scarp	Rework and scrap
26	Rework, redesign, modification costs are…….	Prevention costs	Appraisal cost	Internal failure cost	External failure cost	Internal failure cost
27	Equipment failure, downtime costs are called……..	Prevention costs	Appraisal cost	Internal failure cost	External failure cost	External failure cost
28	Institute leadership and institute training comes under……	TQM pillars	Quality statements	Deming's statement	Leadership	Deming's statement
29	Audit, calibration, test and measurement costs are……..	Prevention costs	Appraisal cost	Internal cost	External cost	Appraisal cost
30	A structured tool, usually industry or activity specific, used to verify that a set of required steps has been performed is called…….	Quality Policy	Check list	Trend analysis	Pareto diagram	Check list

31	Quality chain reaction is popularly known as……	China chain reaction	Japanese chain reaction	American chain reaction	England chain reaction	Japanese chain reaction
32	---------- is an art	Quality	Chart	Standard	Measurement	Quality
33	Quality can be quantified as	Q= P/E	Q= E/P	Q= R/E	Q= P/R	Q= P/E
34	A product is the ---------- of any process	Input	Output	Transform	Feedback	Output
35	The needs are which customer specifies for procurement……..	Stated	Implied	Explicit	Implicit	Stated
36	The state of affairs in which customers feel that their expectations have been met…….	Customer satisfaction	Customer retention	Customer dissatisfaction	Customer motivation	Customer satisfaction

37	Which refers to quality of design……..	Product characteristics	Product features	Product design	Product shape	Product features
38	An operator who periodically measures some aspect of ongoing production and plots the results on a control chart is most likely using:……	Statistical quality control.	Statistical process control.	The zero-defects approach	The just in time approach.	Statistical process control.
39	Reaction time of the service refers to……..	Responsiveness	Empathy	Reliability	Assurance	Responsiveness
40	Which refers to service look or feel?	Intangibles	Tangibles	Quality	Quantity	Tangibles
41	The art of managing to achieving excellence is……..	TQM	Quality assurance	Quality council	Quality standard	Tqm
42	TQM is used to improve the whole……..	Organization	Department	Division	Process	Organization

43	How many pillars are there in TQM house…….	2	3	4	5	4
44	PDSA cycle is also known as…….	Juran cycle	Deming cycle	PDSA cycle	Kaizen cycle	Deming cycle
45	PDSA cycle was actually developed by……..	Shewhart	Deming	Juran	Kaizen	Shewhart
46	Which both charts are quite same?	P and C chart	P and np chart	P and U chart	np and U chart	P and np chart
47	Matrix diagram is also called as……..	Quality table	Quality standard	Quantity table	Quality chart	Quantity table
48	Cause and effect diagram is called as…….	Fish diagram	Fishbone diagram	Arrow diagram	Matrix diagram	Fishbone diagram

49	Qualitative characteristics of data known as……	variables	Information	Attributes	Mean	Attributes
50	Natural probability limits are also called as……	Process Capability limits	Zero defects	Supervision	Process review	Process capability limits
51	……...require a measurement of the quality characteristics of interest	Control charts for attributes	Control charts for variables	Scatter diagram	Histogram	control charts for variables
52	Application of control chart in ambulance…….	Insurance clime accuracy	Billing accuracy	Response time	Sorting accuracy	Response time
53	Just-in-time (JIT) does NOT include which one of the following?	Fast-throughput manufacturing	Lean manufacturing	High inventory production	Batch sizes of one	High inventory production
54	Basic just-in-time techniques do NOT include…….	Line-stop authority	Flexibility	Quality of working life (QWL)	Market research	Market research

55	Visibility measures used in just-in-time (JIT) would NOT include:……..	Displays showing improvement techniques and checklists.	Hidden TV cameras to monitor individual staff at work.	Visual control items such as kanban.	Samples of competitor's products, including good and defective items	Hidden TV cameras to monitor individual staff at work.
56	Which one of the following items is not part of the fundamental JIT concept?	Right quantities	Right time	Right customer	Right place	Right customer
57	Just-in-Time was successfully implemented by……	Toyota	Honda	Suzuki	Volkswagen	Toyota
58	POK stands for……	Product ordering Kanban	Process Ordering Kanban	Production Ordering Kanban	Plan Ordering Kanban	Production Ordering Kanban
59	The sequence of a typical manufacturing supply chain is…….	Storage–Supplier–manufacturing–storage–distributor–retailer–customer	Supplier–Storage-manufacturing–storage–distributor–retailer–customer	Supplier–Storage-manufacturing–distributor–storage–retailer–customer	Supplier–Storage-manufacturing–storage–retailer–distributor–customer	Supplier–Storage-manufacturing–storage–distributor–retailer–customer
60	The purpose of supply chain management is……	provide customer satisfaction	improve quality of a product	integrating supply and demand management	increase production	integrating supply and demand management

Register No.: …….

[18MBAP201]

KARPAGAM ACADEMY OF HIGHER EDUCATION

(Deemed to be University)

(Established under Section 3 of UGC Act, 1956)

(For the candidates admitted from 2018 onwards)

CONTINUOUS INTERNAL ASSESSMENT-I, FEBRUARY - 2019

MASTER OF BUSINESS ADMINISTRATION

SECOND SEMESTER

PRODUCTION AND OPERATIONS MANAGEMENT

Time: 2 Hours **Maximum: 50 Marks**

Date: **Session :**

Part-A (15×1=15 Marks)

Answer All the Questions

1. A strategy which aims to produce a perfect product which will suit everybody is called……..

   a. Product orientation b. Marketing orientation

   c. Production orientation d. Perfect orientation

2. A strategy which aims to produce the maximum amount of goods at the lowest possible price is called……

   a. Production orientation b. Selling orientation

   c. Societal marketing d. Cost orientation

3. Someone who has responsibility for marketing decisions concerning a group of products is……

   a. a product manager b. a brand manager

   c. a sales manager d. a marketing manager

4. Which of the following is true?

   a. Value is always lower than price b. Value is what consumers are prepared to pay

   c. Cost is always lower than price d. Price is always lower than value

5. For corporate banking, which of the following are likely to be key internal performance objectives?

   a. Flexibility, cost, speed b. Flexibility, quality, dependability

   c. Dependability, speed, cost d. Speed, cost, quality

6. Product layout is preferably used for ……...

   a. Repetitive processing b. Intermittent processing

   c. Quantitative processing d. Qualitative Processing

7. The most significant advantage of U-shaped layout is……

   a. Cost minimization b. Easy handling of process

   c. Increased flexibility in work d. Profit maximization

8. MRP stands for…….

   a. Materials Requirements Planning b. Management Reaction Planning

   c. Master Resources Planning d. Manufacturing Resource Planning

9. Which of these layouts is most suitable for processing sugar from sugar beets or sugar cane?

a. Process-oriented layout b. Fixed-position layout

c. Focused factory d. Product-oriented layout

10. Compute the required cycle time for a process that operates 8 hours daily with a required output of 300 units per day?

a. 0.625 minutes b. 1.6 minutes c. 37.5 minutes d. 0.027 minutes

11. Which of the following is not a priority rule for job sequencing?

a. Shortest processing time b. Minimum slack time remaining

c. Last come, randomly served d. Critical ratio

12. The first hour principle is best used when……..:

a. Scheduling two jobs on one machine

b. Scheduling n jobs on two machines

c. Applying input/output control

d. Scheduling personnel in the service industry with changing hourly requirements

13. Which of the following is not a part of Five M's?

a. Material b. Machine c. Motion d. Methods

14. The correct sequence of operations in production planning and control is……

a. Routing-Scheduling-Dispatching-Follow up

b. Scheduling-Routing- Dispatching-Follow up

c. Dispatching-Routing-Scheduling- Follow up

d. Routing-Scheduling-Follow up-Dispatching

15. Loading may be defined as……..

a. Sending the raw material to the machine b. Sending the finished material to the store

c. Assign the work to the facilities d. Uploading a software in machine control panel

Part-B (3×8=24 Marks)

Answer All the Questions

16. a. Define Production and operations Management. Explain its Importance.

(OR)

b. Illustrate the system concept of Production.

17. a. Explain the factors affecting the plant location decision in detail.

(OR)

b. 120 Pizzas are to be produced per night. Tasty Restaurant works from 16.00 hrs to 01.00 hrs. Given the following set of tasks and their relationship may a balanced the assembly line. Calculate the Cycle time, idle time, number of work station and balanced efficiency.

Task	A	B	C	D	E	F
Immediate Predecessors Task	-	A	A	B,C	D	E
Duration (Hrs)	2	1	2	3	3	3

18. a. List and briefly discuss different phases of Production planning and control.

(OR)

b. Explain various Aggregate Planning strategies?

Part-C (1×11=11 Marks)

Case Study (Compulsory)

19. Busy Monday morning, Rahul Bhai was getting ready to go to Office in Kochi. Thirty years, old Rahul Bhai purchased a Honda City car from ABC dealer in Trivandrum on 2008. He could not start his car due to overnight rain. After some moments, he started his car. He was rushing up to go to office. On the middle of the road, the car got jump started. He was annoyed with his car's performance.

The Manufacturers and dealers offer variety of services for their products like arranging car loan, five years warranty period, assisting Insurance and Roadside Assistance Programme etc. They are charging a considerable amount of money for their services. Particularly, Roadside Assistance Programme which means whenever car breaks down, the battery failure, more smoke comes from silencer or carelessly locked door. In such an emergency case, the customer can make a call the toll free number provided and help will arrive at your location. If car cannot be fixed immediately, some programmes offer to tow it to the nearest service station and find accommodation or a replacement car for customer in the mean time. If car is new, the manufacturer or dealer has given you the option of registering for a Roadside Assistance Programme at the time of purchase.

Companies like Volkswagen offers Roadside Assistance Programme free of cost during the two year warranty period. Honda offers five year warranty period. They charge for Roadside Assistance Programme, 1750/-INR for the first year of service, 2900/- INR in th second, 3700/-INR in the third, 4600/-INR in the fourth and 6000/-INR in the fifth year. Compare to Chevrolet too has a subscription fee 1000/- INR during the first year or 2700/-INR for a three year programme. After warranty period, they charge a flat 1350/-INR per year.

If customers purchase second hand vehicle, the manufacturer or dealer unlikely to give you the benefit of Roadside Assistance Programme. In addition, Manufacturer would not be willing to extend such services after the warranty period. Further, the signing up of the Roadside Assistance programme is quite complicated with most manufacturers including details of dealership customer purchased the vehicle from and vehicle identification number that establishes that the automobiles qualifies for the programme.

However, third party enter into the Roadside Assistance Programme, companies like Crossroads India Assistance (CRIA), Carzcare and MyTVS. They provide similar services offered by manufacturers or dealers. In addition, they can also save you money on services such as towing your vehicle in case of a breakdown that cannot be rectified on spot. Most service providers offering concessional rates on this facility. The major drawbacks of some of third parties restrict their services to certain territories. For example, CRIA provides RoadSide Assistance programme only in 23 cities in Country. MyTVS assures customers of assistance anywhere in India, barring J&K and the North East.

Also, Roadside Assistance Programme cap the number of free services customer can entitles to in a year. If car breaks down frequently, it's probably best to junk it! Third parties' service cost is less than obtaining similar kit from manufacturer or dealer after vehicle has crossed a certain age. For example CRIA start at 799/- plan in New Delhi/NCR, My TVS' Basic gold membership plan 1250/- per year.

Questions:

1. As an Operation Manager of a Third Party Company, What operations Strategy should focus for increasing customer satisfaction?
2. Recommend What Competitive Priorities, Manufacturers and dealers should highlights in their operations.

Reg. No.....

[17MBAP201]

KARPAGAM ACADEMY OF HIGHER EDUCATION

(Deemed to be University Established Under Section 3 of UGC Act 1956)
Pollachi Main Road, Eachanari Post, Coimbatore – 641 021.
(For the candidates admitted from 2017 onwards)

MBA DEGREE EXAMINATION, APRIL 2018

Second Semester

BUSINESS ADMINISTRATION

OPERATIONS MANAGEMENT

Time: 3 hours Maximum : 60 marks

PART – A (20 x 1 = 20 Marks) (30 Minutes)
(Question Nos. 1 to 20 Online Examinations)

PART B (5 x 2 = 10 Marks) (2 ½ Hours)
Answer ALL the Questions

21. Give the meaning of Operations Management.
22. What do you mean by facility location?
23. List any two merits of ERP.
24. Define Value Analysis.
25. Give your understanding on 'Quality Circles'.

PART C (4 x 5 = 20 Marks)
Answer ALL the Questions

26. a. Give the functions of Operations Management.

Or

b. Present the types of Production systems.

27. a. What is Product Layout? What is Process Layout?

Or

b. Spell out the advantages of Product Layout.

28. a. What are the determinants of effective capacity planning?

Or

b. Write down the functions of Master Production Schedule.

29. a. Find out the types of inventory.

Or

b. Outline the benefits of Six Sigma.

PART D (1 x 10 = 10 Marks)
CASE STUDY (Compulsory)

30. Product Development Risks

You have the opportunity to invest INR 100 billion for your company to develop a jet engine for commercial aircrafts. Development will span 5 years. The final product costing Rs. 500 million / unit could reach a sales potential, eventually of Rs.2500 billion. The new engine can be placed in service 5 years from now, but only if it qualifies four years from now for certification clearing commercial use and only if it meets America's Federal Aviation Administration's (FAA) even tightening standards for noise reduction. Certification also has to be obtained from India's Director General of Civil Aviation (DGCA). There is competition from world-class manufacturers like Pratt and Whitney and Rolls Royce who are developing competing engines. If you decide to proceed with the project, you must also determine where the new engines will be produced and develop the manufacturing facilities. If you decline to proceed, your company could invest its resources elsewhere and based on its track record, get attractive returns.

i. What would be your line of action?
ii. In case of lengthy product design and development time, what kinds of risks are there?
