OPERATION MANAGEMENT

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Date: 2021
https://www.researchgate.net/publication/349836532_Operation_management

Introduction to Operation Management

- Define the role of operations management as part of the whole organization.
- List the key responsibilities and skills of an operations manager.
- Demonstrate an awareness about the historical development of operations management.
- Outline the different stages of the transformation process using the Input/Output Transformation Model.
- Identify the four key sources of process variations.
- Examine the steps involved in conducting a process efficiency audit.

Role of Operation management

Defining the Role of Operations Management

Introductions

Operations management is the management of processes that transform inputs into goods and services that add value for the customer. The goal of operations management is to maximise efficiency while producing goods and services that effectively fulfill customer needs.

Production and operations management involve three main types of decisions, typically made at three different stages:

1. **Production planning**. The first decisions facing operations managers come at the planning stage. At this stage, managers decide where, when, and how production will occur. They secure site locations and obtain the necessary resources.
2. **Production control**. At this stage, the decision-making process focuses on controlling quality and costs, scheduling, and the actual day-to-day operations of running a factory or service facility.
3. **Improving production and operations**. The final stage of operations management focuses on developing more efficient methods of producing the firm's goods or services.

Overview of Operations Management and Operations Managers

Every organization has an operations function, whether or not it is called 'operations'. The goal or purpose of most organizations involves the production of goods and/or services. To do this, they have to procure resources, convert them into outputs and distribute them to their intended users. The term operations embraces all the activities required to create and deliver an organization's goods or services to its customers or clients.

1-: What is the Operations management?

- Operation Management is concerned with the design, management, and improvement of the systems that create the organization's goods or services. The majority of most organizations' financial and human resources are invested in the activities involved in making products or delivering services. Operations management is therefore critical to organizational success.
- Within large and complex organizations, operations is usually a major functional area, with people specifically designated to take responsibility for managing all or part of the organization's operations processes. It is an important functional area because it plays a crucial role in determining how well an organization satisfies its customers.
- Thus, an understanding of the principles of operations management is important for all managers, because they provide a systematic way of looking at an organization's processes

2-: Strategic Importance of Operations Management

- **Operations** is one of the three strategic functions of any organization. This means that it is a vital part of achieving the organization's strategy and ensuring its long-term survival. The other two areas of strategic importance to the organization are **marketing** and **finance**.
- For example, a company that makes team jerseys for sport teams must have strong marketing ability to identify groups of customers, understand their needs, and communicate with them to win their business.

  The company must also manage its finances so it can pay for building and equipment expenses, bank loans, worker wages, and supplies. Finally, the company must have strong operations skills so it can provide customised team jerseys that are attractive, durable, affordable and delivered on time to the customer.

The reason and benefit to yourself and your organization to learn about Operations Management

- There are many career-related reasons for wanting to learn about operations management, whether you plan to work in the field of operations or not. This is because every aspect of business affects or is affected by operations. Operations and sales are the two-line functions in a business organization. All other functions—accounting, finance, marketing, IT, and so on—support the two-line functions. Finance and operations management personnel cooperate by exchanging information and expertise in such activities as the following:

1. **Budgeting**. Budgets must be prepared to plan financial requirements. Budgets must sometimes be adjusted, and performance relative to a budget must be evaluated.
2. **Economic analysis of investment proposals**. Evaluation of alternative investments in plant and equipment requires inputs from both operations and finance people.
3. **Provision of funds**. The necessary funding of operations and the amount and timing of funding can be critical.

    - Marketing's focus is on selling and/or promoting the goods or services of an organization. Marketing is also responsible for assessing customer wants and needs, and for communicating those who work in operations. For instance, operations needs details about lead time and demand in the short-long term in order to plan accordingly.
    - Operations also interacts with other functional areas of the organization, including legal, management information systems (MIS), accounting, personnel/human resources, and public relations,

Key Responsibilities of an Operations Manager

Operations managers are responsible for managing activities that are part of the production of goods and services. The direct responsibilities of the operations man ager typically include:

- Managing the overall operations process.
- Overseeing activities related to process design, planning, control and performance improvement.
- Developing the operations strategy, and forecasting consumer and production demand.

- Their indirect responsibilities include interacting with those managers in other functional areas within the company whose roles have an impact on operations, such as marketing, finance, accounting, personnel and engineering.
- Thus, operations managers are generally expected to have a diverse range of skills in order to be effective within the many situations they might find themselves in. To be as effective as possible, operations managers will need to have a mix of soft skills and technical skills.
- The soft skills needed for successful operations management include:

  - Communication skills
  - Motivational skills
  - Analytical skills
  - Negotiation skills
  - Organizational skills
  - Problem-solving skills

Historical Development of Operation Management

Systems for production have existed since ancient times. The production of goods for sale, at least in the modern sense, and the modern factory system had their roots in the Industrial Revolution. Thus, operations management has changed dramatically over time, and there are three major phases - **craft manufacturing, mass production** and the **modern period.**

The Industrial Revolution

The Industrial Revolution began in the 1770s in England and spread to the rest of Europe and to the United States during the 19th century. Prior to that time, goods were produced in small shops by craftsmen and their apprentices.

In the earliest days of manufacturing, goods were produced using craft production: highly skilled workers using simple, flexible tools produced goods according to customer specifications. Craft production had major shortcomings as production was slow and costly. Then, a number of innovations in the 18th century changed the face of production forever by substituting machine power for human power.

A major change that occurred during the Industrial Revolution a boost was the development of **standard gauging systems**. This greatly reduced the need for custom-made goods. Factories began to spring up and grow rapidly, providing jobs for countless people who were attracted in large numbers from rural areas.

However, despite the major changes that were taking place, management theory and practice had not progressed much from early days.

Scientific Management

- The scientific management era brought widespread changes to the management of factories. The movement was spearheaded by the efficiency engineer and inventor Frederick Winslow Taylor, who is often referred to as the father of scientific management.
- Taylor believed in a "**science of management**" based on observation, measurement, analysis and improvement of work methods, and economic incentives. He studied work methods in great detail to identify the best method for doing each job. Taylor also believed that management should be responsible for planning, carefully selecting and training workers, finding the best way to perform each job, achieving cooperation between management and workers, and separating management activities from work activities.
- During the early part of the 20th century, automobiles were just coming into vogue in the United States. Ford's Model T was such a success that the company had trouble keeping up with orders for the cars. In an effort to improve the efficiency of operations, Ford adopted the scientific management principles espoused by Frederick Winslow Taylor. He also introduced the **moving assembly line**, which had a tremendous impact on production methods in many industries.
- Among Ford's many contributions was the introduction of **mass production** to the automotive industry, a system of production in which large volumes of standardised goods are produced by low-skilled or semiskilled workers using highly specialised, and often costly, equipment.

The Modern Period

- Mass production worked well as long as high volumes of mass-produced goods could be produced and sold in predictable and slowly changing markets. However, during the 1970s, markets became highly fragmented, product life cycles reduced dramatically and consumers had far greater choice than ever before.
- An unforeseen challenge to Western manufacturers emerged from Japan. New Japanese production techniques, such as total quality management (TQM), just-in-time (JIT) KIZEN, Six Sigma, Five why? and employee involvement were emulated elsewhere in the developed world, with mixed results.
- More recently, the mass production paradigm has been replaced, but there is no single approach to managing operations that has become similarly dominant. The tabs below outline the different approaches for managing operations in today's modern business world:

Flexible Specialization

Flexible specialisation refers to companies who focus on separate parts of the value-adding process and collaborate within networks to produce whole products. Such an approach requires highly developed networks, effective processes for collaboration and the development of long-term relationships between firms. [4]

This approach is best suited for smaller organizations.

Lean Production

The lean production approach evolved from the highly successful Toyota Production System. It focuses on the elimination of all forms of waste from a production system. A focus on driving inventory levels down also exposes inefficiencies, reduces costs and cuts lead times. [5]

Mass Communication

- Mass customisation seeks to combine high volume, as in mass production, with adapting products to meet the requirements of individual customers.
- Mass customisation is becoming increasingly feasible with the advent of new technology and automated processes.

Agile Manufacturing

Agile manufacturing emphasises the need for an organization to be able to switch frequently from one market-driven objective to another.

Again, agile manufacturing has only become feasible on a large scale with the advent of enabling technology.

Process Management

1-:Introduction

- A key aspect of operations management is process management. A process consists of one or more actions that transform inputs into outputs. In essence, the central role of all management is process management.
- Businesses are composed of many interrelated processes. Generally speaking, there are three categories of business processes:

Upper-management processes. These govern the operation of the entire organization. Examples include organizational governance and organizational strategy.

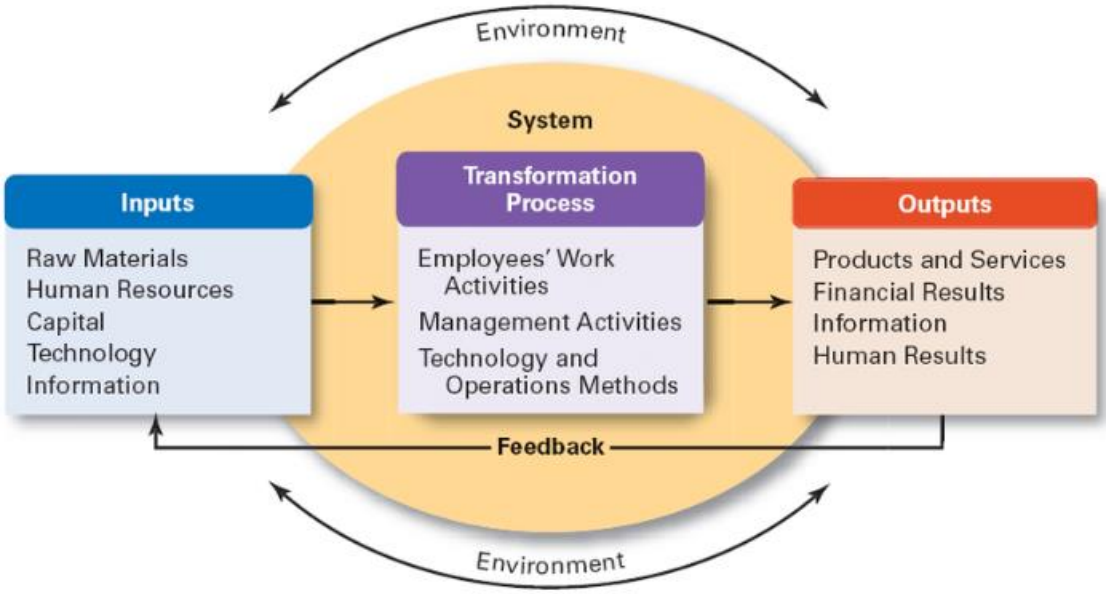
Operational processes. These are the core processes that make up the value stream. Examples include purchasing, production and/or service, marketing, and sales.

Supporting processes. These support the core processes. Examples include accounting, human resources, and IT (information technology).

Business processes, large and small, are composed of a series of supplier–customer relationships, where every business organization, every department, and every individual operation is both a customer of the previous step in the process and a supplier to the next step in the process

2-:The Input/Output Transformation Model

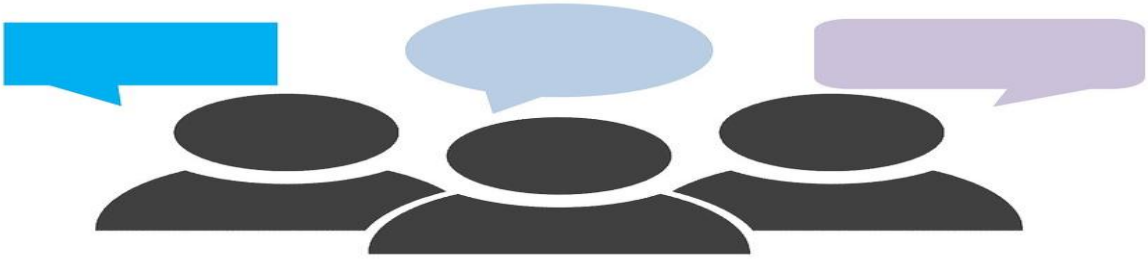
- Operations management transforms inputs (labor, capital, equipment, land, buildings, materials and information) into outputs (goods and services) that provide added value to customers. This full process is summarized in the image below which represents a typical example of the transformation process:



3-:The Input/Output Transformation Model

Another component of the transformation model in is the feedback loop. Feedback is used to control the operations system, by adjusting the inputs and transformati on processes that are used to achieve desired outputs.

Feedback is essential for operations managers. It can come from both internal and external sources:



Internal sources include testing, evaluation and continuously improving goods and services.

External sources include those who supply products or services to end-customers as well as feedback from customers themselves.

For example, a chef relies on a flow of information from the customer, through the waiter, about the quality of the food. Adverse feedback might lead the chef to change the inputs or the transformation process (for example by changing how a process is completed).

4-:The Input/Output Transformation Model - Case Study Example

The 3M Company is a good example of the strategic importance of transforming inputs into outputs that provide competitive advantage in the marketplace. 3M manufactures a top-quality adhesive tape called “Magic Tape”. Magic Tape is used for everyday taping applications, but it offers attractive features that most other tapes do not, including smooth removal from the tape roll, an adhesive that is sticky enough to hold items in place (but not too sticky that it can not be removed and readjusted if necessary!), and a non-reflective surface.

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For several decades, 3M has enjoyed a substantial profit margin on its Magic Tape product because 3M engineers make the manufacturing equipment and design the manufacturing processes that produce Magic Tape. In other words, 3M enjoys a commanding competitive advantage by controlling the transformation processes that turn raw material inputs into the high value-added Magic Tape product.

Controlling the transformation process makes it extremely difficult for competitors to produce tape of the same quality as Magic Tape, allowing 3M to reap significant profits from this superior product

5-:Managing a Process to Meet Demand

- Ideally, the capacity of a process will ensure that output just matches demand. Excess capacity is wasteful and costly; too little capacity means dissatisfied customers and lost revenue.
- Having the right capacity requires having accurate forecasts of demand, the ability to interpret forecast results into capacity requirements, and a process in place that is capable of meeting the expected demand. However, process variation and demand variability can make the achievement of a match between process output and demand difficult. Therefore, to be effective, it is also necessary for managers to be able to deal with variation.
- Variations can be disruptive to operations and supply chain processes, interfering with optimal functioning. Some examples of how process variations can lead to disruptive operations include:
- Additional cost, delays and shortages. Poor quality products and/or services. Inefficient work systems.
- Poor quality and product shortages or service delays can lead to dissatisfied customers which will likely damage an organization's reputation and image and may affect future sales.

1. **The variety of goods or services being offered**. The greater the variety of goods and services, the greater the variation in production or service requirements.
2. **Structural variation in demand**. These variations, which include trends and seasonal variations, are generally predictable. They are particularly important for capacity planning.
3. **Random variation**. This natural variability is present to some extent in all processes, as well as in demand for services and products, and it cannot generally be influenced by managers.
4. **Assignable variation**. These variations are caused by defective inputs, incorrect work methods, out-of-adjustment equipment, and so on. This type of variation can be reduced or eliminated by analysis and corrective action.

An important aspect of being able to deal with variation is to use metrics to describe it. Two widely used metrics are the **mean** (average) and the **standard deviation**. The standard deviation quantifies the variation around the mean.

6-:Process Efficiency Audits

- The overall goal of process management is to continuously help drive incremental improvements (often minor) in all processes under the belief that the collective

impact of that effort will result in valuable improvements for the overall business performance and ultimately increase profitability.

- In order to achieve these efficiencies, however, involves conducting process efficiency audits to identify any areas where improvements can be made. This process efficiency audit usually entails the following steps:

1. Establishing the process owner/s.
2. Identifying the end-users and customers/clients for the process, as well as their needs and expectations in regards to the outputs of the process.
3. Identifying the inputs into the process - examples of inputs include data, materials, resources, knowledge, people etc. and are required by the process to produce its outputs.
4. Ensuring that the quality of these inputs is adequate to provide the expected outputs from the process.
5. Determining what internal and external resources are vital to make the process work to its optimum efficiency.
6. Breaking down the process into sub-processes, activities and tasks/steps.
7. Continuously analysing where efficiencies or improvements can be made and implementing those changes.
8. Establishing performance measures to monitor the effectiveness of the process and track the effect of any improvements made. [1]

- **Role of Decision Making in Operation management**

Introduction

The chief role of an operations manager is that of planner/decision maker. In this capacity, the operations manager exerts considerable influence over the degree to which the goals and objectives of the organization are reached. Most decisions involve many possible alternatives that can have quite different impacts on costs or profits. Consequently, it is important to make **informed** decisions.

Operations management professionals make a number of key decisions that affect the entire organization. These include the following:

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

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

Where: Where will the work be done?

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

Who: Who will do the work?

Strategic versus Tactical Operations Decisions

Strategic and tactical operations decisions determine how well the organization can accomplish its goals. They also provide opportunities for the organization to achieve unique competitive advantages that attract and help to retain customers. There are two main categories of decision making - Strategic Operations Decisions and Tactical Operations Decisions. Click on the tabs below to learn more about each.

Operations decisions include decisions that are strategic in nature, meaning that they have long-term consequences and often involve a great deal of expense and resource commitments. Strategic operations decisions include facility location decisions, the type of technologies that the organization will use, determining how labour and equipment are organised, and how much long-term capacity the organization will provide to meet customer demand.

Tactical Operation Decisions

Tactical operations decisions have short to medium term impact on the organization, often involve less commitment of resources, and can be changed more easily than strategic decisions. Tactical decisions include workforce scheduling, establishing quality assurance procedures, contracting with vendors, and managing inventory.

The use of Models as a Decision-Making Tool

Firstly a model can be defined as a simplified representation of something. Models are sometimes classified as physical, schematic, or mathematical:

1. **Physical models** look like their real-life counterparts. For instance, scale-model buildings would be an example of a physical model. The advantage of these models is their visual correspondence with reality.
2. **Schematic models** are more abstract than their physical counterparts; that is, they have less resemblance to the physical reality. Examples include graphs and charts, blueprints, pictures, and drawings. The advantage of schematic models is

that they are often relatively simple to construct and change. Moreover, they have some degree of visual correspondence.

3. **Mathematical models** are the most abstract: They do not look at all like their real-life counterparts. Examples include numbers, formulas, and symbols. These models are usually the easiest to manipulate, and they are important forms of inputs for computers and calculators.

- The variety of models in use is enormous. Nonetheless, all have certain common features: They are all decision-making aids and simplifications of more complex real-life phenomena.

Type of Operation Management Decisions

Introduction

Countless operations decisions that have both long-term and short-term impacts on the organization's ability to produce goods and services that provide added value to customers must be made. If the organization has made mostly good operations decisions in designing and executing its transformation system to meet the needs of customers, its prospects for long-term survival are greatly enhanced.

Major operations decisions areas include the following nine decision areas:

(1)Inventory (2) Capacity (3) Quality (4) Scheduling (5) Process
(6) Technology (7) Location (8) Layout (9)Supply Chain Management

1. Inventory Decisions

The key question that must be answered for inventory is "How much?" Understanding the best inventory levels to carry is critical to the organization because too much inventory and too little inventory are both costly to the organization.

Inventory that exceeds what is needed to satisfy customer demand imposes unnecessary costs such as storage, deterioration, obsolescence, theft, and money tied up in inventory that cannot be used for other purposes. Too little inventory means the organization cannot meet 100 per cent of its customer demand and sales revenues are delayed or lost.

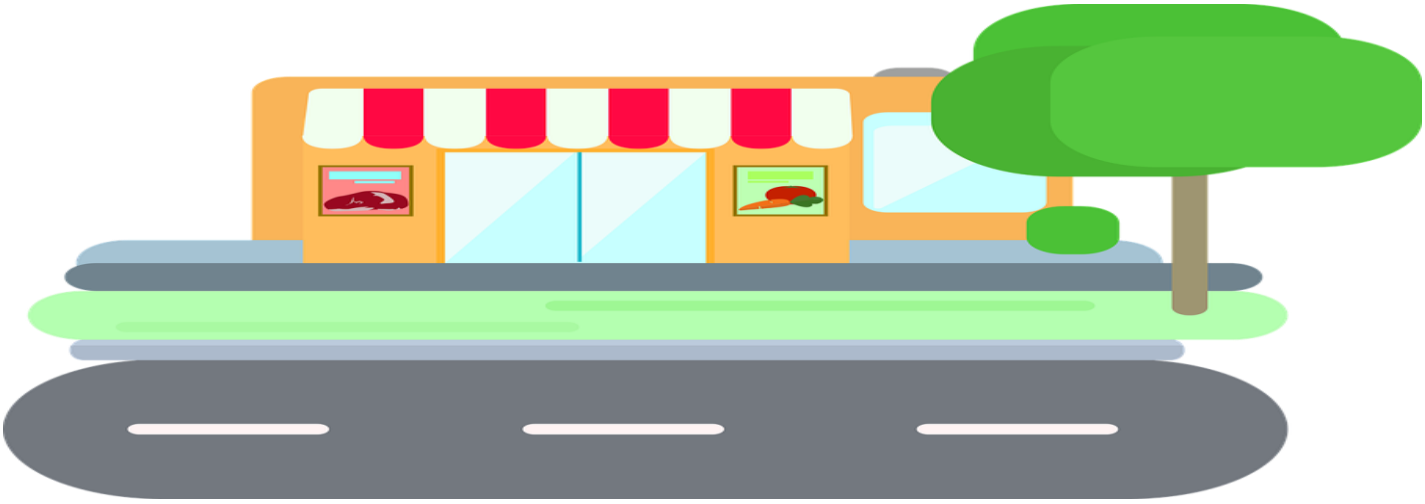
For example, a restaurant that specialises in serving fresh fish needs to make careful purchasing decisions so it has enough fresh fish each day to serve its customers, but not so much that unsold fish must be severely discounted or discarded at the end of the day. Computer companies such as Dell must carefully manage its computer chip inventory so it can meet current customer orders, but

not be stuck with too much inventory if a new computer chip comes out or if vendors reduce prices.

2. Capacity Decisions

The question managers must answer for the capacity decision area is the same as the question for inventory: “How much?” Determining the organization’s capacity to produce goods and services involves both long-term and short-term decisions. Long-term capacity decisions involve facilities and major equipment investments.

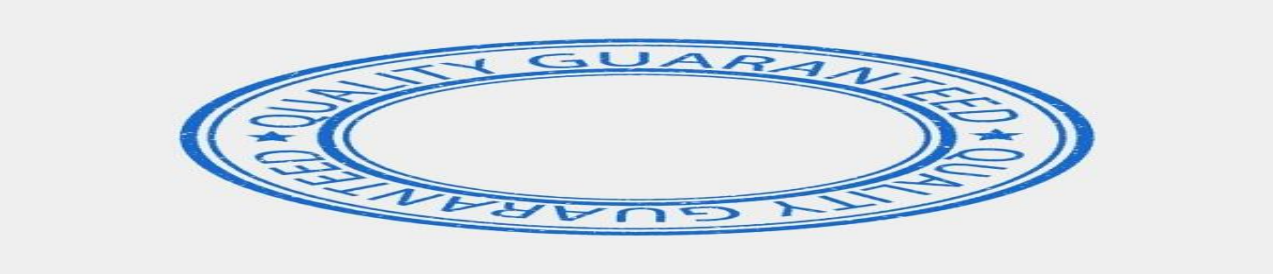
Capacity decisions also involve short-term situations. In a grocery store for example, the number of customers that need to pay for their groceries at any one point during the day will vary significantly. To provide good customer service, managers must make sure that sufficient cash registers and employees are on hand to meet check-out demand. Similarly, hotels must make sure that they have enough employees to register arriving guests, to clean hotel rooms, and to provide food and beverages to customers. These decisions must be made carefully to avoid excessive labor costs from having too many employees for the number of customers being served.



3. Quality Decisions

The decision relating to quality is not "how much" quality to have. If asked whether they support high quality in their organization, virtually all managers will respond enthusiastically that they fully support high quality! Rather, the quality of goods and services is determined by numerous decisions throughout the organization that have both long-term and short-term consequences for the organization's quality performance.

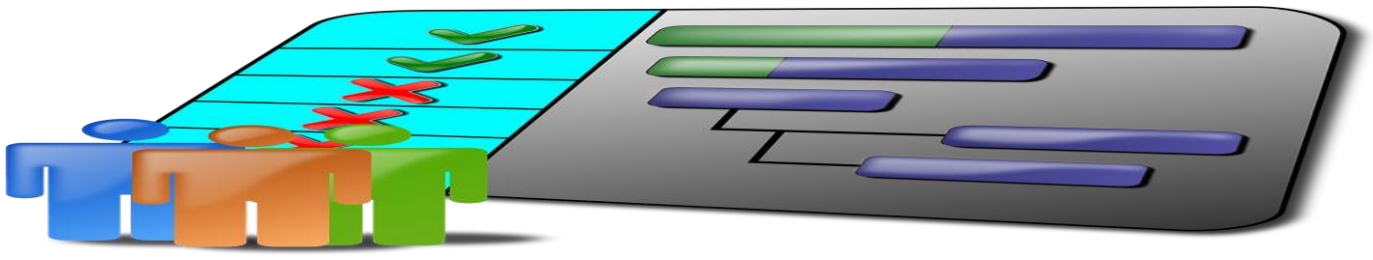
Quality improvement efforts require a great deal of analysis and teamwork, as well as a determined effort to make quality a top priority in the organization. Improving quality requires everyone to adopt a "continuous improvement" philosophy, where everyone approaches their work with the view that there are always opportunities to improve on the organization's key performance measures. Continuous improvement efforts are multidimensional and complex, and require partnerships among workers, management, suppliers, and customers.



- **4. Scheduling/Planning Decisions**

Scheduling is an operations decision that strives to provide the right mix of labor and machines to produce goods and services at the right time to achieve both efficiency and customer service goals. For example, a hotel must anticipate the peaks and valleys in demand that may occur during a day, during the week, and at different times of the year.

Labor (front desk clerks, room service personnel, housekeepers, bellhops, etc.) must be scheduled carefully to meet customer demand at any given time, without scheduling excess employees that would impose unnecessary costs on the hotel. In a hospital setting, scheduling surgeries is a very important activity. Surgeons, nurses, support staff, equipment, supplies, and operating rooms must be scheduled carefully so patient surgeries can be conducted in an efficient manner.



Planning decisions can include **aggregate planning** (What is the annual production plan for all products or services to be produced?) and **master scheduling** (How many of each product will be produced in a specific time period.

5. Process Decisions

Operations managers' must decide how to organise equipment and labor to achieve the competitive goals of the organization. There are two basic choices for organising the workplace to produce goods and services:

(1) Intermittent processes, (2) repetitive processes and (3) Cellular processes.

Repetitive processes are used to produce identical or very similar products in high volumes. **Equipment and labor are organised in a line flow arrangement to meet very specific customer or product processing requirements.** Examples include assembly lines that produce products such as computers, cars, hamburgers, automatic car washes, and cafeteria lines.

In all of these cases, the products or customers follow the same production steps to produce a standardized outcome. Since the production requirements to produce each unit of output are so well understood, there are many opportunities to achieve high levels of efficiency in repetitive process environments. **Efficiency is a key goal in repetitive process environments.**

Thus, in contrast to intermittent processes, repetitive processes are very efficient at reducing unit production costs, waiting time, and inventories, but they are not very flexible in accommodating high product/customer variety.

A compromise solution is the cellular process layout that captures the advantages of both intermittent and repetitive processes.

A cellular process arranges dissimilar machines and equipment together in a line that is dedicated to producing a specific family of products that have similar processing requirements. By setting up multiple dedicated cells, the facility can efficiently produce a wide variety of products

Since the products within a family have similar production requirements, equipment setup times, inventories, and lot sizes can be kept to a minimum. This approach allows each product to be sent through the manufacturing process one piece at a time, according to the immediate set of customer orders. It provides workers the flexibility to change a product or customize it in some way in response to specific customer requirements. The cells are usually arranged in a **U shape**.

6. Technology decisions

There are many benefits that technology can bring to an operations environment. Automated machinery, programmable equipment, and management information systems can provide speed, low unit processing costs, labor cost savings, increased accuracy and consistency, and sophisticated tracking and decision support

systems to increase operations efficiency and effectiveness for both manufacturing and service environments.

The challenge for managers in technology is selecting the right technology for the right application. For example, if a manufacturing company believes that automation can help adapt to a competitive environment, questions should be asked, such as:

What type of flexibility does the company need to thrive?

Does it need to quickly switch production across a wide variety of products (product mix flexibility)?

Does it need to quickly produce new products for a rapidly changing marketplace (product development flexibility)?

Does it need to be able to quickly ramp up production during times of high demand, and quickly scale down production when cyclical or seasonal demand hits downturns (volume flexibility)?

7. Location Decisions

There are many factors that can determine where an organization will locate its facilities. For any given situation, some factors become more important than others in how facility location affects an organization's efficiency and effectiveness.

- **Proximity to sources of supply**: Firms that process bulk raw materials usually locate close to the source of supply to reduce transportation costs.
- **Proximity to customers:** There are several reasons why an organization would locate close to end customers. Service firms need to be close to customers to be convenient, as is the case for grocery stores, gas stations, fast food restaurants, and hospitals.
- **Community factors**: Communities may offer a number of incentives to entice companies, including waiving or reducing taxes, and providing access roads, water and sewer connections, and utilities. Conversely, some communities may actively discourage companies that might bring more pollution, noise, and traffic to the area.
- **Labor factors**: Research shows that the majority of location decisions are largely based on labor factors, since labor is a critical variable for many firms. Labor factors include the prevailing wage rate in a community for similar jobs, the supply of qualified workers, and the average education level of the local population.

- **Other factors**: Many other factors can play a role in the location decision, including quality of life (crime rates, good schools, climate, and recreation options), access to major transportation arteries, construction costs, proximity of the competition, and opportunities for future expansion.

8. Layout and Flow

This area of decision making refers to determining the placement of desks, workstations, and how materials are delivered and used. To a large extent the objectives of any layout will depend on the strategic objectives of the operation, but there are some general objectives that are relevant to all operations:

- **Inherent safety** – all processes that could put staff or customers in risk should not be accessible to anyone who is not authorized.
- **Length of flow** – the flow of materials, information or resources should be appropriate for the operation.
- **Clarity of flow** – all flow of materials and customers should be well signposted, clear and evident to customers and staff alike.
- **Staff conditions** – staff should be located away from unpleasant or noisy parts of the business operations.
- **Management coordination** – supervision and communication should be facilitated by the location of staff.
- **Accessibility** – all machines and facilities should be accessible for cleaning and maintenance.
- **Use of space** – all layouts should use space appropriately.
- **Long term flexibility** – layouts may need to be changed periodically. An effective layout should devised with the possible future needs of the operat ion in mind.

9. Supply Chain Decisions

- Supply chain management is the business function that coordinates and manages all the activities of the supply chain, including suppliers of raw materials, components and services, transportation providers, internal departments, and information systems. Thus, the company must decide how to coordinate and manage all activities in the supply chain.

Operation Strategy

Introduction

The operations strategy focuses on the pattern of strategic decisions and actions which define the role, objectives and activities of an organization's operations.

The most fundamental role of operations it to implement strategy. Most companies will have some kind of strategy but it is the operation that puts these decisions and actions into practice. Without effective implementation even the most well-developed strategy could be rendered totally ineffective if not implemented correctly.

Hayes and Wheelwright's Four Stages of Operations Contribution

The success of any operation within a company can be evaluated by considering the organizational aims or aspirations of the operations function.

Hayes and Wheelwright of Harvard University developed a four stage model which can be used to evaluate the role and contribution of the operations function. As shown in the image below, the model traces the progression of the operations function from what is the largely negative role of stage 1 operations to becoming the central element of competitive strategy in stage 4 operations.

	Neutral	Supportive
Internally	*Stage 1* *Internally neutral* Objective is to minimise the negative impact of 'operations'	*Stage 3* *Internally supportive* Objective is for 'operations' to provide credible support for the business strategy
Externally	*Stage 2* *Externally neutral* Objective is for 'operations' to help the business maintain parity with its competitors	*Stage 4* *Externally supportive* Objective is for 'operations' to provide a source of competitive advantage

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The Hayes and Wheelwright four-stage model

Hayes and Wheelwright's Four Stages of Operations Contribution

Stage-1: Internally Neutral

At the lowest levels of capability (Stage 1) the operation is seen as holding the organization back. This is because the operation regularly under-performs, relative to its market requirements, and/or regularly makes mistakes that can deliver low quality product or service to the customer at tremendous cost of loss of reputation and rework.

Stage-2: Externally Neutral

A high proportion of operations are probably at Stage 2: they are striving to adopt best practice in their industry and are usually as good as their competitors at serving their market. These operations are good enough to help implement the organization's strategy but the operation itself does not convey any competitive advantage.

Stage-3: Internally Supportive

At Stage 3 the operation offers the best capabilities in the sector and so the competitive strategy can be linked to operations. The organization can exploit the operations' capabilities to offer better prices, differentiated products, faster deliveries or greater flexibility to maximise returns and increase market share.

Stage- 4: Externally Supportive

Very few organizations ever operate at the levels described in Stage 4 of the model, where operations convey such a competitive advantage through their performance and capability that the entire organization strategy can be built around the operation. In these situations the market expectations of what can be achieved are changed by the operations performance.

Managing Overall Equipment Effectiveness

Define what the metric Overall Equipment Effectiveness (OEE) is commonly used for.

Outline the basic formula used to calculate OEE.

Describe what valuable operating time and loading time mean.

Explain what Total Equipment Effectiveness Performance (TEEP) is used to measure.

Identify what the key types of losses based on the Six Big Losses Model.

Discuss how to apply OEE to process improvement activities.

Identify the four key stages of the Deming Circle/PDSA approach.

Outline the use of static and dynamic data as part of the Deming Circle/PDSA approach.

Introduction

Overall equipment effectiveness (OEE) is a performance KPI commonly used by operations managers, production and process engineers to measure and compare the performance of the equipment in a factory. OEE is a powerful tool that can be used also to perform diagnostics as well as to compare production units in differing industries.

OEE was established as the backbone of Total Productive Maintenance (TPM)[1] and then of other techniques employed in asset management programs, Lean manufacturing,[2] Six Sigma,[3] World Class Manufacturing.[4]

By the end of the 1980's, the concept of Total Production Maintenance became more widely known in the Western world and along with OEE implementation too. OEE takes into account the losses of production and divides them into one of three categories which are:

(1)-:Availability (2)-:Performance (3)-: Quality

For example, an OEE of 100% means that only good parts are produced (100% *quality*), at the maximum speed (100% *performance*), and without interruption (100% *availability*).

OEE Calculation Model

The OEE calculation model is then designed to isolate losses that degrade the equipment effectiveness. The basic definition of OEE is:

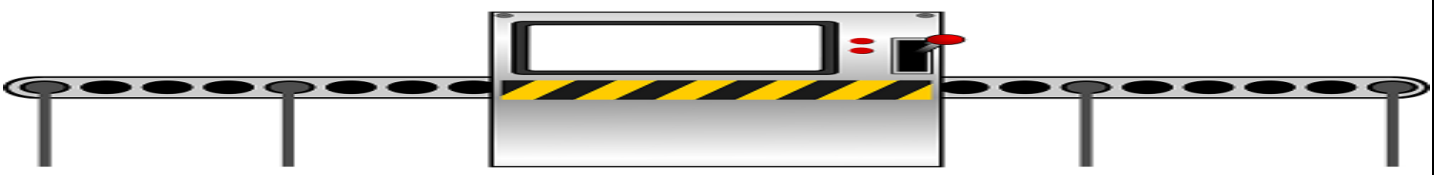
$$OEE = \frac{Valuable\ Operating\ Time}{Loading\ Time}$$

where:

Valuable Operating Time is the net time during which the equipment actually produces an acceptable product;

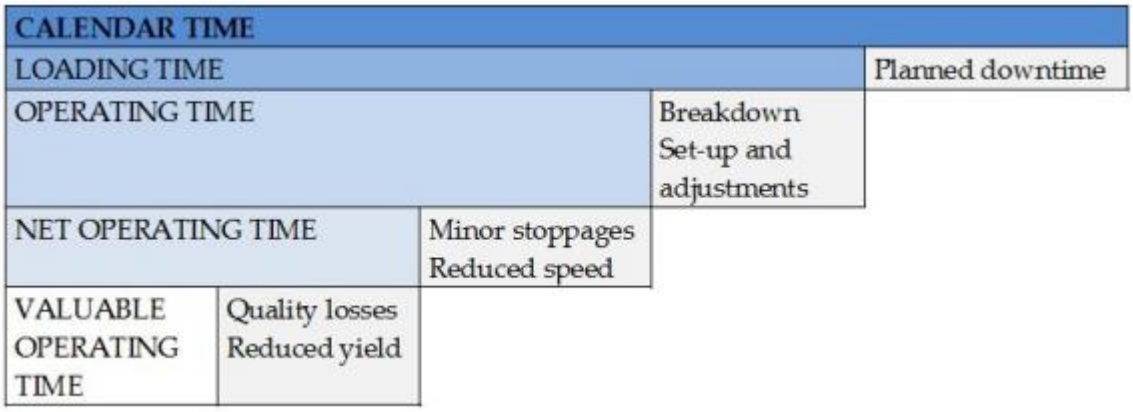
Loading Time is the actual number of hours that the equipment is expected to work in a specific period (year, month, week, or day).

- The formula indicates how much the equipment is doing what it is supposed to do and it captures the degree of conforming to output requirements. It is clearly a measure of effectiveness.
- OEE is not only a metric, but it also provides a framework to improve the process. A model for OEE calculation aims to point out each aspect of the process that can be ranked for improvement.
- To maximise equipment effectiveness it is necessary to bring the equipment to peak operating conditions and then keeping it there by eliminating or at least minimising any factor that might diminish its performance. In other words a model for OEE calculation should be based on the identification of any losses that prevent equipment from achieving its maximum effectiveness.



Total Equipment Effectiveness Performance (TEEP) and OEE

Total Equipment Effectiveness Performance (TEEP) measures OEE effectiveness against Calendar Time, i.e.: 24 hours per day, 365 days per year. The image below highlights the typical breakdown of calendar time.



OEE and TEEP are thus two closely related measurements. TEEP is useful for business analysis and can be calculated using the following formula:

$$TEEP = \frac{Valuable\ Operating\ Time}{Calendar\ Time} = OEE \times \frac{Loading\ Time}{Calendar\ Time}$$

TEEP Calculation Formula

- **Defining Elements of the OEE Calculation Model**

  Thus, OEE breaks the performance of equipment into three separate and individually measurable components:

  Availability: it is the percentage of time that equipment is available to run during the total possible loading time. Equipment availability can be even calculated as:

$$Availability\ (A) = \frac{Operating\ Time}{Loading\ Time}$$

  Availability is different than utilization. Availability only includes the time the machine was scheduled, planned, or assigned to run. Utilization covers all hours of the calendar time.

  Utilization is more effective in capacity planning and analyzing fixed cost absorption. Availability looks at the equipment itself and focuses more on variable cost absorption.

Defining Elements of the OEE Calculation Model

Performance: measures how well machines run within the operating time, which can be calculated as:

$$Performance\ (P) = \frac{Net\ Operating\ Time}{Operating\ Time}$$

Quality: measures the number of parts that meet specification compared to how many were produced:

$$Quality = \frac{Actual\ output\ (units) - Defect\ amount\ (units)}{Actual\ output\ (units)}$$

After the various factors are taken into account, all the results are expressed as a percentage that can be viewed as a snapshot of the current equipment effectiveness.

- **Example of OEE Calculation**

  The example below illustrates the sensitivity of the OEE measure to a low and combined performance. Consequently, it is impossible to reach 100 % OEE within an industrial context. Worldwide studies indicate that the average OEE rate in manufacturing plants is 60%.

Availability	86,7%
Performance	93%
Quality	95%
OEE	76,6%

Example of OEE Calculation

As pointed out by e.g. Bicheno[5] world class level of OEE is in the range between 85-92% for non-process industry. Clearly, there is room for improvement in most manufacturing plants! The challenge is, however, not to peak on those levels but thus to exhibit a stable OEE at world-class level.

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Loss Analysis and OEE

Introduction

- Firstly, losses are activities that absorb resources without creating value. Losses can be divided by their frequency of occurrence, their cause and by different types they are. The latter one has been developed by Nakajima[1] and it is the well-known Six Big Losses framework. The other ones are interesting in order to rank rightly losses.
- According to Johnson et al.[2], losses can be chronic or sporadic. **Chronic losses** are usually defined as “small, hidden and complicated” while the **sporadic losses** occur quickly and with large deviations from the normal value.
- The loss frequency combined with the loss severity gives a measure of the damage and it is useful in order to establish the order in which the losses have to be removed. This classification makes it possible to rank the losses and remove them on the basis of their seriousness or impact on the organization.

Losses can be caused by any of the following:

Machine malfunctioning: an equipment or a part of this does not fulfill the demands.

Process: the way the equipment is used during production.

External causes: cause of losses that cannot be improved by the maintenance or production team.

Down Time Losses, Speed Losses and Quality Losses

The external causes such as shortage of raw materials, lack of personnel or limited demand do not impact on the equipment effectiveness. They are of great importance for top management and they should be examined carefully because their reduction can directly increase the revenues and profit. However they are not responsibility of the production or maintenance team and so they are not taken into consideration through the OEE metric.

To improve the equipment effectiveness the losses because of external causes have to be taken out and the losses caused by machine malfunctioning and process, changeable by the daily organization, can still be divided into down time losses, speed losses and quality losses, which are explained further in the tabs below.

Down time losses: when the machine should run, but it stands still. Most common downtime losses happen when a malfunction arises, an unplanned maintenance task must be done in addition to the big revisions or a set-up/startup time occurs.

Speed losses: the equipment is running, but it is not running at its maximum designed speed. Most common speed losses happen when equipment speed decrease but it is not zero. It can depend on a malfunctioning, a small technical imperfections, like stuck packaging or because of the start-up of the equipment related to a maintenance task, a setup or a stop for organizational reasons.

Quality losses: the equipment is producing products that do not fully meet the specified quality requirements. Most common quality losses occur because equipment, in the time between start-up and completely stable throughput, yields products that do not conform to quality demand or not completely. They even happen because an incorrect functioning of the machine or because process parameters are not tuned to standard.

Managing the Six Big Losses

By having a structured framework based on the Six Big Losses, OEE lets to track underlying issues and root causes. By knowing what the Six Big Losses are and some of the causes that contribute to them, the next step is to focus on ways to monitor and correct them. In the following let's see what is the way:

Breakdown: eliminating unplanned downtime is critical to improving OEE. Other OEE factors cannot be addressed if the process is down. It is not only important to know how much and when down time equipment is but also to be able to link the lost time to the specific source or reason for the loss. With down time data tabulated, the most common approach is the **Root Cause Analysis**, which is typically based on the PDSA or PDCA cycle. For instance, in the "Plan" phase of PDSA or PDCA, the root cause of the issue is identified and a plan to address it is created. This approach usually focuses on the most severe loss categories first.

Set-up and adjustments: tracking setup time is critical to reducing this loss. The most common approach to reduce this time is
the **Single Minute Exchange of Dies** (SMED) program, which aims to convert as many elements as possible to “external” (performed while the equipment is running) in order to reduce set-up time.

Minor stoppages and reduced speed: minor stoppages and reduced speed are the most difficult of the Six Big Losses to monitor and record.

Cycle Time analysis should be utilised to point out these loss types. In most processes recording data for Cycle Time analysis needs to be automated since the cycles are as quick as they do not leave adequate time for manual data logging. By comparing all cycles to the theoretical Cycle Time, the losses can be automatically clustered for analysis. It is important to analyse Minor stoppages and Reduced speed separately because the root causes are typically very different.

Quality losses and reduced yield: parts that require rework of any kind should be considered rejects. Tracking when rejects occur and the type is critical to point out potential causes, and in many cases patterns will be discovered. Often a TQM approach is adopted, where a common metric is achieving a defect rate of less than 3.4 defects per million opportunities, is used to focus attention on a goal of “zero defects”.

Applying OEE to Process Improvement Activities

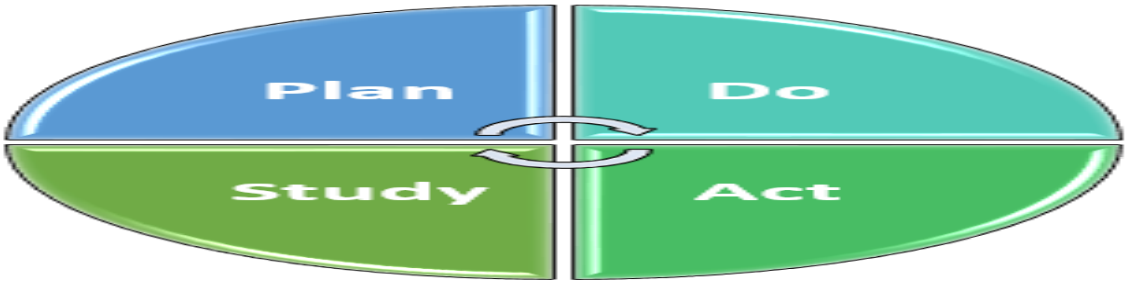
OEE provides simple and consolidated formulas to measure effectiveness of the equipment or production system. Moreover, Dal et al.,[1] point out that it can also be used as an indicator of process improvement activities since OEE is directly linked to the losses and can be even used to compare performance across the factory highlighting poor line performance or to quantify improvements made.[2] Moreover improving can be pursued by:

Backtracking to determine what loss reduces effectiveness.

Identifying bottlenecks as not only the slowest machine, but as the machine both slower and less effective.

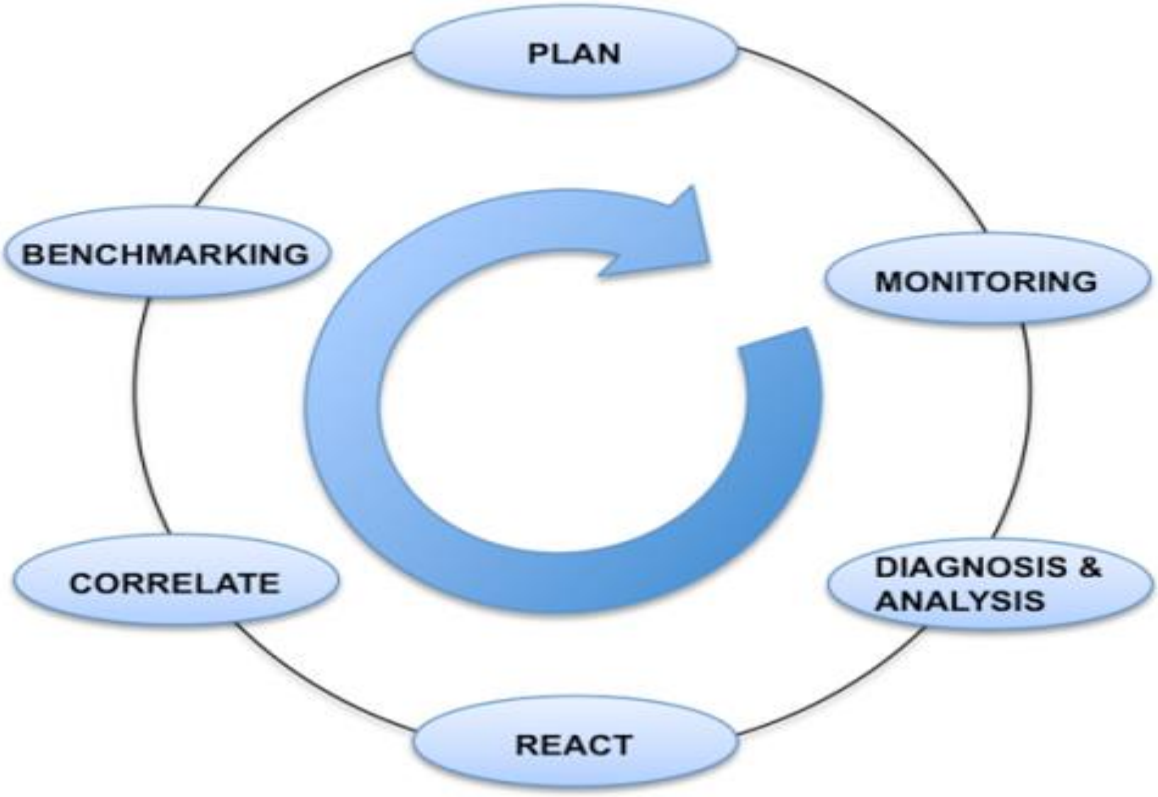
All of these goals should use an approach based on the Deming Cycle (also known as the PDSA), A continuous improvement model which consists of four key stages: **Plan**, **Do**, **Study**, and **Act.**

Another variation of this model is the PDCA (Plan, Do, Check, Act) approach, which is commonly used as part of continuous process improvement initiatives.



Applying OEE to Process Improvement Activities

Process improvement activities require a large amount of data which can be static or dynamic:



Example of an Improvement Approach to Increase an Organization's OEE

Static data: refers to the collection of data at the end of a certain period and used in the Diagnosis and Analysis stage (see image of Deming Cycle on next page).

Dynamic data: refers to a data collection process whereby data is collected in real time through a continuous monitoring process which immediately identifies possible problems and react in real-time using appropriate corrective actions. This second approach requires then a data collection system completely automatised and moreover the Diagnosis and Analysis stage should be automatic.

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QUALITY MANAGEMENT

Introduction to Quality Management

- **General Overview**

Quality management refers to the process of overseeing different activities and tasks within an organization to ensure that products and services offered, as well as the means used to achieve them, are consistent.

Operations Managers are concerned with the quality of the output of their operations system. This quality may be associated with the reliability of the product or service, the conformity to regulations, the level of waste, the level of after sales service provided, the design of the product, and the consistency of delivery of the product or service.

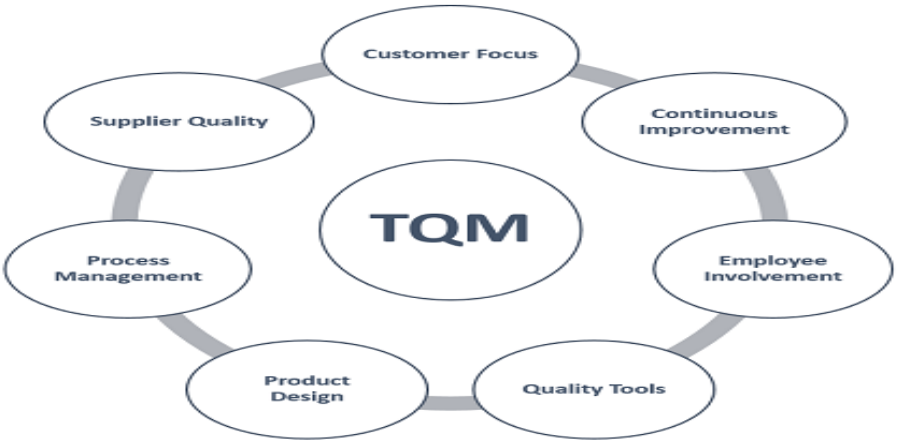
Quality benchmarks may be achieved by using one or more of the following strategies:

- **Quality control** (where the quality is monitored during the production or the service provision process).
- **Quality assurance** (where the organization achieves certification that is dependent upon them achieving specified levels of quality in the actual production of the good or service).
- **Total quality management** (where the organization applies both quality control and quality assurance to their production or provision processes).

Types of Quality Management Approaches

Total Quality Management (TQM)

- TQM aims to improve quality and productivity by striving to perfect the entire production process. TQM stresses coordination between departments, especially product design, purchasing, sales and service so that all groups are working together. It is based on promoting continuous improvement in the quality of all the processes involved.



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TOTAL SEVEN BASIS ELEMENT OF TQM

- **Overview of TQM (TOTAL QUALITY MANAGEMENT**

  Operations management has evolved over the past three decades with the introduction of new models, such as Total Quality Management (TQM). TQM entails an organization-wide management of quality that includes facilities, equipment, labor, suppliers, customers, policies, and procedures.

  TQM promotes the view that quality improvement never ends, quality provides a competitive advantage for the organization. Zero defects is the ideal goal that will minimise total quality costs. While this special topic on TQM is not a comprehensive discussion of all aspects of TQM, several key concepts will be discussed.

  An important basis for justifying TQM practice is understanding its impact on total quality costs. TQM is rooted in the belief that preventing defects is cheaper than dealing with the costs of quality failures. In other words, total quality costs are minimised when managers strive to reach zero defects in the organization.

  The four major types of quality costs include:

  (1) Prevention costs (2)Appraisal costs
  (2) (3) Internal failure costs (4)External failure costs

1. Prevention Costs

- **Prevention costs are the costs created from the effort to reduce poor quality**. Examples are designing the products so that they will be durable, training employees so they do a good job, certifying suppliers to ensure that suppliers provide quality in products and services, conducting preventive maintenance on equipment, and documenting quality procedures and improvements. In a traditional organization that does not practice TQM, prevention costs typically comprise the smallest percentage of total quality costs.
- **Employee training is also a very important prevention cost**. For instance, employees in a vegetable/fruit packaging warehouse need to understand what a bad vegetable/fruit looks like, since customers will not want to buy spoiled produce in the store. In many circumstances in both manufacturing and service businesses, the training of employees can make an enormous difference in preventing defects.
- **Supplier selection and certification are critical prevention activities**. A product or service is only as good as the suppliers who partner with an organization to provide the raw materials, parts and components, and supporting

services that make up the final products and services that the end customers receive

- **Preventive maintenance is necessary for preventing equipment breakdowns**. In addition, **documenting quality is a necessary prevention** cost because it helps the organization track quality performance, identify quality problems, collect data, and specify procedures that contribute to the pursuit of zero defects

2.Appraisal Costs

Appraisal costs are a second major type of quality cost. **Appraisal costs include the inspection and testing of raw materials**, **work-in-process (WIP)**, **and finished goods**. In addition, quality audits, sampling, and statistical process control also fall under the umbrella of appraisal costs.

Inspection and testing of raw materials is very important, since substandard raw materials lead to substandard products. Raw materials used for a bridge determine the strength of the bridge. For example, soft steel will erode away faster than hardened steel. Moreover, the concrete bridge decking needs to be solid, as concrete with air pockets will erode and crumble faster creating an unsafe bridge.

Finished goods and work-in-process (WIP) inventory also need inspecting and testing. **Quality audits and sampling** are also important appraisal costs. Quality audits are checks of quality procedures to ensure that employees and suppliers are following proper quality practices. With sampling, a company can ensure with confidence that a batch of products is fit for use.

Statistical process control (SPC) is the final type of appraisal cost. SPC tracks on-going processes in manufacturing or service environments to make sure that they are producing the desired performance. For example, a restaurant might statistically track customer survey results to make sure that customer satisfaction is maintained over time.

3. Internal Failure Costs

Internal failure costs are a third category of quality costs. This cost occurs when quality defects are discovered before they reach the customer. Examples of internal failure costs include:

(1)Scrapping a product (2) Reworking the product

(3) Lost productivity due to machine breakdowns (4) Labour errors

Internal failure costs are typically more expensive than both prevention and appraisal costs because a great deal of material and labor often has been invested prior to the discovery of the defect.

For example, if a book publisher prints 10,000 books, then discovers that one of the chapters is missing from every copy, the cost of reworking or scrapping the books represents a major loss to the company. It may have been much cheaper to have procedures in place to prevent such a mistake from happening in the first place.

4. External Failure Costs

External failure costs are the fourth major cost of quality. External failure costs occurs when the defect is discovered after it has reached the customer. This is the most expensive category of quality costs. Examples include:

(1)Product returns/recalls (2) Product repairs (3)Warranty claims

(4)Lost reputation and lost business

NOTES

One spectacular example of external failure cost was when the Hubbell telescope was launched into space with mirrors that were ground improperly. When the telescope was turned on, instead of a magnificent view of stars, planets, and galaxies, the scientists were only able to see blurred images. The price of correcting the problem was over USD 1 billion.

Because of the huge costs of internal and external failures, all companies should aim for zero defects. Successful TQM practice dictates that pursuing zero defects will result in the minimisation of total quality costs by spending more on prevention and appraisal activities in order to reduce the much higher costs of internal and external failure.

APPLYING TQM PRACTICE IN OPERATION MANAGEMENT

Introduction

Successful practice of Total Quality Management involves both technical and people aspects that cover the entire organization and extend to relationships with suppliers and customers. Seven basic elements capture the essence of the TQM philosophy: customer focus, continuous improvement, employee empowerment, quality tools, product design, process management, and supplier quality

The seven basic elements that capture the essence of the TQM philosophy include:

(1)Customer focus (2)Continuous improvement (3)Employee empowerment

(4) Quality tools (5) Product design (6) Process management (6)Supplier quality

Quality Awards and Standards

There are several quality awards and standards that are available for organizations to access. The large majority of organizations that use these programs use them as tools to help improve their quality processes and move toward implementing and successfully practicing TQM.

THE MALCOLM BALBRIGE AWARD

The Malcolm Baldrige Award is a United States quality award that covers an extensive list of criteria that are evaluated by independent judges if an organization chooses to compete for the award.

In many cases, organizations use the Baldrige criteria as a guide for their internal quality efforts rather than compete directly for the award.

The criteria can be accessed from the Internet at:
http://www.baldrige.nist.gov/rnet

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION

The International Organization for Standardization (ISO) sponsors a certification process for organizations that seek to learn and adopt superior methods for quality practice (ISO 9000) and environmentally responsible products and methods of production (ISO 14000).

These certifications are increasingly used by organizations of all sizes to compete more effectively in a global marketplace due to the wide acceptance of ISO certification as a criterion for supplier selection.

More details about ISO 9000 and ISO 14000 can be found on the ISO website at: http://www.iso.org/iso/home.htm

THE DEMING PRIZE

Another popular quality award is the Deming Prize, which is a Japanese quality award for which organizations from any country can apply.

The Deming Prize was named after W. Edwards Deming, an American statistician, author, and consultant who is widely credited with assisting post-war Japan in rebuilding their nation's production infrastructure in the areas of product design, product quality, and testing through the application of statistical methods.

More information on the Deming Prize can be found at: http://www.juse.or.jp/e/deming/index.html

SUPPLY CHAIN MANAGEMENT

The Role of the Supply Chain In Operation Management

Introduction

Supply chain management is the business function that coordinates and manages all the activities of the supply chain, including suppliers of raw materials, components and services, transportation providers, internal departments, and information systems.

In the manufacturing sector, supply chain management addresses the movement of goods through the supply chain from the supplier to the manufacturer, to wholesalers or warehouse distribution centers, to retailers and finally to the consumer.

Supply chain concepts also apply to the service sector, where service firms must coordinate equipment, materials, and human resources to provide services to their customers in a timely manner. For example, a retail store that sells electronic products may contract with an outside business to provide installation services to its customers. In many cases, the customer does not even know the installation was done by an outside contractor.

The supply chain is not just a one way process that runs from raw materials to the end customer. Although goods tend to flow this way, important data such as forecasts, inventory status, shipping schedules, and sales data are examples of information that is constantly being conveyed to different links in the supply chain. Money also tends to flow "upstream" in the supply chain so goods and service providers can be paid.

The Bullwhip Effect

- A major goal in supply chain management strategy is to minimise the bullwhip effect. The bullwhip effect occurs when inaccurate or distorted information is passed on through the links in the supply chain.
- As the bad information gets passed from one party to the next, the distortions worsen and cause poor ordering decisions by upstream parties in the supply chain that have little apparent link to the final end-item product demand.

  This can results in the following:

  (1)Wasteful inventory investments (2)Poor customer service
  (3) Inefficient distribution (4)Misused manufacturing capacity
  (5)Lost revenues for all parties involved the supply chain

- The bullwhip effect is primarily caused by demand forecast updating, order batching, price fluctuation, and rationing and gaming, which will be explained in further detail on the next page.

DEMAND FORECAST UPDATING

Demand forecast updating is done individually by all members of a supply chain. Each member updates its own demand forecast based on orders received from its "downstream" customer. The more members in the chain, the less these forecast updates reflect actual end-customer demand.

ORDER BATCHING

Order batching occurs when each member takes order quantities it receives from its downstream customer and rounds up or down to suit production constraints, such as equipment setup times or truckload quantities. The more members who conduct such rounding of order quantities, the more distortion occurs of the original quantities that were demanded.

PRICE FORMULA

Price fluctuations due to inflationary factors, quantity discounts, or sales tend to encourage customers to buy larger quantities than they require. This behavior tends to add variability to quantities ordered and uncertainty to forecasts.

RATIONING AND GAMING

Rationing and gaming is when a seller attempts to limit order quantities by delivering only a percentage of the order placed by the buyer. The buyer, knowing that the seller is delivering only a fraction of the order placed, attempts to "game" the system by making an upward adjustment to the order quantity. Rationing and gaming create distortions in the ordering information that is being received by the supply chain

Counteracting the Bullwhip Effect

To improve the responsiveness, accuracy, and efficiency of the supply chain, a number of actions must be taken to combat the bullwhip effect:

Make real-time end-item demand information available to all members of the supply chain. Information technologies such as electronic data interchange (EDI), bar codes, and scanning equipment can assist in providing all supply chain members with accurate and current demand information.

Eliminate order batching by driving down the costs of placing orders, by reducing setup costs to make an ordered item, and by locating supply chain members closer to one another to ease transportation restrictions.

Stabilise prices by replacing sales and discounts with consistent "**every-day low prices**" at the consumer stage and uniform wholesale pricing at upstream stages. Such actions remove price as a variable in determining order quantities.

Discourage gaming in rationing situations by using past sales records to determine the quantities that will be delivered to customers.

- Relationship between Operations, Productivity and Competitiveness

Relationship Between Operation Productivity and Competitiveness

Introduction

In addition to managing the supply chain to ensure competitive advantages can be realised, operations managers are also involved in helping to ensure productivity levels are optimised. Every organization attempts to improve its productivity (i.e. its rate of production output per unit of input in a given time period) as it helps to facilitate a more competitive cost structure for the organization and enables the organization to offer more competitive prices to its customers.

There are three key types of productivity: (1)Technological productivity (2):Employee productivity (3)Managerial productivity

LEAN PRODUCTION SYSTEM

Introduction

JUST IN TIME

Just-in-Time inventory management was first proposed within the Toyota Production System (TPS) by Taiichi Ohno after the 50's when he conceived a more convenient way to manage inventory and control production systems.[1] TPS, now more commonly known as **Lean Production**, is a mix of a philosophy for production systems management and a collection of tools to improve the enterprise performances. [2]

Lean production or TPS is focused on the reduction of **muda** (wastes), **mura** (unevenness) and **muri** (overburden). Ohno identified seven wastes[3] that should be reduced to maximise the return of investment of a production facility:

(1)Transportation (2)Inventory (3)Motion (e.g. unnecessary motion/exertion) (4)Waiting (e.g. idle time between actions) (5)Over-processing (6)Over-producing (7)Defects

One-Card Kanban System

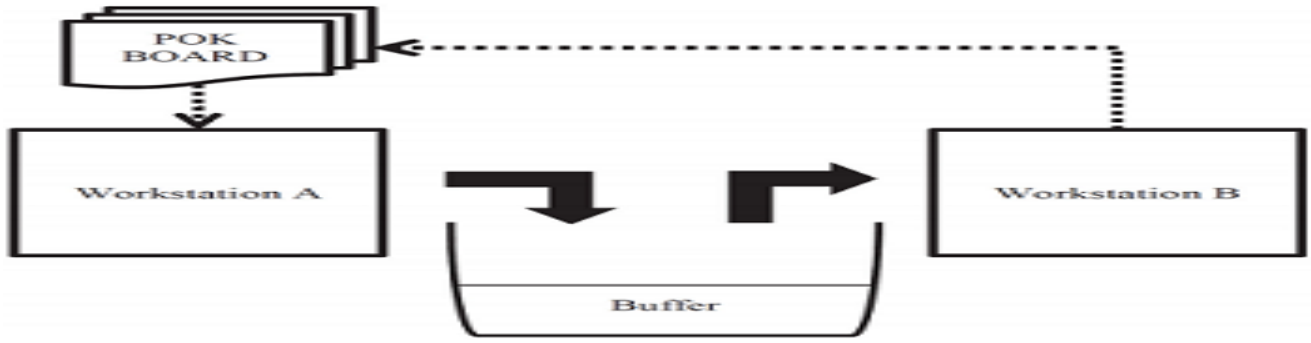
The "one-card" is the simplest implementation of kanban systems. This approach is used when the upstream and downstream workstations (respectively, the preceding and succeeding processes) are physically close to each other, so they can share the same stock buffer. The card is called "**Production Order Kanban**" (POK). The stock buffer acts as the outbound buffer for the first (A) workstation or as the inbound buffer for the second (B) workstation.

Here, each container (the JIT unit load) has a POK attached, indicating the quantity of a certain material contained, along with eventual complementary information. The POK also represents a production order for the Workstation A, indicating to replenish the container with the same quantity. When a B operator withdraws a container from the buffer, he removes the POK from the container and posts it on a board. Hence, A operator knows that one container with a specific part-number must be replenished in the stock buffer.

Two-Card Kanban System (Continued)

The example two-card kanban system shown on the previous stage can be managed using the following actions:

- When a container is withdrawn from the inbound buffer, the B operator posts the WK on the WK board.
- Then, a warehouse-keeper operator uses the WK board to replenish the inbound buffer: he/she takes the WK off the board and look for the paired POK in the outbound buffer.
- Then, he/she moves the corresponding quantity of the indicated material from the A outbound to the B inbound buffer, while exchanging the related POK with the WK on the container, restoring the initial situation.
- Finally, he/she posts the left POK on the POK board. Hence, like in the previous scenario, A workstation operator knows that one container of that kind must be replenished in the outbound stock buffer.
- The effectiveness of this simple technique is significantly influenced by the policy followed to determine the kanban processing order, in the boards.



Standard Approaches to Manage the Kanban Board

From the previously described procedure, it is clear that the each workstation bases its production sequence on kanban cards posted on the POK board.

The most commonly used policy requires having a board for each station, and this should be managed as a single First-In-First-Out (FIFO) queue.[9] The board is usually structured as one vector (one column, multiple rows): POK are posted on

the board in the last row. Rows are grouped in three zones (red/yellow/green) which indicate three levels of urgency (respectively, high/medium/low).

For example, if a kanban reaches the red rows, it means that the correspondent material is likely to be requested soon, by the succeeding process. Thus, it should be urgently replenished in the outbound buffer, in order to avoid stock-outs.

A **heijunka box** is similar to an enhanced kanban board, which acts as a visual scheduling tool to obtain production leveling at the workstations. A typical type of heijunka box contains a grid of small boxes, or 'pigeon holes,' mounted on a wall. Each row of these boxes represent a component or process, while each column represents a time period.

Hence, the use of a heijunka box not only provides a representation for each job queued for production, but for its scheduled time as well, and allows operators to pursue production leveling when inserting new POKs in the boxes.

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INVENTORY MANAGEMENT TECHNIQUES

Introduction

An effective operations management system will not only involve planning the operations but also controlling the costs associated with these operations. These costs may be classified as either direct or indirect costs:

Direct costs are those costs directly related to output and in direct proportion to t hat output level e.g. supplies and employee costs.

Indirect costs are those costs that are incurred irrespective of output levels e.g. re nt and other related costs.

A large portion of the operations manager's job thus consists of inventory management. Inventory is defined as the goods that an organization keeps on hand for use in the production process. There are three key types of inventory:

Finished goods inventory includes items that have passed through the entire production process but have not yet been sold. This form of inventory is expensive because the organization has invested labour costs and other related costs to make the finished product but as yet it has not been sold.

Work-in-progress inventory includes the materials moving through the stages of the production process that are not yet completed products.

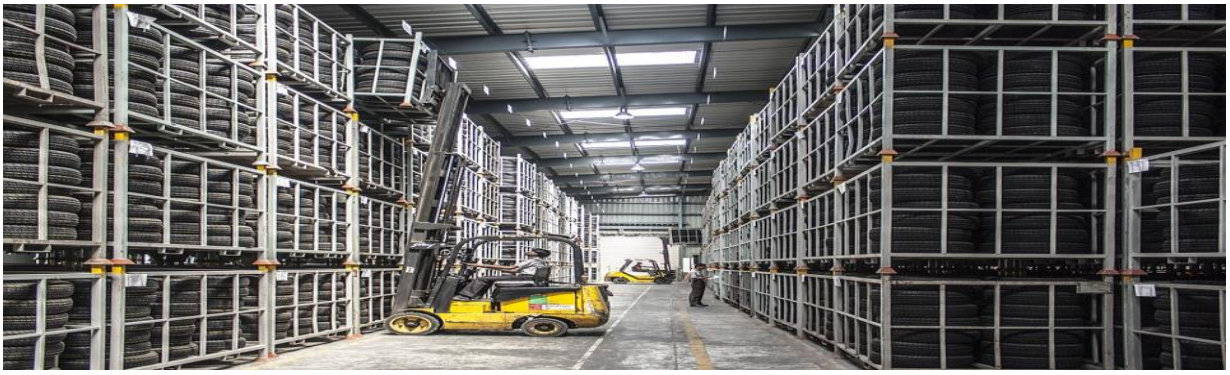
Raw materials inventory includes the basic inputs to the organization's production process. This form of inventory is the cheapest because the organization has not yet invested labour in its conversion or transformation.

Types of Inventory Management Techniques

Inventory is a staple in most supply chains. Balance is the main objective; too little causes delays and disrupts schedules, but too much adds unnecessary costs and limits flexibility.

There are four important techniques of inventory management:

(1)Economic order quantity (2)Materials requirement planning
(3)Just-in-time inventory planning (4)Manufacturing resource planning



(1) Materials Requirement Planning

A more complicated inventory problem occurs with dependent demand inventory. The most common inventory control system used for handling dependent inventory is materials requirement planning (MRP).

MRP is dependent demand inventory planning and involves the implementation of a control system that schedules the exact amount of all materials required to support the desired end product.

MRP is computer based and requires sophisticated calculations to coordinate information on inventory location, bills of materials (a listing of all components including partially assembled pieces and basic parts that make up an end product), purchasing, production planning, invoicing, and order entry specified in the master schedule.

In essence, inventory levels are based on past consumption and are aimed at reducing inventory costs and keeping the production line supplied with the materials necessary to keep it running smoothly.

MANAGING PRODUCTION SYSTEM

The key points from this module are: MANAGING PRODUCTION SYSTEM

Lean Production, is focused on the reduction fo **muda** (wastes), **mura** (unevenness) and **muri** (overburden) within an organization. There are 7 types of waste which include: **transportation**, **inventory**, **motion**, **waiting**, **over-processing**, **over-producing** and **defects**.

The Lean Production emphasises the "**zero**" concept: zero machine changeovers ("setups"), zero defects in finished products, zero inventories, zero production stops, zero bureaucracy and zero misalignments.

For instance, Deming's **Plan-Do-Check-Act Cycle (PDCA)** is a four-step problem-solving method for continuous process improvement.

A **kanban system** is a multistage production scheduling and inventory control system. **Kanban cards** are used to control production flow and inventories, keeping a reduced production lead time and work-in-process. The "one-card" is the simplest implementation of kanban systems, which is called "**Production Order Kanban**" (POK).

In the two-card system, each workstation has separate inbound and outbound buffers. Two different types of cards are used: **Production Order Kanbans (POK)** and **Withdrawal Kanbans (WK).**

The most commonly used policy requires having a kanban board for each station, which should be managed in a single **First-In-First-Out (FIFO)** queue. A **heijunka box** is similar to an enhanced kanban board, which acts as a visual scheduling tool to obtain production leveling at the workstations.

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- There are four important techniques of inventory management:

  (1) Economical Order Quantity (2) Material Requirement Planning

  (3)Just in time Inventory (4) Manufacturing Planning and Control

  - $$EOQ = \sqrt{\frac{2DC}{H}}$$

The EOQ calculation indicates the order quantity size that will minimise holding and ordering costs based on the organization's use of inventory.

The EOQ formula includes ordering costs, holding costs and annual demand (*D = Product Annual Demand; C = Ordering Costs per Unit and H = Holding Costs per Unit.*)

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Manufacturing planning and control (MPC) systems enable the firm to move materials through the operation and schedule so that the company satisfies customer needs at a minimal cost e.g. MRP II* and JIT.

*MRP II - a technique for managing inventory; it is a computer-based information system that integrates the production planning and control activities of basic MRP systems with related financial, accounting, personnel, engineering and marketing information.