UNIT-I Introduction to Production and Operations Management:
Introduction, Objectives, Scope and Differences among Production and Operations Management. Historical evolution of Production and Operations Management. Characteristics of Modern Operation functions. Recent trends in Production and Operations Management. Operations Management interaction with other functional areas of management. The transformation Process: Manufacturing. Service and Hybrid Agile Manufacturing.

UNIT-II Operations Planning:
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UNIT-III Designing and Managing Operational systems:
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UNIT-I INTRODUCTION TO PRODUCTION AND OPERATIONS MANAGEMENT:

Introduction, objectives, scope and differences among production and operations management. Historical evolution of production and operations management. Characteristics of modern operation functions. Recent trends in production and operations management. Operations management interaction with other functional areas of management. The transformation process: manufacturing. Service and hybrid agile manufacturing.

Operations comes from the Latin word 'opus,' meaning work. Operations management is the management of that work—to make it run well and to improve on it. the operations function designs, makes, and delivers an organization's products or services. It gathers materials and resources and transforms them into finished goods and services through value-adding conversion activities. Operations management (OM) is the design, management, and improvement of the systems and activities involved in this task.

Scope and Differences between production and operations management - The major key feature of a product is that it is physical and it is also tangible. This implies that a product can be held, it can be seen, felt or smelled. As such, the sale of a product is a once off transaction. However, it should also be noted that a product can be returned to the seller for replacement or refund in the event that it is wrong or damaged. When the customer is not satisfied with the product, he can return it to the seller in exchange of the right type of product desired.

The value of the product is often created and derived from the product by the user. In other words, the user knows what exactly he or she truly desires from a product hence the decision to buy it. It is the same customer who can derive value from purchasing a product unlike the value of the service that is created by the service provider.

A service is work done by another person for another individual. For instance, a person will visit a restaurant to have the desired services performed by other people while they relax on their

tables. Legal advice is another good example of a service rendered to another person by professional lawyers. In most cases, people are usually attracted by the quality of service they get from a particular organization instead of the product itself. Quality service is satisfactory and people who are satisfied will continue doing business with the company.

(b) Service Management: Nature of services. customer as participant and customer as product

Service operation coordinates and carries out the activities and processes required to deliver and manage services at agreed levels to business users and customers. ... Service operation includes the processes of event management, incident management, request fulfilment, problem management, and access management.

The type of process technology used in service industries in which there is high capital investment and relatively low customer contact, e.g. postal services. These industries involve a limited range of standardized services with a high level of reliability.

Types of Service operations- Scheduling challenges in Various service Operations,

Line operations. Line operations progress in a linear fashion.

Job Shop Operations. This type of service model provides customer satisfaction by tailoring the service to the client's needs.

Intermittent Operations. Some service projects are unique and seldom repeated.

Quasi manufacturing,

Quasi Manufacturing - low customer contact, low labor intensity, rigid standardized process, concerned with developing reliable delivery schedules e.g. airlines, federal express

Custom-shop Services/ Service Shop - high customer contact, capable to provide customized services with professional staff in relatively capital intensive conversion technology e.g. hospital

Mass Service - Labor intensive conversion process, offers a standardized product, training & development and scheduling if human resources is critical for successful service delivery e.g. live entertainment, cafeterias

Professional Service - Customized service delivered through intensive interaction between customer and professional, professional skills relating to customer is essential e.g. medical diagnosis

Value creation through service. The value of a service comes from what it enables someone to do and what the service is made from. Thus we can say that the value of a service is determined by the customer and not the service provider.

Service quality, Culture and innovation

Service quality (SQ), in its contemporary conceptualization, is a comparison of perceived expectations (E) of a service with perceived performance (P), giving rise to the equation SQ=P-E. This conceptualization of service quality has its origins in the expectancy-disconfirmation paradigm. A business with high service quality will meet or exceed customer expectations whilst remaining economically competitive. Evidence from empirical studies suggests that improved service quality increases profitability and long term economic competitiveness. Improvements to service quality may be achieved by improving operational processes; identifying problems quickly and systematically; establishing valid and reliable service performance measures and measuring customer satisfaction and other performance outcomes.

Historical evolution of production and operations management.

The history of production and operations management dates back to the late 18th century when Adam Smith recognized the economic benefits of specialization of labor. He recommended breaking down jobs into sub-tasks and assigning workers to specialized tasks in which they would become highly skilled and efficient [1]. In the early 20th century, F.W. Taylor implemented Smith's theories and developed scientific management. From then until the 1930s, many techniques were developed that prevailed the traditional view. Production management became the acceptable term from the 1930s to the 1950s. As F.W. Taylor's works became more widely known, managers developed techniques that focused on economic efficiency in manufacturing. Workers were studied in great detail to eliminate wasteful efforts and achieve greater efficiency. At the same time, psychologists, socialists, and other social scientists began to study people and human behavior in the working environment. In addition, economists, mathematicians, and computer socialists contributed newer, more sophisticated analytical approaches. With the 1970s emerged two distinct changes in our views. The most obvious of these, reflected in the new name operations management, was a shift in the service and manufacturing sectors of the economy. As the service sector became more prominent, the change from 'production' to

'operations' emphasized the broadening of our field to service organizations. The second, more suitable change was the beginning of an emphasis on synthesis, rather than just analysis, in management practices.

Characteristics of modern operation functions.

Modern production and operation functions have evolved over time. They are characterized by the following:

Manufacturing as a competitive advantage: Modern production and operation functions view manufacturing as a competitive advantage.

Service orientation: Modern production and operation functions are service-oriented.

Positive environmental impact: Due to better and efficient technology, modern production and operation functions have led to the disappearance of smokestacks, which has had a positive environmental impact.

Small is beautiful: Modern production and operation functions have embraced the concept of small being beautiful.

In addition, operations management is one of the major functions in an organization along with supply chains, marketing, finance, and human resources. The operations function requires management of both the strategic and day-to-day production of goods and services. The role of operations management is to uphold operational efficiency. Always be on the lookout for new advancements to remove bottlenecks and improve your operations strategy.

Recent trends in production and operations management.

Some of the recent trends in production and operations management are:

Employee wellbeing, safety and health: This trend focuses on the ethical and social responsibility of a company towards its workforce, as well as the benefits of improving morale and productivity. It involves evaluating and improving the workplace environment, whether remote or in-office, to facilitate employee satisfaction and engagement.

Automation and digitalization: This trend involves using technology to automate time-consuming, repetitive, and low-value tasks, and to enhance the efficiency and quality of

production and operations. It also involves using digital tools to improve communication, collaboration, and data analysis across the organization.

Sustainability and circular economy: This trend involves adopting environmentally friendly practices and reducing waste and emissions in production and operations. It also involves shifting from a linear to a circular economy, where resources are reused, recycled, and regenerated, rather than disposed of.

Globalization and localization: This trend involves expanding the market reach and customer base of a company, while also adapting to the local needs and preferences of different regions and cultures. It involves managing the complexity and diversity of global supply chains, distribution channels, and regulations.

Customer-centricity and customization: This trend involves putting the customer at the center of production and operations, and delivering products and services that meet or exceed their expectations and preferences. It involves using data and feedback to understand customer needs and wants, and to offer personalized and customized solutions.

Operations management interaction with other functional areas of management.

Operations management is the function of managing the processes and resources that produce and deliver goods and services. It interacts with other functional areas of management, such as finance, marketing, human resources, and information systems, to achieve the strategic goals of the organization. Some examples of how operations management interacts with other functional areas are:

Finance: Operations management and finance work together to plan and control the budget, cash flow, and capital investments of the organization. Operations management provides information on the costs, revenues, and profitability of different products, processes, and activities, while finance provides the funds and financial analysis to support the operations decisions.

Marketing: Operations management and marketing collaborate to design and deliver products and services that meet or exceed customer expectations and preferences. Operations management ensures that the products and services are produced efficiently, effectively, and with high quality, while marketing conducts market research, segmentation, positioning, and promotion to attract and retain customers.

Human resources: Operations management and human resources coordinate to recruit, train, motivate, and retain the workforce that performs the operations tasks. Operations management defines the job requirements, skills, and performance standards for the employees, while human resources provides the policies, procedures, and incentives to manage the human resources.

Information systems: Operations management and information systems utilize technology to improve the operations performance and competitiveness of the organization. Operations management uses information systems to collect, store, analyze, and communicate data and information related to the operations processes and activities, while information systems provides the hardware, software, and network infrastructure to support the operations functions.

The transformation Process: Manufacturing, Service & Hybrid Agile

The transformation process is the way that an organization converts inputs (such as materials, labor, and information) into outputs (such as goods, services, and value) that meet customer needs and expectations. Different types of organizations have different transformation processes, depending on their nature and objectives. Here are some examples of the transformation processes for manufacturing, service, and hybrid agile organizations:

Manufacturing: Manufacturing organizations transform raw materials into finished products through physical, chemical, or mechanical processes. For example, a car manufacturer transforms steel, rubber, glass, and other components into vehicles that customers can buy and use. Manufacturing organizations typically have high capital intensity, low customer contact, and standardized outputs.

Service: Service organizations transform human or intangible assets into benefits that customers value and are willing to pay for. For example, a bank transforms money into financial services, such as loans, deposits, and investments. Service organizations typically have low capital intensity, high customer contact, and customized outputs.

Hybrid agile: Hybrid agile organizations combine elements of both manufacturing and service transformation processes, as well as elements of both traditional and agile project management methodologies. For example, a software development organization transforms user requirements into software products that can be delivered and updated frequently. Hybrid agile organizations typically have moderate capital intensity, moderate customer contact, and adaptable outputs.

Machines and labor are organized in five distinct ways—project production, job shop, batch, assembly (worker-paced or machine-paced line), and continuous process. Let's begin by understanding these arrangements of production factors and their rationales. *Project production* assembles or manufactures a product that is too large or too fragile to be moved, such as building construction and ship manufacturing. Equipment, material, and labor are transported to the production location to work on the product. The product being made is generally in numbers of one or a few. Such an arrangement is akin to a project and is thus called project production. The project production environment is covered in the project management chapter and hence does not find elaboration here. The other four types of organization are found where the product moves as it's made. A *job shop* organization is a product-oriented layout with different products moving among different work centers, while the remaining process types are progressive variations of process-oriented systems with increasingly standardized products moving at progressively higher rates through a fixed sequence of work steps. As one goes down the list from job shop to continuous flow, the speed of the flow of product through the steps of the process increases.

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UNIT-II OPERATIONS PLANNING:

PPC introduction, objectives, basic types of production control, capacity planning. Capacity requirement, resources aggregate planning, MPS, MRP-1, MRP-II, economic batch quantity, lean operations, JIT, line balancing, ERP.

PPC introduction, objectives, basic types of production control-

PPC stands for production planning and control, which is a process of managing the production activities of a manufacturing enterprise. The objectives of PPC are to deliver quality goods in right quantity, right time, right place and right price. PPC also aims to use the resources efficiently and effectively, and to coordinate and integrate the production operations with other functions of the organization

There are different types of production systems, depending on the nature and volume of the products. The basic types of production systems are:

- Job production: This is a type of production where each product is made individually, according to the specific requirements of the customer. Job production is suitable for low-volume and high-variety products, such as customized furniture, machinery, or artwork. Job production requires skilled workers, flexible machines, and high-quality materials

- Batch production: This is a type of production where a group of similar products are made together, in batches. Batch production is suitable for medium-volume and medium-variety products, such as bakery products, pharmaceuticals, or clothing. Batch production requires semi-skilled workers, semi-automatic machines, and standardized materials

- Mass production: This is a type of production where a large number of identical products are made continuously, in mass. Mass production is suitable for high-volume and low-variety products, such as automobiles, electronics, or canned food. Mass production requires unskilled workers, automatic machines, and mass-produced materials

A master production schedule (MPS) is a plan for individual commodities to be produced in each time period such as production, staffing, inventory, etc. It is usually linked to

manufacturing where the plan indicates when and how much of each product will be demanded.

Capacity Planning, capacity requirement: Capacity Planning- Capacity is calculated as (number of machines or workers) × (number of shifts) × (utilization) × (efficiency). Capacity planning determines the production capacity needed by an organization to meet changing demands for its products. In the context of capacity planning, design capacity is the maximum amount of work that an organization is capable of completing in a given period. Effective capacity is the maximum amount of work that an organization is capable of completing in a given period due to constraints such as quality problems, delays, material handling, etc.

The phrase is also used in business computing and information technology as a synonym for capacity management. IT capacity planning involves estimating the storage, computer hardware, software and connection infrastructure resources required over some future period of time. A common concern of enterprises is whether the required resources are in place to handle an increase in users or number of interactions. Capacity management is concerned about adding central processing units (CPUs), memory and storage to a physical or virtual server. This has been the traditional and vertical way of scaling up web applications, however IT capacity planning has been developed with the goal of forecasting the requirements for this vertical scaling approach.

A discrepancy between the capacity of an organization and the demands of its customers results in inefficiency, either in under-utilized resources or unfulfilled customers. The goal of capacity planning is to minimize this discrepancy. Demand for an organization's capacity varies based on changes in production output, such as increasing or decreasing the production quantity of an existing product, or producing new products. Better utilization of existing capacity can be accomplished through improvements in overall equipment effectiveness (OEE). Capacity can be increased through introducing new techniques, equipment and materials, increasing the number of workers or machines, increasing the number of shifts, or acquiring additional production facilities.

Line Balancing - A production line is said to be in balance when every worker's task takes the same amount of time. Line balancing is a manufacturing-engineering function in which whole collection of production-line tasks are divided into equal portions. Well-balanced lines avoid labour idleness and improve productivity.

Aggregate planning-

Aggregate planning is a process of managing the production activities of a manufacturing enterprise. It involves forecasting the potential demand for an organization's goods or services and preparing the company to fulfill this demand. Aggregate planning aims to balance the demand and capacity, minimize the costs, and optimize the use of resources. Aggregate planning is usually done in advance of 6 to 18 months and covers all the jobs being done at a facility or across several facilities. Aggregate planning can use different strategies, such as pricing, advertising, back ordering, new demand creation, workforce, overtime, subcontracting, or inventory, to adjust the production levels and meet the demand. Aggregate planning is important for any company that wants to achieve its long-term objectives and deliver quality goods in right quantity, right time, right place and right price.

Aggregate Planning: Aggregate Demand, criteria for selecting Aggregate Plans , Aggregate Plans for Service & mathematical Models for Aggregate Planning- Aggregate planning is a marketing activity that does an aggregate plan for the production process, in advance of 6 to 18 months, to give an idea to management as to what quantity of materials and other resources are to be procured and when, so that the total cost of operations of the organization is kept to the minimum.

MPS, MRP-1, MRP-II,ERP-

MPS, MRP-1, and MRP-II are acronyms for different types of production planning and control systems. They are related but have some differences in their scope and functionality. Here is a brief explanation of each term:

- MPS stands for Master Production Schedule, which is a plan that specifies the quantity and timing of the finished products to be produced in a given period. MPS meets the direct or independent demand, which is the demand that comes from the customers or the market. MPS is based on the sales orders or the forecasts, and it determines the production levels and inventory requirements for the final products. MPS is the first step in the production planning process, and it provides the input for the MRP system.

Master Production Scheduling: Objective, Procedure and Time frame. A master production schedule (MPS) is a plan for individual commodities to be produced in each time period such

as production, staffing, inventory, etc. It is usually linked to manufacturing where the plan indicates when and how much of each product will be demanded.

Materials Management: Materials management is a core supply chain function and includes supply chain planning and supply chain execution capabilities. Specifically, materials management is the capability firms use to plan total material requirements. The material requirements are communicated to procurement and other functions for sourcing. Materials management is also responsible for determining the amount of material to be deployed at each stocking location across the supply chain, establishing material replenishment plans, determining inventory levels to hold for each type of inventory (raw material, WIP, Finished Goods), and communicating information regarding material needs throughout the extended supply chain.

Need and importance of Materials management. Typical roles in Materials Management include: Materials Manager, Inventory Control Manager, Inventory Analyst, Material Planner, Expediter and emerging hybrid roles like "buyer planner". The primary business objective of Materials Management is assured supply of material, optimum inventory levels and minimum deviation between planned and actual results.

Materials Requirement Planning- Material requirements planning (MRP) is a production planning, scheduling, and inventory control system used to manage manufacturing processes. Most MRP systems are software-based, but it is possible to conduct MRP by hand as well. An MRP system is intended to simultaneously meet three objectives:

Ensure materials are available for production and products are available for delivery to customers.

Maintain the lowest possible material and product levels in store

Plan manufacturing activities, delivery schedules and purchasing activities.

MRP-1 stands for Material Requirements Planning, which is a system that calculates the quantity and timing of the materials and components needed to produce the products specified by the MPS. MRP-1 meets the dependent demand, which is the demand that depends on the production of other items. MRP-1 is based on the bill of materials (BOM), which is a list of all the materials and components required to make a product, and the inventory records, which show the current stock levels and the planned receipts. MRP-1

generates the purchase orders and the work orders for the materials and components, and it helps to minimize the inventory costs and avoid stockouts

Manufacturing Resource Planning- Manufacturing resource planning (MRP II) is defined as a method for the effective planning of all resources of a manufacturing company. Ideally, it addresses operational planning in units, financial planning, and has a simulation capability to answer "what-if" questions and extension of closed-loop MRP. This is not exclusively a software function, but the management of people skills, requiring a dedication to database accuracy, and sufficient computer resources. It is a total company management concept for using human and company resources more productively.

MRP-II stands for Manufacturing Resource Planning, which is an extension of MRP-1 that incorporates other aspects of the manufacturing process, such as capacity planning, scheduling, quality control, cost accounting, and human resources. MRP-II is a comprehensive system that integrates the information from all the functional areas of the organization, such as marketing, finance, and engineering. MRP-II uses additional data from the accounting records and the sales forecasts to analyze and optimize the production resources and the profitability. MRP-II is a strategic tool that helps to improve the efficiency and effectiveness of the manufacturing operations

ERP stands for enterprise resource planning, which is a type of software that helps you manage your entire business. ERP software supports automation and integration of various business processes, such as finance, human resources, manufacturing, supply chain, services, procurement, and more. ERP software also provides intelligence and analytics that help you make better decisions and improve your performance. ERP software can be deployed on-premises or in the cloud, depending on your needs and preferences. Some of the benefits of ERP software are:

- It streamlines and simplifies your business operations, saving you time and money.
- It improves your data quality and accuracy, reducing errors and risks.
- It enhances your collaboration and communication, both internally and externally.
- It increases your visibility and transparency, giving you a single source of truth for your business.

- It boosts your efficiency and effectiveness, enabling you to meet your customer expectations and achieve your goals.

JIT- JIT stands for just-in-time, which is a method of inventory management that aims to reduce costs and waste by ordering and receiving goods only as they are needed for production. JIT is based on accurate demand forecasting and efficient supply chain coordination. JIT can improve the quality, efficiency, and profitability of manufacturing operations, but it also requires high reliability and flexibility from suppliers and workers. JIT was popularized by Toyota in the 1970s and is also known as the Toyota Production System

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UNIT-III DESIGNING AND MANAGING OPERATIONAL SYSTEMS:

INTRODUCTION TO PRODUCT DESIGN, IMPORTANCE, OBJECTIVE, FACTORS INFLUENCING, CHARACTERISTICS OF GOOD PRODUCT DESIGN. PROCESS DESIGN AND SELECTION, PROCESS PLANNING, PROCESS STRATEGY, PRODUCT LIFE CYCLE VERSUS PROCESS LIFE CYCLE.

WORK STUDY, METHOD STUDY, TIME STUDY, MOTION STUDY AND WORK MEASUREMENT. FACILITY LOCATION, FACILITY LAYOUT, TYPES OF LAYOUTS, JOB SEQUENCING, JOHNSON'S ALGORITHM, N JOBS TWO MACHINES, N JOBS THREE MACHINES, N JOBS M MACHINES, (PROBLEMS) SCHEDULING.

Introduction to product design, importance, objective, factors influencing, characteristics of good product design.

- Product design is the process of imagining, conceptualizing, iterating and refining a product, service or experience so it’s ready for its end user. Product design is a cross-functional discipline that spans research, strategy, design, and business—with lots of collaboration along the way

- Product design is important for both end user satisfaction and business success. It helps businesses and brands to deliver a positive user experience and gain loyal customers, secure a competitive edge, reduce costs and waste, optimize the use of resources, and achieve their goals.

- The objective of product design is to create products that meet a specific user need, make sense from a business perspective, and compete successfully in their given market.

Product design is based on accurate demand forecasting, market research, competitor analysis, user research, and creative thinking

- The factors influencing product design are the user needs and preferences, the business goals and constraints, the market trends and opportunities, the technological innovations and limitations, the environmental and social impacts, and the legal and ethical regulations

- The characteristics of good product design are functionality, reliability, quality, safety, maintainability, usability, ergonomics, aesthetics, and sustainability. These characteristics create effective product design that satisfies the end users, the business, and the society.

product life cycle versus process life cycle.

Products, like people, have life cycles. The product life cycle is broken into four stages: introduction, growth, maturity, and decline. This concept is used by management and by marketing professionals as a factor in deciding when it is appropriate to increase advertising, reduce prices, expand to new markets, or redesign packaging. The process of strategizing ways to continuously support and maintain a product is called product life cycle management.

Work Study, Method Study, Time study, Motion Study and work measurement:
(a) Work study : Definition and its advantages and the various components. Work study is a means of enhancing the production efficiency (productivity) of the firm by elimination of waste and unnecessary operations. It is a technique to identify non-value adding operations by investigation of all the factors affecting the job. According to British Standards Institution (BS 3138): “Method study is the systematic recording and critical examination or existing and proposed ways or doing work as a means or developing and applying easier and more effective methods and reducing cost.” Method study in Production and Operation Management. ...

Techniques of methods analysis - The process is often seen as a linear, described by its main steps of:

Select (the work to be studied);

Record (all relevant information about that work);

Examine (the recorded information);

Develop (an improved way of doing things);

Install (the new method as standard practice);

Maintain (the new standard proactive).

Motion study in Production Management. Motion study is part of method study where analysis of the motion of an operator or work will be studied by following the prescribed methods.

For recording the movements, the chief techniques used are: Memo-motion analysis, Micro-motion analysis and Flow diagrams. However, the most commonly used technique used for recording is by using flow charts. These are classified into three different types,

Motion study is a business efficiency technique. ... These motions are productively used in workplace to organize a better method of performing a job. According to Gilbreth, “Motion study is the science of eliminating wastefulness, resulting from using unnecessary, ill directed and inefficient motion.

WORK MEASUREMENT

Work measurement is the application of techniques which is designed to establish the time for an average worker to carry out a specified manufacturing task at a defined level of performance.

Work measurement helps to uncover non-standardization that exist in the workplace and non-value adding activities and waste. A work has to be measured for the following reasons:

To discover and eliminate lost or ineffective time.

To establish standard times for performance measurement.

To measure performance against realistic expectations.

To set operating goals and objectives.

Techniques

Time study

Predetermined motion time systems

Synthesis from elemental data

Work sampling

Analytical estimating

Uses

Revealing existing causes of ineffective time through study, important though it is, is perhaps less important in the long term than the setting of sound time standards, since these will continue to apply as long as the work to which they refer continues to be done. They will also show up any ineffective time or additional work which may occur once they have been established. Purpose

Work Measurement is a technique for establishing a Standard Time, which is the required time to perform a given task, based on time measurements of the work content of the prescribed method, with due consideration for fatigue and for personal and unavoidable delays. Method study is the principal technique for reducing the work involved, primarily by eliminating unnecessary movement on the part of material or operatives and by substituting good methods for poor ones. Work measurement is concerned with investigating, reducing and subsequently eliminating ineffective time, that is time during which no effective work is being performed, whatever the cause. Work measurement, as the name suggests, provides management with a means of measuring the time taken in the performance of an operation or series of operations in such a way that ineffective time is shown up and can be separated from effective time. In this way its existence, nature and extent become known where previously they were concealed within the total. To see how much work has been done by the worker and how much salaries is given to him

Facility location and Facility layout. Service facility layout-Facility Location is the right location for the manufacturing facility; it will have sufficient access to the customers, workers, transportation, etc. The study of facility location problems, also known as location analysis, is a branch of operations research and computational geometry concerned with the optimal placement of facilities to minimize.

Facility layout is an arrangement of different aspects of manufacturing in an appropriate manner as to achieve desired production results. Facility layout considers available space, final product, safety of users and facility and convenience of operations.

Service facility layouts- Layout is the way or arrangement in which service facility is organized. The arrangement could be of service facility area, equipment, workstations or any physical entity. ... Facility layouts are designed so as to encourage proper and convenient maintenance activities and to incorporate safety and security measures.

Job Sequencing, Johnson's Algorithm, n jobs two machines, n jobs three machines, n jobs m machines, (Problems) Scheduling : Sequence refers to the order of carrying out activities. Scheduling is the timing (or timetable) to carry out the activities Operation Sequencing

It is to plan the order of the operation by process, regarding the fixed orders through the Operation Order Release Planning. It is to grasp the progress status of the operation, to consider the priority, setup time, and etc., and to make an operation sequencing list. we first discuss counterpart models and how to use simulation to solve them. In addition to analyzing stochastic counterparts of deterministic problems, we also examine the potential usefulness of deterministic counterparts. In other words, we explore whether the deterministic representation can tell us something about the solution to a stochastic problem. Next, we turn our attention to sequencing rules for performance measures based on the maximum cost and the total cost. This discussion highlights the tendency of the deterministic counterpart to produce optimistic performance measurements, and we address this bias in more detail. To support optimal sequencing decisions, we then introduce the concept of stochastic dominance and association.

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UNIT-IV PRODUCTIVITY, QUALITY AND MAINTENANCE MANAGEMENT:

Productivity, importance, measurement of productivity, tools to increase productivity, factors affecting industrial productivity, TQM, essentials, principles, scope and ISO standards basics. Statistical Quality Control (SQC), Control charts for variables and attributes (Problems). Break Down Maintenance, Preventive Maintenance, Replacement of machines, Replacement Models. when money's worth is not considered in capital cost of the Asset, when money's worth is considered in capital cost of the Asset, Individual and Group replacement (problems)

Productivity, importance, measurement of productivity, tools to increase productivity, factors affecting industrial productivity-

- Productivity is the ratio of output to input in a production process. It measures how efficiently and effectively the resources are used to produce the goods or services. Higher productivity means more output with less input, or the same output with less input. Lower productivity means less output with more input, or the same output with more input

- Productivity is important for both the producers and the consumers. For the producers, higher productivity means lower costs, higher profits, better quality, and more competitiveness. For the consumers, higher productivity means lower prices, higher availability, and more variety. Productivity also affects the economic growth, employment, income, and living standards of a country

- Productivity can be measured in different ways, depending on the level and the purpose of the analysis. The most common method is to calculate the partial productivity ratios, which are the output divided by a single input, such as labour, capital, or materials. Another method is to calculate the total factor productivity, which is the output divided by all the inputs combined, or the output minus the inputs. A third method is to calculate the multifactor productivity, which is the output divided by a group of inputs, such as labour and capital, or labour and energy

• Productivity can be increased by using various tools and techniques, such as automation, innovation, quality management, lean production, just-in-time, kaizen, benchmarking, outsourcing, and training. These tools and techniques aim to reduce waste, improve efficiency, enhance quality, and optimize the use of resources

• Productivity is affected by various factors, both internal and external to the production process. Some of the internal factors are the technology, the equipment, the materials, the labour, the management, the organization, and the environment. Some of the external factors are the government policy, the market demand, the competition, the supply chain, the social and cultural factors, and the legal and ethical factors

TQM, essentials, principles, scope and ISO standards basics. Statistical Quality Control (SQC), Control charts for variables and attributes (Problems)-

• TQM stands for Total Quality Management, which is an approach to success through continuous improvement. TQM involves all members of an organization in improving processes, products, services, and the culture in which they work. TQM aims to achieve customer satisfaction, employee empowerment, and organizational excellence

• The essentials of TQM are the following

• Customer focus: The customer ultimately determines the level of quality. TQM strives to understand and meet the current and future needs and expectations of the customers.

• Total employee involvement: All employees participate in working toward common goals. TQM encourages teamwork, collaboration, learning, and innovation among the employees.

• Process approach: TQM views the organization as a system of interrelated processes that deliver value to the customers and other stakeholders. TQM seeks to optimize and improve the performance and efficiency of the processes.

• Continuous improvement: TQM is a dynamic and ongoing process that seeks to identify and eliminate the root causes of problems and prevent their recurrence. TQM uses various tools and techniques, such as PDCA cycle, benchmarking, and quality audits, to monitor and measure the quality results and implement corrective and preventive actions.

• Fact-based decision making: TQM relies on data and information to analyze and evaluate the processes and outcomes. TQM uses statistical methods, such as SQC, to collect, analyze, and interpret the data and support the decision making process.

• Strategic and systematic approach: TQM aligns the quality vision, mission, and objectives with the overall strategy and goals of the organization. TQM integrates the quality principles and practices into the policies, plans, and procedures of the organization.

• Leadership and commitment: TQM requires the top management to provide the direction, resources, and support for the quality initiatives. TQM also requires the managers and supervisors to act as role models and facilitators for the quality culture and values.

• The principles of TQM are the following

• Customer satisfaction: TQM aims to exceed the customer requirements and expectations by delivering high-quality products and services that add value and solve the customer problems.

• Employee involvement and empowerment: TQM recognizes the employees as the most valuable asset of the organization and empowers them to take responsibility and ownership for their work. TQM also provides the employees with the necessary training, tools, and recognition to improve their skills and motivation.

• Teamwork and collaboration: TQM fosters a culture of cooperation and mutual respect among the employees and other stakeholders. TQM also encourages the formation of cross-functional teams that work together to solve problems and implement improvements.

• Continuous improvement and innovation: TQM promotes a culture of learning and experimentation that encourages the employees to seek new ways of doing things and to embrace change. TQM also supports the generation and implementation of new ideas and solutions that enhance the quality and value of the products and services.

• Quality leadership and management: TQM requires the leaders and managers to demonstrate their commitment and involvement in the quality activities and to communicate the quality vision, mission, and objectives to the employees and other stakeholders. TQM also requires the leaders and managers to provide the feedback, guidance, and recognition to the employees and to ensure the alignment and integration of the quality efforts with the organizational strategy and goals.

• The scope of TQM covers all the aspects of the organization, such as the products, services, processes, people, culture, and environment. TQM applies to all the functions and

levels of the organization, such as marketing, finance, human resources, engineering, and operations. TQM also extends to the external stakeholders, such as the customers, suppliers, partners, and society

- ISO standards are international standards that specify the requirements and guidelines for quality management systems. ISO standards are developed and published by the International Organization for Standardization (ISO), which is a non-governmental organization that represents the national standards bodies of over 160 countries. ISO standards are voluntary and consensus-based, and they are widely recognized and adopted by various organizations and industries around the world

- The basics of ISO standards for quality management are the following

- ISO 9000: This is a standard that describes the fundamental concepts and terminology of quality management systems. It provides the basis for understanding and applying the other ISO standards for quality management.

- ISO 9001: This is a standard that specifies the requirements for a quality management system that an organization can use to demonstrate its ability to consistently provide products and services that meet the customer and regulatory requirements. It is the only ISO standard for quality management that can be used for certification purposes.

- ISO 9004: This is a standard that provides the guidelines for enhancing the performance and effectiveness of a quality management system. It focuses on the improvement of the organization's overall quality and sustainability.

- ISO 19011: This is a standard that provides the guidelines for conducting internal and external audits of quality management systems. It covers the principles, methods, and practices of auditing and the competence and evaluation of auditors.

- SQC stands for Statistical Quality Control, which is a branch of statistics that deals with the analysis and control of the quality of products and processes. SQC uses various methods and tools, such as sampling, descriptive statistics, hypothesis testing, and control charts, to measure, monitor, and improve the quality of the products and processes

- Control charts are graphical tools that display the variation of a quality characteristic over time and compare it with the predetermined control limits. Control charts help to identify and separate the common causes and the special causes of variation, and to determine

whether a process is in a state of statistical control or not. Control charts can be classified into two types: control charts for variables and control charts for attributes.

- Control charts for variables are control charts that monitor the quality characteristics that can be measured on a continuous scale, such as length, weight, temperature, or time. Control charts for variables include the following types

- X-bar and R charts: These are control charts that monitor the mean and the range of a sample of observations from a process. X-bar and R charts are used when the sample size is small (usually between 2 and 10).

- X-bar and S charts: These are control charts that monitor the mean and the standard deviation of a sample of observations from a process. X-bar and S charts are used when the sample size is large (usually more than 10).

- Individual and moving range (I-MR) charts: These are control charts that monitor the individual observations and the moving range of two consecutive observations from a process. I-MR charts are used when the sample size is one or when the sampling frequency is high.

- Control charts for attributes are control charts that monitor the quality characteristics that can be counted or classified into categories, such as defective or non-defective, pass or fail, or yes or no. Control charts for attributes include the following types

- P charts: These are control charts that monitor the proportion or the fraction of defective items in a sample of observations from a process. P charts are used when the sample size is variable and the defectives are rare.

- NP charts: These are control charts that monitor the number of defective items in a sample of observations from a process. NP charts are used when the sample size is constant and the defectives are rare.

- C charts: These are control charts that monitor the number of defects per unit in a sample of observations from a process. C charts are used when the sample size is constant and the defects are rare.

- U charts: These are control charts that monitor the number of defects per unit in a sample of observations from a process. U charts are used when the sample size is variable and the defects are rare.

Break Down Maintenance, Preventive Maintenance, Replacement of machines, Replacement Models. when money's worth is not considered in capital cost of the Asset, when money's worth is considered in capital cost of the Asset, Individual and Group replacement-

The goal of maintenance management is to control the resources, time and costs of a company to ensure the efficiency and adequacy of the maintenance operations and to avoid waste of resources or periods of downtime due to faulty equipment Computerized maintenance management system, also known as computerized maintenance management information system, is a software package that maintains a computer database of information about an organization's maintenance operations.

1- Preventive maintenance: Equipment is maintained before any fault occur or the equipment to be in working condition. It's to maintain a level of certain service on equipment, programming or configuration if required and done by maitenance department.

2- Periodic Maintenance: The basic maintenance of equipment by its user or operator. It consists of data collection, visual inspection, cleaning, lubrication, re tightening of screws for which only a brief training is required and.

3- Corrective maintenance: It is to correct the defect to be found in the equipment and are corrected by the maintenance department.

CONTENTS

UNIT-V INVENTORY CONTROL AND STORES MANAGEMENT:

ROLE AND IMPORTANCE OF INVENTORY, INVENTORY PLANNING AND CONTROL, INVENTORY DECISIONS - ECONOMIC ORDER QUANTITY (EOQ), SELECTIVE INVENTORY CONTROL, SAFETY STOCK AND REORDER LEVEL AND INVENTORY MODELS-INVENTORY ANALYSIS AND CONTROL SYSTEMS: ABC, (PROBLEMS) VED, FNSD ANALYSIS, JUST IN TIME (JIT)

STORES MANAGEMENT: FUNCTIONS OF STORES AND MATERIALS CONTROL. CLASSIFICATION, CODIFICATION, SIMPLIFICATION AND STANDARDIZATION OF MATERIALS, BIN CARD, DOUBLE-BIN AND STORES LEDGER. EVOLUTION OF COMPUTER BASED STORES MANAGEMENT AND EMERGING TRENDS IN STORES MANAGEMENT.

Role and Importance of inventory, Inventory planning and control, Inventory decisions - Economic Order Quantity (EOQ)-

- Inventory is the stock of goods or materials that a business or organization holds for its current or future needs. Inventory can include raw materials, work-in-progress, finished goods, spare parts, or supplies. Inventory plays a vital role in the production and operation of a business, as it ensures the availability and continuity of the goods or services that the business provides to its customers

- Inventory planning and control is the process of managing the inventory levels and activities of a business or organization. Inventory planning and control involves forecasting the demand and supply of the goods or materials, determining the optimal order quantity and timing, maintaining the inventory records and reports, and monitoring and adjusting the inventory performance. Inventory planning and control aims to balance the inventory costs and benefits, and to optimize the use of the resources and the cash flow

• Inventory decisions are the choices that a business or organization makes regarding its inventory management. Inventory decisions include the selection of the inventory models, methods, and systems that suit the business objectives and constraints. One of the most common inventory decisions is the economic order quantity (EOQ), which is a formula that calculates the optimal order quantity that minimizes the total inventory costs. The total inventory costs consist of the ordering costs, the holding costs, and the shortage costs. The EOQ formula is given by:

$$EOQ = \sqrt{\frac{2 \times D \times S}{H}}$$

where D is the annual demand, S is the ordering cost per order, and H is the holding cost per unit per year

• The EOQ model is based on several assumptions, such as constant and known demand, constant and known lead time, constant and known costs, no discounts or price changes, no stockouts or shortages, and no quantity or quality variations. The EOQ model helps the business or organization to determine the optimal order quantity and frequency, the optimal reorder point, and the optimal safety stock level. Inventory control or stock control can be broadly defined as "the activity of checking a shop’s stock. However, a more focused definition takes into account the more science-based, methodical practice of not only verifying a business' inventory but also focusing on the many related facets of inventory management (such as forecasting future demand) "within an organization to meet the demand placed upon that business economically. Other facets of inventory control include supply chain management, production control, financial flexibility, and customer satisfaction. At the root of inventory control, however, is the inventory control problem, which involves determining when to order, how much to order, and the logistics (where) of those decisions. An extension of inventory control is the inventory control system. This may come in the form of a technological system and its programmed software used for managing various aspects of inventory problems , or it may refer to a methodology (which may include the use of technological barriers) for handling loss prevention in a business.

Deterministic Models of Inventory:

Inventory model is a mathematical model that helps business in determining the optimum level of inventories that should be maintained in a production process, managing frequency of ordering, deciding on quantity of goods or raw materials to be stored, tracking flow of supply of raw materials and goods to provide. A deterministic model is a method based on

the assumption that all parameters and variables associated with an inventory stock are known and that there is no uncertainty associated with demand and replenishment of inventory stock.

Probabilistic Models of Inventory :

Fixed order quantity systems and fixed period quantity systems Probabilistic inventory models consisting of probabilistic supply and demand are more suitable in most circumstances. ... An incremental analysis is used to determine the optimal order quantity for a single period inventory with probabilistic demand.

Inventory models-Inventory analysis and control systems: ABC, (Problems) VED, FNSD analysis, Just In Time (JIT)-

Selective Inventory Control: ABC, XYZ, VED, FNS and SDE Analysis.

Selective Inventory Control is an essential part of Materials Management. Selective control is emphasizes on variations in methods of control from item to item based on selective basis. We can not apply uniform control since it's expensive and gives diffused effect.

ABC Analysis

• Classifies items based on the annual usage value (AUV)

• Identify a small percentage of items which account for most of the total inventory value

Basic Principle

20/80 - Rule

Pareto’s Law – Vilfredo Pareto – Italian Economist

“Few are vital’ and ‘many are trivial’

AUV = Annual demand X Price

Pareto’s law applied to inventories

• The relationship between the percentage of items and the percentage of AUV follows a

pattern

A – about 20 % of items account for about 80 % of the AUV

B - about 30 % of items account for about 15 % of the AUV

C - about 50 % of items account for about 5 % of the AUV

Steps in Making an ABC Analysis

1. Determine the annual usage for each item

2. Calculate the AUV of each item

3. List the items according to their AUV (descending order)

4. Calculate the cumulative AUV and the cumulative percentage of items

5. Examine the annual usage distribution and group the items into A, B, C based on percentage of AUV

Using ABC approach, there are two general rules to follow:

- Have plenty of low-value items
- Use the money and control effort to reduce the inventory of high-value items

Different Controls used with different classes

- A Items: High priority – Tight control including complete accurate records, regular and frequent review by management, frequent review of demand forecast and close follow-up and expediting to reduce lead time
- B Items: Medium priority – Normal Control
- C Items: Lowest priority – Simplest possible control. Perhaps use a two-bin system or periodic review system. Order larger quantities and carry sufficient safety stock

An example:

XYZ Analysis

• Based on the value of inventory undertaken during the closing of annual accounts

X – High value; Y – Medium value; Z – Low value

HML Analysis

• Items are classified according to the unit value as high, medium, and low. It is used to control the purchase value of items.

Movement Analysis (FSN Analysis)

• Check stock rotations and identifies the obsolescence of items. This is particularly useful for spare parts

Fast-, Slow- and Non-moving Analysis

Criticality criteria (VED Analysis)

Vital, Essential and Desirable

• This is in the point view of operation particularly useful for spare parts control

• A vital equipment is one, which feeds a battery of equipments downstream

GOLF – Government-controlled, Ordinarily available in the open market, Locally available and Foreign imported purchase

SDE – Scarce item or single source item, Difficult to obtain or Easy to obtain as it is an offthe-shelf item.

SOS – seasonal and Off-seasonal

MUSIC – 3D (Multi-Unit Selective Inventory Control – Three Dimensional)

Three dimensions are finance, operations and lead-time of materials

Stores Management: Functions of stores and Materials control. Classification, codification, simplification and standardization of materials, Bin card, Double-Bin and stores Ledger. Evolution of Computer Based Stores Management and emerging trends in stores management.

One of the most useful techniques of "Materials Management'' is a rationalized codification system for properly classifying equipments, raw materials, components and spares to suit to the particular needs of any organization. An article of stores is identified by its simple description or nomenclature

Standardization in Material Management

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

Advantages of Standardization

All the sections of company will be benefited from standardization as mentioned below.

Benefits to Design Department

Fewer specifications, drawings and part list have to prepared and issued.

More time is available to develop new design or to improve established design.

Better resource allocation.

Less qualified personnel can handle routine design work.

Benefits to Manufacturing Department

Lower unit cost.

Better quality products.

Better methods and tooling.

Increased interchangeability of parts.

Better utilization of manpower and equipment.

Accurate delivery dates.

Better services of production control, stock control, purchasing, etc.

More effective training.

Benefits to Marketing Department

Better quality products of proven design at reasonable cost leads to greater sales volume.

Increased margin of profit.

Better product delivery.

Easy availability of sales part.

Less sales pressure of after-sales services.

Bin Card, Double-Bin and stores Ledger. Two bin system means an Inventory control method (used usually for small or low value items) in which when the first bin is used up, an order is made out for replenishment. The second bin contains enough quantity of the item to last until the ordered quantity arrives. Three-Bin System. Definition: The Three-Bin System is like a two-bin system, wherein the third bin of inventory is reserved with the supplier. In other words, a manufacturing firm keeps a stock of inventory in two bins, and at the same time, the supplier of the inventory will keep one bin reserved at his location.

Evolution of Computer Based Stores Management and emerging trends in stores management-

Computer-based store management, or inventory management, is the process of managing the stock of goods or materials that a business or organization holds for its current or future needs. Computer-based store management has evolved over time with the development of information technology and the changing needs and expectations of the customers and the market. Some of the emerging trends in store management are:

- E-commerce and omnichannel: With the rise of online shopping and the demand for seamless and convenient customer experience, store management has to integrate the physical and digital channels and provide consistent and accurate information on the availability, location, and delivery of the products. Store management also has to optimize the order fulfillment and the inventory allocation across the different channels and locations

- Artificial intelligence and machine learning: With the availability of large amounts of data and the advancement of analytical tools, store management can use artificial intelligence and machine learning to improve the forecasting, planning, and optimization of the inventory levels and activities. Store management can also use artificial intelligence and

machine learning to automate and personalize the customer service, the product recommendations, and the pricing strategies

- Internet of things and RFID: With the proliferation of connected devices and sensors, store management can use the internet of things and RFID to track and monitor the inventory in real time and to improve the visibility and accuracy of the inventory data. Store management can also use the internet of things and RFID to enhance the security, quality, and efficiency of the inventory operations and to reduce the errors, losses, and waste