TQM/QCMM

By :
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Quality means different to different people:

- **Customer-Based:** Fitness for use, meeting customer expectations.
- **Manufacturing-Based:** Conforming to design, specifications, or requirements. Having no defects.
- **Product-Based:** The product has something that other similar products do not that adds value.
- **Value-Based:** The product is the best combination of price and features.
- **Transcendent:** It is not clear what it is, but it is something good...


Total
Inclusion:
Customers
Employees
Supplier
Quality
Products
Processes
Work
Company
TQM
Continuous Improvement
Management
Teamwork
Ability to learn
Responsibility

Various Definitions

- Total quality management (TQM) has been defined as an integrated organizational effort designed to improve quality at every level.

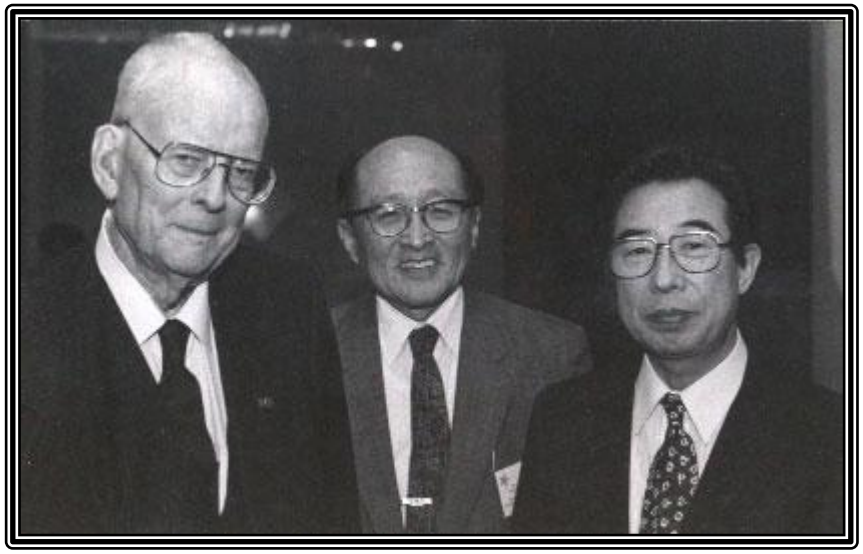
- The process to produce a perfect product by a series of measures require an organized effort by the entire company to prevent or eliminate errors at every stage in production is called total quality management.

- According to international organization for standards defined tqm as, "TQM is a management approach for an organization, centered on quality, based on the participation of all its members and aiming at long-term success through customer satisfaction and benefits to all members of the organization and to the society.


Performance
Reputation
Features
Aesthetics
Dimensions of Quality
Conformance
Response
Reliability
Service
Durability

TQM Guru's

Name	Contribution
Welter A. Shewart	Control chart theory, PDSA cycle
Ronald Fisher	DOE, ANOVA
W. Edwards deeming	Deeming philosophy
Joseph M. Juran	Juran Trilogy
Armand V. Feigenbaum	Concept of TQC
Kaoru Ishikawa	SPC, quality circle
Philip B. Crosby	Zero defect
Genichi Taguchi	Taguchi loss function

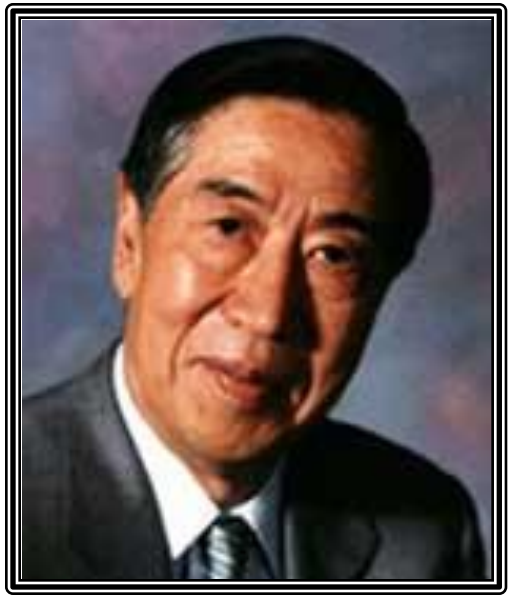


J. Edward Deming

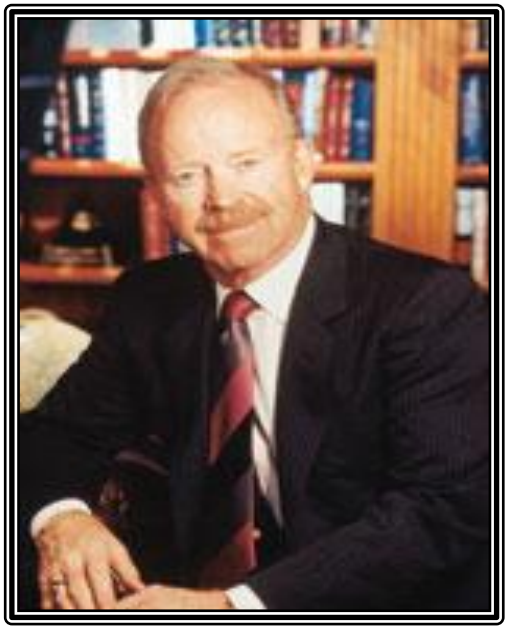
Joseph M. Juran

Armand V Feigenbaum

Dr Kaoru Ishikawa

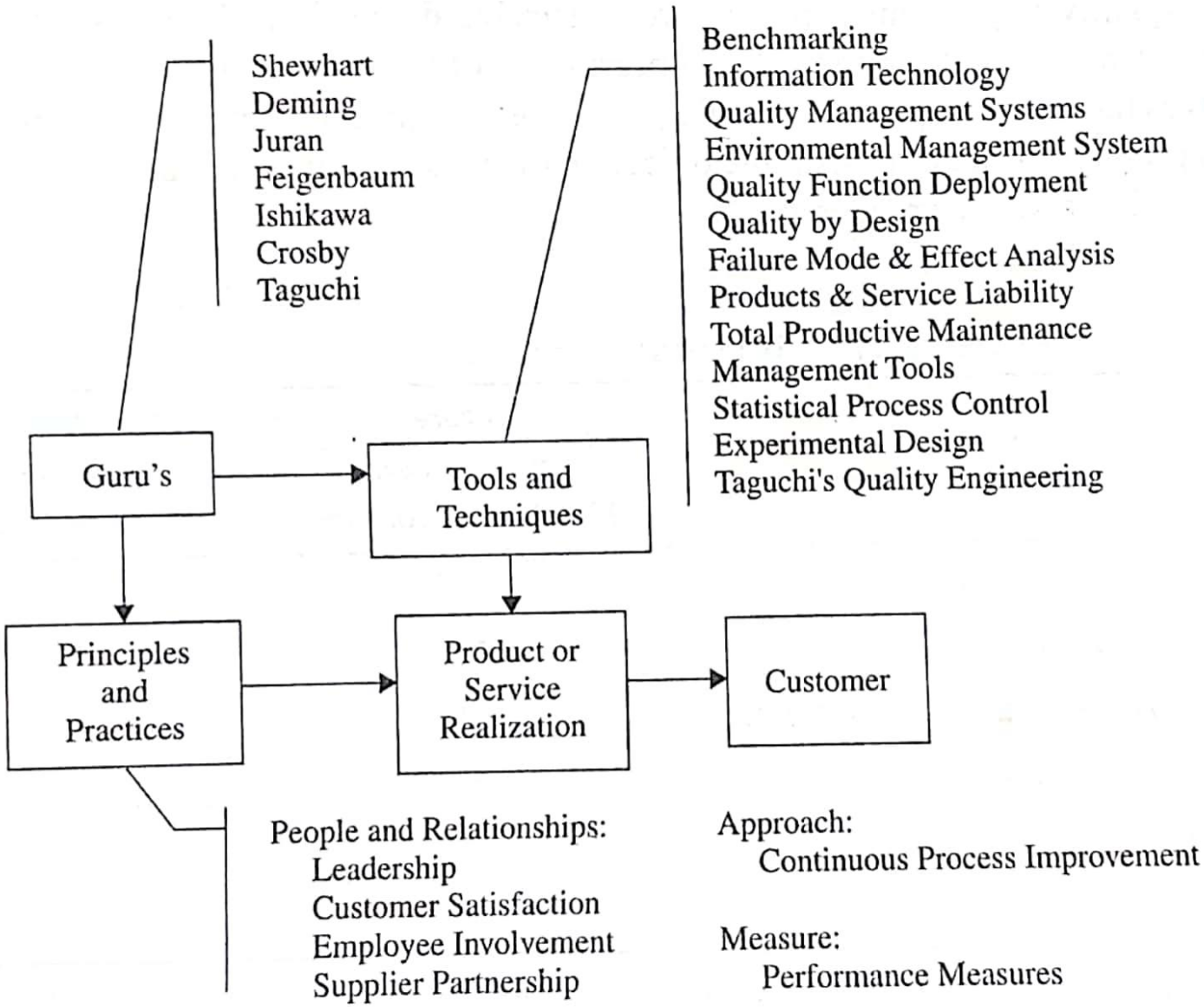


Dr Genichi Taguchi



Philip B Crosby

TQM Framework



ure 1-1 TQM Framework

Characteristics of TQM

- Committed management.
- Adopting and communicating about total quality management.
- Closer customer relations.
- Closer provider relations.
- Benchmarking.
- Increased training.
- Open organization
- Employee empowerment.
- Flexible production.
- Process improvements.
- Process measuring

❑ Principles of TQM:

❖ Management Commitment

1. Plan (drive, direct)
2. Do (deploy, support, participate)
3. Check (review)
4. Act (recognize, communicate, revise)

❖ Employee Empowerment

1. Training
2. Suggestion scheme
3. Measurement and recognition
4. Excellence teams

❖ Fact Based Decision Making

1. SPC (statistical process control)
2. DOE, FMEA
3. The 7 statistical tools
4. TOPS (Ford 8D – team-oriented problem solving)

❖ Continuous Improvement

1. Systematic measurement and focus on CONQ
2. Excellence teams
3. Cross-functional process management
4. Attain, maintain, improve standards

❖ Customer Focus

1. Supplier partnership
2. Service relationship with internal customers
3. Never compromise quality
4. Customer driven standards

Focus on the customer

- It is important to identify the organization's customers.
- External customers consume the organization's product or service.
- Internal customers are employees who receive the output of other employees.

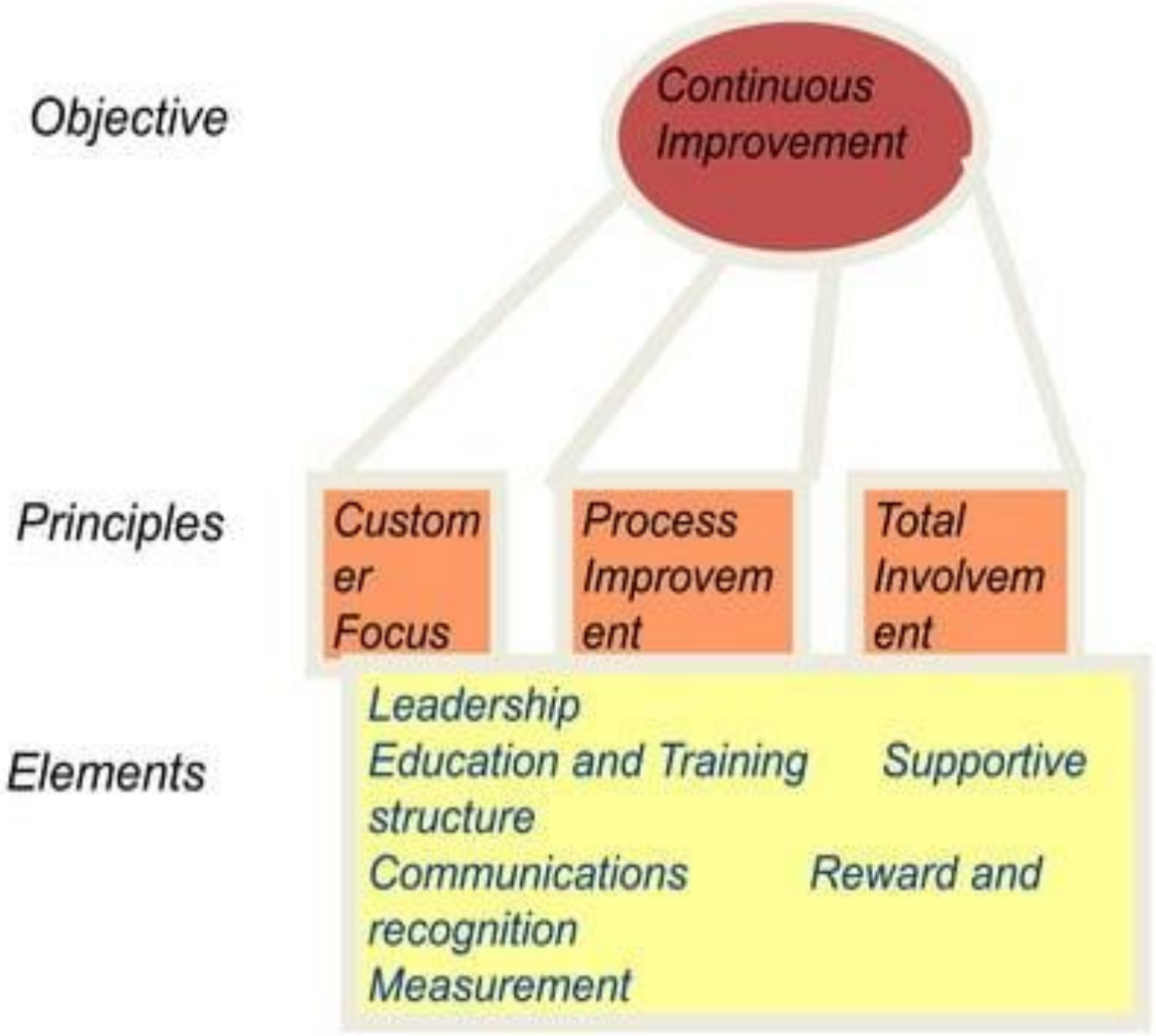
Employee Involvement

- Since the quality is considered the job of all employees, employees should be involved in quality initiatives.
- Front line employees are likely to have the closest contact with external customers and thus can make the most valuable contribution to quality.
- Therefore, employees must have the authority to innovate and improve quality.

CONTINUOUS IMPROVEMENT

- The quest for quality is a never-ending process in which people are continuously working to improve the performance, speed and number of features of the product or service.
- Continuous improvement means that small, incremental improvement that occurs on a regular basis will eventually add up to vast improvement in quality.
- TQM is the management process used to make continuous improvements to all functions.
- TQM represents an ongoing, continuous commitment to improvement.
- The foundation of total quality is a management philosophy that supports meeting customer requirements through continuous improvement.

THE TQM SYSTEM



❖ Features of TQM:

1) **Customer-oriented** - TQM focuses on customer satisfaction through creation of better quality products and services at lower costs.

2) **Employee involvement and empowerment** - Teams focus on quality improvement projects and employees are empowered to serve customers well.

3) **Organization-wide** - TQM involves every department or division.

4) **Continuous improvement** - Quality improvement is a never-ending journey.

5) **Strategic focus** - Quality is viewed as a strategic, competitive weapon.

6) **Process management** - TQM adopts the concept of prevention through process management.

7) **Change in corporate culture** - TQM involves the creation of a work culture that is conducive to quality improvement.

BENEFITS OF TQM:

- Improved quality.
- Employee participation.
- Team work.
- Working relationships.
- Customer satisfaction.
- Employee satisfaction.
- Productivity.
- Communication.
- Profitability.
- Market share.


How to Implement
Total Quality Management?
1. Commitment from Employees
2. Quality Improvement Culture
3. Continuous Improvement in Process
4. Co-operation from Employees
5. Focus on Customer Requirements
6. Effective Control shall be laid down


Committment
Control
Culture
6 Cs of TQM
Customer Focus
Continous Improvement
Cooperation

- **ISO** (International Organization for Standardization)

  Is an independent, non-governmental international organization that develops standards

  Founded: 1947

  Headquarters: Geneva, Switzerland

ISO International Organization for Standardization

Quality Management System

- A quality management system (QMS) defines and establishes an organization's quality policy and objectives.
- It also allows an organization to document and implement the procedures needed to attain these goals.
- A properly implemented QMS ensures that procedures are carried out consistently, that problems can be identified and resolved, and that the organization can continuously review and improve its procedures, products and services.
- It is a mechanism for maintaining and improving the quality of products or services so that they consistently meet or exceed the customer's implied or stated needs and fulfill their quality objectives

INTRODUCTION TO ISO 9000

- The **ISO 9000** family of standards is related to quality management systems and designed to help organizations ensure that they meet the needs of customers and other stakeholders while meeting statutory and regulatory requirements.
- ISO 9000 deals with the fundamentals of quality management systems, including the eight management principles on which the family of standards is based.

- International standards promote international trade by providing one consistent set of requirements recognized around the world.

- ISO 9000 can help a company satisfy its customers, meet regulatory requirements and achieve continual improvement. It provides the base level of a quality system, not a complete guarantee of quality.

- Originally published in 1987 by the International Organization for Standardization (ISO), a specialized international agency for standardization composed of the national standards bodies of 90 countries.

Eight Quality Management Principles

ISO 9000 Series

ISO 9000	• Explains fundamental quality concepts and provides guidelines for the selection and application of each standard
ISO 9001	• Model for quality assurance in design, development, production, installation and servicing.
ISO 9002	• Model for quality assurance in the production and installation of manufacturing systems
ISO 9003	• Quality assurance in final inspection and testing.
ISO 9004	• Guidelines for the applications of standards in quality management and quality systems.

Benefits of ISO registration

- Improved Product & Service Quality
- Increased Customer Satisfaction
- Better Operational Efficiency
- Competitive Advantage
- Compliance with Regulations
- Access to Global Markets
- Cost Savings
- Enhanced Trust with Stakeholders

Benefits of ISO Certification

- Improved product/service quality
- Enhanced customer satisfaction
- Increased efficiency and cost savings
- Stronger market credibility

ISO 9001 Requirements

1. Context of the Organization

- Understand the internal and external factors affecting the business.
- Identify interested parties (customers, suppliers, stakeholders).
- Define the scope of the Quality Management System (QMS).

2. Leadership

- Top management must demonstrate commitment to quality.
- Establish a quality policy and communicate it across the organization.
- Assign roles, responsibilities, and authorities for QMS implementation

3. Planning

- Identify risks and opportunities related to quality.
- Set quality objectives aligned with the business strategy.
- Plan actions to address risks and opportunities.

4. Support

- Provide resources, infrastructure, and environment for QMS.
- Ensure competency of employees through training.
- Maintain proper documentation and records.

5. Operation

- Plan and control product and service delivery.
- Define customer requirements clearly.
- Implement design, development, and production processes.
- Ensure outsourced processes meet quality requirements

6. Performance Evaluation

- Monitor and measure processes, customer satisfaction, and product quality.
- Conduct internal audits to ensure compliance.
- Perform management reviews to assess QMS effectiveness.

7. Improvement

- Take corrective actions to address non-conformities.
- Focus on continuous improvement of processes.
- Learn from customer feedback, audits, and performance data

LEADERSHIP

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Leadership

- A leader is a person who guides, influences, or directs a group, organization, or society toward a common goal. Leaders inspire and motivate others, make decisions, and take responsibility for achieving objectives.
- Leadership plays a vital role in driving quality in an organization

Quality Statements include:

- ***Vision Statement:***

Future-focused goal for quality excellence.

- ***Mission Statement:***

Defines the organization's purpose regarding quality.

- ***Quality Policy:***

Commitment to continuous improvement and customer satisfaction.

Leadership Concept

- ***Transactional Leadership***

Focuses on structure, rewards, and penalties.

- ***Transformational Leadership***

Inspires and motivates followers to achieve beyond expectations.

- ***Servant Leadership***

Prioritizes the needs of employees and stakeholders.

- ***Situational Leadership***

Adapts leadership style based on circumstances.

Importance of Leadership

- Drives progress and success.
- Builds strong and cohesive teams.
- Encourages innovation and problem-solving.
- Creates a positive and motivated environment

- Leadership is essential for organizational success.
- Effective leaders demonstrate vision, ethics, and adaptability.
- The Deming philosophy emphasizes continuous improvement and quality.
- Ethics and strong personal characteristics are key to leadership effectiveness.

characteristics of quality leaders

- Visionary Thinking
- Integrity & Honesty
- Effective Communication
- Confidence
- Emotional Intelligence (EQ)
- Adaptability & Resilience
- Accountability & Responsibility
- Inspirational & Motivational
- Strong Decision-Making Skills
- Commitment to Growth & Learning

Characteristics of Effective People

- Proactive Mindset
- Clear Goal Setting
- Strong Decision-Making Skills
- Time Management and Discipline
- Continuous Learning and Growth
- Emotional Intelligence and Relationship Building

Ethics in Leadership

- Ethics refers to moral principles that govern behavior.
- Key ethical principles in leadership:
  - Honesty and Integrity
  - Fairness and Justice
  - Responsibility and Accountability
  - Transparency and Trustworthiness

The Deming Philosophy

- **W. Edwards Deming**

  Pioneer of Total Quality Management (TQM).

- Key principles:
  - Focus on quality and continuous improvement.
  - Use of data and statistical analysis in decision-making.
  - Employee involvement and teamwork.
  - Systematic problem-solving approach.

The Deming 14 Points (Summary)

- Create constancy of purpose for improvement.
- Adopt a new philosophy of quality.
- Cease dependence on mass inspection.
- Improve the system continuously. Institute training on the job.
- Adopt leadership that helps people do a better job.
- Drive out fear and build trust.
- Break down barriers between departments.
- Eliminate slogans and unrealistic targets.
- Eliminate quotas and management by objectives.
- Remove barriers to pride in workmanship.
- Encourage education and self-improvement.
- Institute transformation in management

Role of TQM Leaders

- Visionary leadership: Setting clear goals
- Commitment to quality: Leading by example
- Empowering employees: Encouraging participation
- Encouraging innovation: Fostering continuous improvement
- Customer-focused approach: Aligning efforts with customer needs

Implementation of TQM

- **Step 1:** Top Management Commitment
- **Step 2:** Employee Training and Awareness
- **Step 3:** Customer-Centric Approach
- **Step 4:** Process Management & Continuous Improvement
- **Step 5:** Performance Measurement & Feedback

Core Values of TQM

- Customer Focus
- Continuous Improvement (Kaizen)
- Employee Involvement & Teamwork
- Process-Oriented Approach
- Fact-Based Decision Making

Core Concepts of TQM

- Deming's 14 Points
- PDCA Cycle (Plan-Do-Check-Act)
- Six Sigma
- Lean Management
- Benchmarking

TQM Framework

- Leadership & Strategic Planning
- Customer Focus
- Employee Involvement
- Process Management
- Performance Measurement
- Continuous Improvement

Strategic Planning in TQM

- Define Vision & Goals
- Establish Key Performance Indicators (KPIs)
- Align Organizational Processes
- Use Data-Driven Decision Making
- Monitor, Evaluate, and Improve Continuously

Communication in TQM

- Transparent Information Sharing
- Feedback Mechanisms
- Cross-Functional Team Collaboration
- Employee Involvement in Decision-Making

Decision-Making in TQM

- Data-Driven Decisions
- Root Cause Analysis (5 Whys, Fishbone Diagram)
- Risk Assessment & Mitigation
- Continuous Monitoring & Adjustments

TQM TOOLS AND TECHNIQUES

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The Seven Traditional Tools of Quality

- Check Sheet
- Histogram
- Pareto Chart
- Cause-and-Effect Diagram (Fishbone/Ishikawa)
- Scatter Diagram
- Control Chart
- Flowchart

Check Sheet

- **Definition:** A structured form for collecting and analyzing data
- **Purpose:** Helps identify patterns and frequency of problems

Check Sheet

Vehicle Breakdown Maintenance Check Sheet

Name of operator: David **Sheet Number:** 12

Date: 04-Nov-2020

Place: Amherst, Ohio

Defect Types	Frequency					
	Vehicle 1	Vehicle 2	Vehicle 3	Vehicle 4	Vehicle 5	Total
Brake pads worn out	X		X			2
Fuel tank leakage		X				1
Steering locked				X		1
Engine oil seepage		X	X			2
AC not working	X			X		2
Battery darined out			X			1
Lights not working	X				X	2
Total	3	2	3	2	1	

Types of Check Sheets:

- **Defect Check Sheet** – Records the frequency of defects in a process.
- **Tally Check Sheet** – Uses tally marks to count occurrences of an event.
- **Location Check Sheet** – Identifies defect locations in a product or machine.
- **Cause Check Sheet** – Captures possible causes of defects or failures.
- **Process Distribution Check Sheet** – Monitors variation in a process over time.

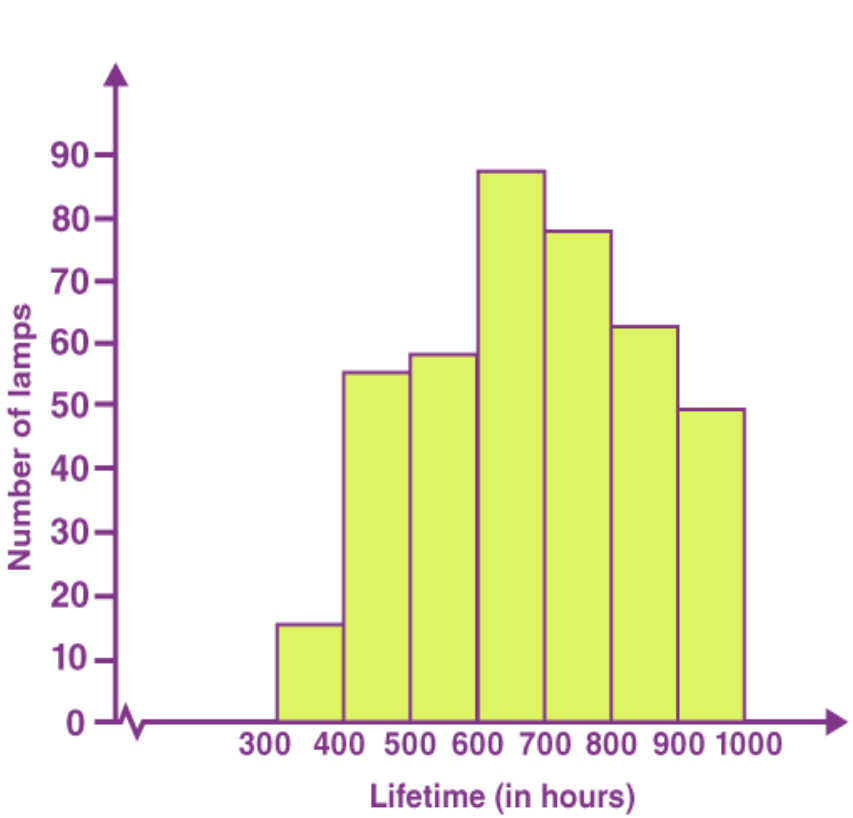
How to Create a Check Sheet:

- **Define the Purpose** – Determine what data needs to be collected.
- **Design the Format** – Create a structured table with necessary fields.
- **Collect Data** – Record data consistently using tally marks or numerical values.
- **Analyze Results** – Summarize the collected data and identify trends.
- **Take Action** – Use insights to make improvements or solve problems.

Histogram

It is widely used in quality control, manufacturing, and service industries to enhance overall efficiency and performance.

- **Definition:** A bar graph representing frequency distribution
- **Purpose:** Identifies variation patterns in processes



Components of a Histogram:

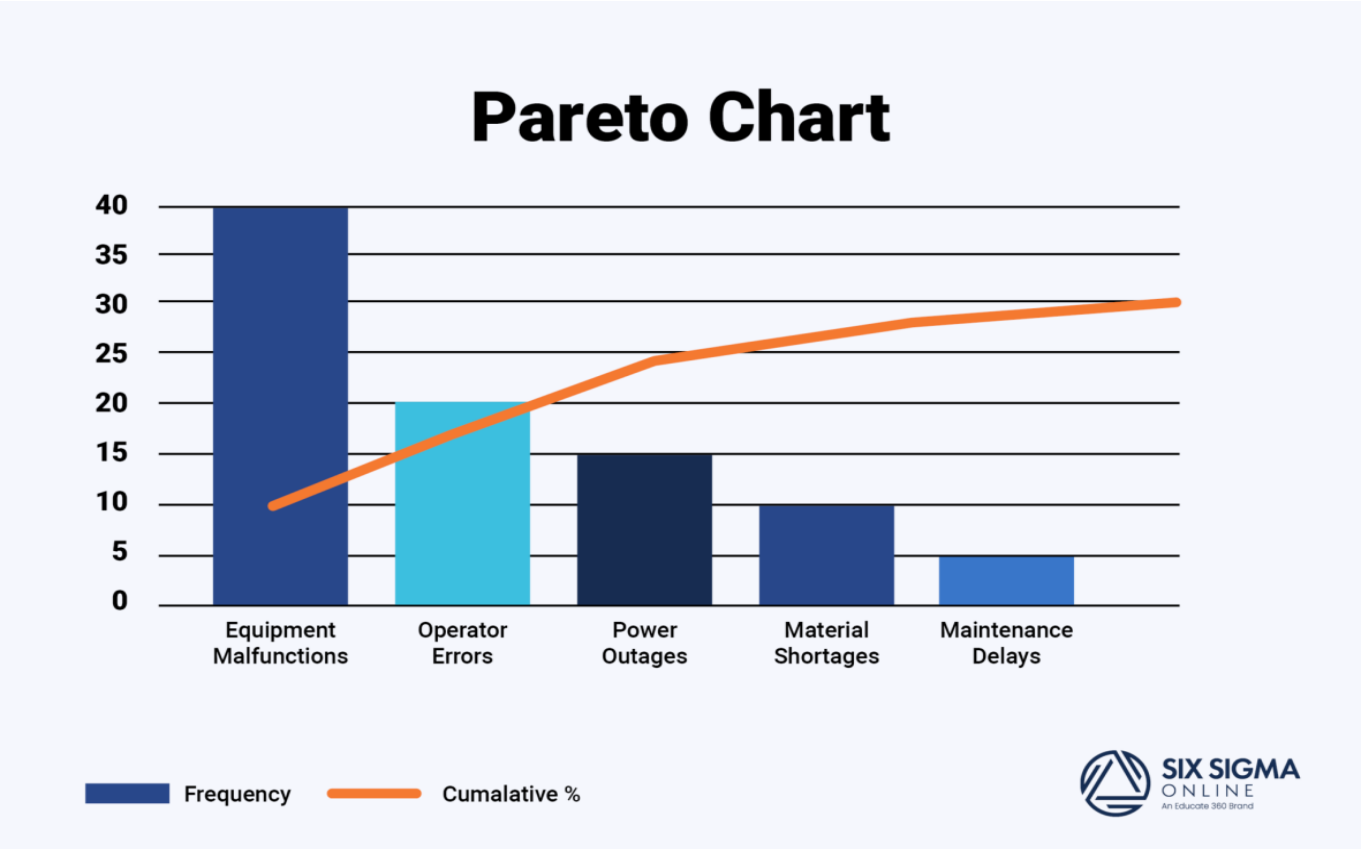
- **X-Axis (Horizontal Axis)** – Represents the data intervals (bins).
- **Y-Axis (Vertical Axis)** – Shows the frequency of occurrences in each interval.
- **Bars** – Represent the number of occurrences within each range.

How to Create a Histogram:

- **Collect Data** – Gather relevant data for analysis.
- **Determine the Range** – Identify the minimum and maximum values in the dataset.
- **Divide Data into Intervals (Bins)** – Group data into equal-sized ranges.
- **Count Frequency** – Determine how many values fall into each bin.
- **Draw the Histogram** – Plot the bins on the X-axis and frequencies on the Y-axis.
- **Analyze the Shape** – Observe the distribution pattern to identify trends.

Pareto Chart

- **Definition:** A bar chart that follows the 80/20 rule (Pareto Principle)
- **Purpose:** Helps prioritize the most significant factors in a problem



- A Pareto Chart is a bar graph that represents the frequency or impact of problems in a process, arranged in descending order. It is based on the **Pareto Principle (80/20 Rule)**, which states that **80% of problems are caused by 20% of the causes**. The chart helps identify the most significant issues that need attention.

Purpose of a Pareto Chart:

- Highlights the most common problems or defects in a process.
- Helps prioritize improvement efforts by focusing on critical issues.
- Provides a clear visual representation of problem distribution.
- Aids in root cause analysis and decision-making.
- Supports continuous improvement initiatives in quality management.

Components of a Pareto Chart:

- **X-Axis (Categories)** – Represents different categories of defects, issues, or causes.
- **Y-Axis (Frequency or Impact)** – Shows the number of occurrences or cost impact.
- **Bars** – Display the frequency of each category, sorted in descending order.
- **Cumulative Line** – Represents the cumulative percentage of occurrences.

How to Create a Pareto Chart:

- **Identify Categories** – Determine the different types of issues or defects.
- **Collect Data** – Record the frequency or impact of each category.
- **Sort Data in Descending Order** – Arrange the categories from highest to lowest occurrence.
- **Calculate Cumulative Percentage** – Compute the running total percentage for each category.
- **Draw the Chart** – Plot bars for each category and a cumulative line.
- **Analyze the Results** – Identify the most significant issues based on the 80/20 rule.

Feature	Check Sheet	Pareto Chart	Histogram
Purpose	To collect and record data systematically.	To identify and prioritize the most significant factors in a dataset.	To show the distribution of data and variations over a range.
Data Type	Raw, real-time data (e.g., tally marks, checkmarks).	Categorical or frequency-based data.	Continuous numerical data.
Representation	Simple table or sheet with marks or tallies.	Bar chart sorted in descending order, often with a cumulative percentage line.	Bar chart showing frequency distribution.
Use Case	Identifying defects, errors, or specific occurrences over time.	Identifying the most common causes of defects or problems (80/20 rule).	Understanding data distribution, central tendency, and variability.
Example	Recording defects in a manufacturing line using tally marks.	Categorizing customer complaints to identify the most frequent issues.	Displaying the height distribution of students in a school.
Best For	Data collection and pattern identification.	Prioritizing issues for quality impro ent.	Analyzing data distribution and trends.

Cause and Effect Diagram (Ishikawa / Fishbone Diagram)

Definition

A Cause and Effect Diagram, also known as an Ishikawa Diagram or Fishbone Diagram, is a graphical tool used to identify, analyze, and visualize the potential causes of a specific problem or effect.

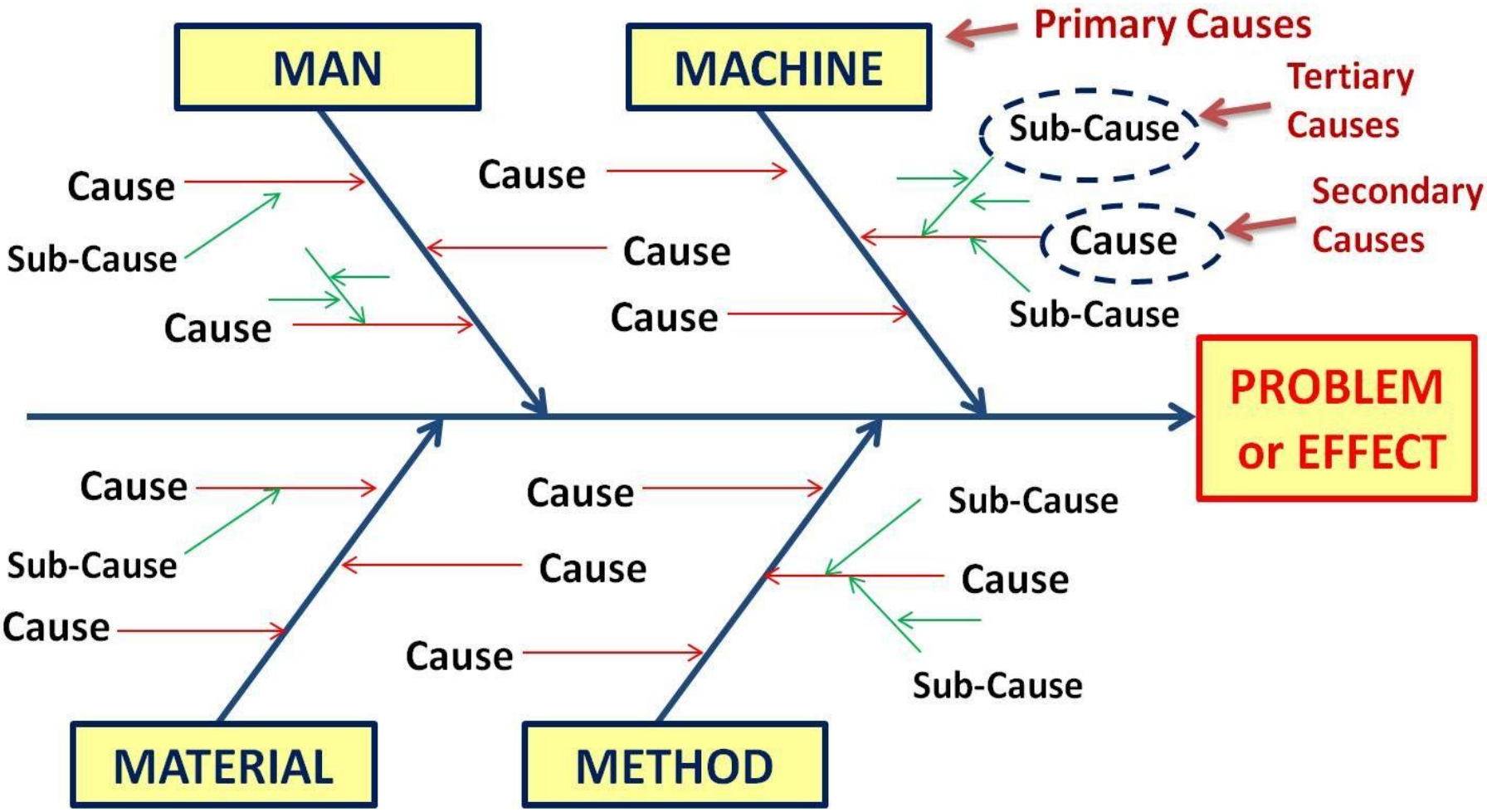
Purpose

- Helps in root cause analysis.
- Identifies possible causes contributing to a problem.
- Supports brainstorming and problem-solving in quality management.
- Enhances team collaboration in diagnosing issues.

Structure of the Diagram

- **Head (Effect/Problem):**
- The main issue being analyzed is placed at the right side of the diagram.
- **Spine (Main Line):**
- A horizontal arrow pointing to the effect (problem).
- **Bones (Main Causes):**
- Major categories contributing to the problem, typically branching from the spine.
- **Sub-branches (Sub-causes):**
- Specific factors under each main cause contributing to the effect

CAUSE AND EFFECT DIAGRAM



Common Categories (6M Method for Manufacturing)

- **Man** – Human factors (skills, training, errors, attitudes).
- **Machine** – Equipment, tools, technology used.
- **Material** – Raw materials, quality, supply issues.
- **Method** – Processes, procedures, work methods.
- **Measurement** – Data accuracy, inspection methods.
- **Environment** – Workplace conditions, external factors

Steps to Create a Cause and Effect Diagram

- **Identify the Problem:** Define the issue clearly and write it at the head of the diagram.
- **Determine Major Causes:** Use brainstorming to identify broad categories affecting the problem.
- **List Sub-Causes:** Under each major cause, identify specific reasons contributing to the problem.
- **Analyze and Prioritize Causes:** Examine which factors are most significant in contributing to the issue.
- **Take Corrective Actions:** Develop strategies to eliminate or reduce the root causes.

Example –1

Manufacturing Industry – Defective Products

Problem: High defect rate in a production line

- **Causes & Categories (6M Method)**
- **Man**: Lack of training, human error, poor supervision
- **Machine**: Worn-out parts, machine breakdowns, improper calibration
- **Material**: Low-quality raw materials, inconsistent suppliers
- **Method**: Inefficient processes, poor quality control, lack of standardization
- **Measurement**: Incorrect data recording, inaccurate inspections
- **Environment**: Dust, temperature fluctuations, poor lighting

Example-2

Service Industry – Customer Complaints in a Restaurant

Problem: High number of customer complaints

- **Causes & Categories**
- **People**: Rude staff, lack of training, slow service
- **Process**: Delayed order processing, wrong orders, unclear policies
- **Place**: Unclean dining area, poor seating arrangements, noisy atmosphere
- **Product (Food Quality)**: Inconsistent taste, stale ingredients, incorrect portion sizes
- **Equipment**: Faulty ovens, unclean utensils

Scatter Diagram

Definition

- A **Scatter Diagram** (also called a **Scatter Plot** or **XY Graph**) is a graphical tool used to show the relationship between two numerical variables. It helps determine if there is a correlation between them.

2. Purpose

- Identifies relationships (correlation) between two variables.
- Helps in quality control and root cause analysis.
- Supports decision-making by visualizing trends and patterns in data.

3. Components of a Scatter Diagram

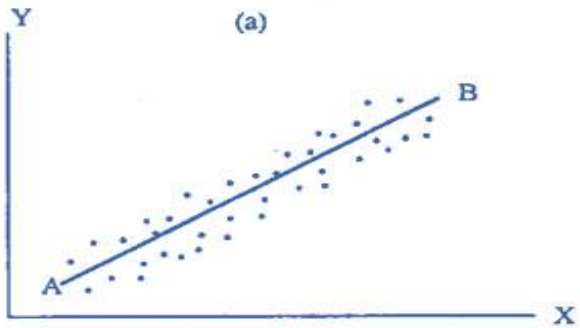
- **X-Axis (Independent Variable):** Represents the input or cause.
- **Y-Axis (Dependent Variable):** Represents the output or effect.
- **Data Points:** Each point represents an observation with values for both variables.

Types of Correlation in Scatter Diagrams

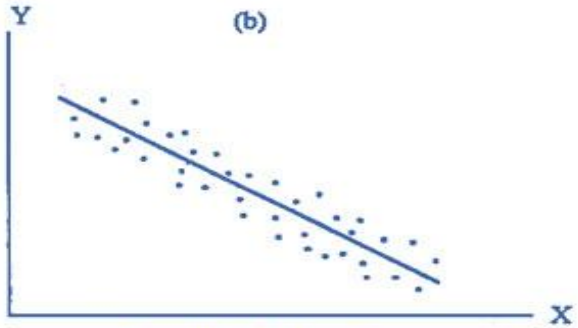
- **Positive Correlation (↑↑)** As X increases, Y also increases. Example: More study hours → Higher exam scores.
- **Negative Correlation (↑↓)**As X increases, Y decreases. Example: More machine age → Lower efficiency.
- **No Correlation** – No clear relationship between X and Y. Example: Shoe size vs. IQ level.

Steps to Create a Scatter Diagram

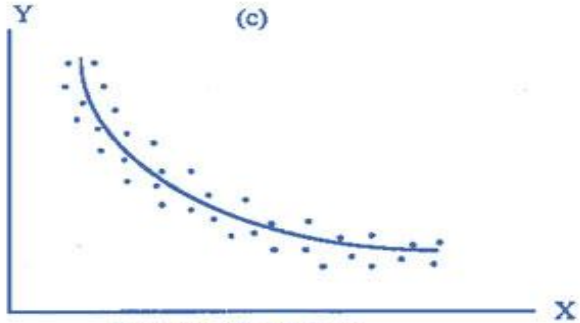
- **Collect Data:** Gather paired values for the two variables.
- **Plot the Data:** Place data points on an XY graph.
- **Analyze the Pattern:** Identify the type of correlation.
- **Draw a Trend Line (if needed):** Helps visualize the direction of the relationship.
- **Interpret Results:** Determine if a strong, weak, or no correlation exists.



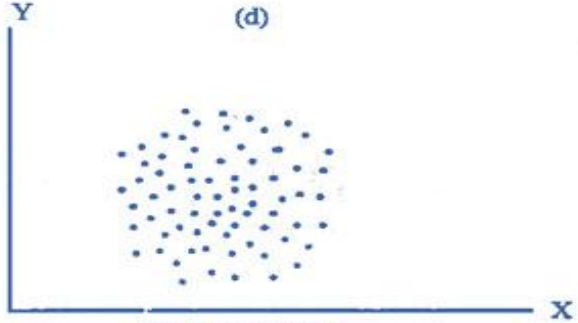
Positive and Linear



Negative and Linear



Negative Non–Linear



No Relationship

Control chart

- **Quality Control and Measurement Management (QCMM)**, Control Charts are essential tools used to monitor **process performance** and ensure **measurement system stability** over time.

Purpose in QCMM

- **Ensure consistency** in measurement systems.
- **Identify variations** in measurement processes or instruments.
- **Improve accuracy** and **repeatability** of data collected.
- Support **decision-making** based on statistically controlled processes.

How Control Charts Support QCMM

- *Measurement System Monitoring*
  - Track repeatability and reproducibility.
  - Ensure measurement tools are functioning correctly.
- *Process Validation*
  - Prove that processes meet required standards and tolerances.
  - Help maintain compliance with **ISO**, **Six Sigma**, or other quality frameworks.
- *Corrective Action Identification*
  - Detect when the process is going out of control.
  - Prompt timely interventions.
- *Data Integrity Assurance*
  - Verify the trustworthiness of data used in QC decisions.

Benefits in QCMM

- Increased reliability of measurement systems.
- Reduced process variation.
- Early detection of potential quality issues.
- Better alignment with total quality management (TQM) principles.

SIX SIGMA

- **Six Sigma** is a **data-driven methodology** used to eliminate defects, reduce variation, and improve quality in processes.
- Six Sigma means **"6 standard deviations from the mean“.**

Goal of Six Sigma

- **Achieve near-perfection** in processes.
- Improve **customer satisfaction** by reducing errors.
- Increase **efficiency**, **productivity**, and **profitability**.

Six Sigma Methodologies

- Six Sigma methodologies are structured, systematic approaches to improving processes. They are primarily represented by

1. **DMAIC** (for improving existing processes)
2. **DMADV** (for creating new processes).

Both methodologies are focused on eliminating defects and minimizing process variation.

Six Sigma Methodologies

1. DMAIC – For improving existing processes:

- **D – Define:** Identify the problem and customer requirements.
- **M – Measure:** Collect data and measure current performance.
- **A – Analyze:** Identify root causes of problems.
- **I – Improve:** Develop and implement solutions.
- **C – Control:** Monitor the process to sustain improvements.

2. DMADV – For developing new processes:

- **D – Define**
- **M – Measure**
- **A – Analyze**
- **D – Design**
- **V – Verify**

DMAIC – For improving existing processes

- **D – Define**
  - **Objective:** Clearly define the problem, project goals, and customer requirements.
  - Identify stakeholders and team members.
  - Develop a **Project Charter** and set **Key Performance Indicators (KPIs)**.
  - Define **CTQs** (Critical to Quality) and **scope**.
- **Tools:**
  - Project Charter
  - Voice of the Customer (VOC)
  - Stakeholder Analysis
- **M – Measure**
  - **Objective:** Measure the current performance of the process.
  - Collect data and identify **key metrics** (e.g., DPMO, process capability).
  - Assess the **current process capability**.
  - Ensure that the measurement system is **accurate and reliable** (e.g., Gage R&R studies).
- **Tools:**
  - Data Collection Plan
  - Pareto Charts
  - Control Charts
  - Measurement System Analysis

- **A – Analyze**
  - **Objective:** Analyze data to identify the root causes of defects and process inefficiencies.
  - Use statistical tools to determine which factors have the most impact on process performance.
  - Verify root causes and determine which ones are within your control.
- **Tools:**
  - Fishbone Diagram (Ishikawa)
  - 5 Whys
  - Hypothesis Testing
  - Regression Analysis
- **I – Improve**
  - **Objective:** Identify, implement, and validate solutions to address root causes.
  - Develop and test process improvements.
  - Ensure the improvements are practical and cost-effective.
  - Standardize the solution to ensure sustainability.
- **Tools:**
  - Brainstorming
  - FMEA (Failure Modes and Effects Analysis)
  - Solution Design
  - Pilot Testing

- **C – Control**
  - **Objective:** Implement control measures to sustain improvements.
  - Develop a plan to monitor the process after improvements.
  - Use control charts and other tools to ensure long-term effectiveness.
  - Update documentation and train team members.
- **Tools:**
  - Control Charts
  - Standard Operating Procedures (SOP)
  - Process Control Plans
  - Control Plan

2. DMADV Methodology

DMADV is used for **designing new processes** or products that meet customer needs and process capability from the beginning. It ensures that the design is optimized for quality, efficiency, and performance.

DMADV Phases:

- **D – Define**
  - **Objective:** Define the project goals, customer requirements, and deliverables.
  - Establish project scope and timeline.
  - Develop a **Project Charter** and **VOC** (Voice of the Customer).
- **Tools:**
  - Project Charter
  - VOC Analysis
  - Stakeholder Analysis
- **M – Measure**
  - **Objective:** Identify critical quality characteristics (CTQs) and the appropriate design targets.
  - Establish **measurement systems** and validate that measurements are reliable.
  - Gather data to understand the current state and desired future state.
- **Tools:**
  - CTQ Tree
  - Measurement Systems Analysis
  - Benchmarking

- **A – Analyze**
- **Objective:** Analyze alternative designs and select the best one based on data.
- Use tools to compare and analyze potential solutions.
- Analyze designs for their ability to meet customer needs and specifications.
- **Tools:**
- FMEA (Failure Modes and Effects Analysis)
- Design of Experiments (DOE)
- Simulation Models
- Decision Matrix
- **D – Design**
- **Objective:** Design the new process or product.
- Create detailed designs, prototypes, or process models.
- Develop process flows and specifications for production.
- **Tools:**
- Process Mapping
- Flowcharting
- Design Specifications

- **V – Verify**
- **Objective:** Verify that the design meets customer needs and performs as expected.
- Conduct pilot runs or testing of the new process/product.
- Ensure that the design is capable of meeting the requirements.
- **Tools:**
- Pilot Testing
- Verification Testing
- Validation Metrics

Tools & Techniques Used in Six Sigma Methodologies

- **Pareto Analysis**: Identifying the most significant factors contributing to a problem.
- **Fishbone Diagram (Ishikawa)**: Identifying root causes of issues.
- **Control Charts**: Monitoring process variation.
- **FMEA (Failure Modes and Effects Analysis)**: Assessing potential risks in designs and processes.
- **Design of Experiments (DOE)**: Optimizing process variables to improve outcomes.

Bench marking

- The process of comparing an organization's performance, processes, or practices against those of leading competitors or industry best practices. The goal is to identify areas for improvement and adopt practices that lead to enhanced performance.

Objective of Benchmarking

- **Identify best practices** within and outside the industry.
- **Set performance standards** based on the best performers.
- **Close performance gaps** by adapting strategies and processes.
- Drive continuous improvement in quality, productivity, and customer satisfaction.

- *Types of Benchmarking*
- **Internal Benchmarking**
- Comparing practices and performance within the same organization.
- Useful for identifying variations in different departments or units.
- **Competitive Benchmarking**
- Comparing an organization's performance against direct competitors.
- Aimed at understanding the competition's strengths and weaknesses.
- **Functional Benchmarking**
- Comparing practices and performance across similar functions in different organizations (can be within or outside the industry).
- **Example**: comparing customer service processes across businesses in different industries.
- **Generic Benchmarking**
- Comparing processes or practices that are similar but not necessarily in the same industry.
- Focuses on universal best practices that can be applied across industries.
- **Strategic Benchmarking**
- Comparing strategies to achieve long-term goals, focusing on key aspects like competitive advantage and strategic positioning.
- Involves analysis of vision, mission, and market strategy.

Reasons to Benchmark

1. Identify Best Practices
2. Improve Performance
3. Enhance Competitive Advantage
4. Set Realistic Performance Targets
5. Optimize Processes and Resources
6. Enhance Customer Satisfaction
7. Improve Decision-Making
8. Accelerate Continuous Improvement
9. Improve Supplier and Vendor Relationships

Benchmarking Process

- **Planning**
  - Identify the area, process, or function to be benchmarked (e.g., customer service, supply chain management, production processes).
  - Define the goals and scope of benchmarking (e.g., quality improvement, cost reduction).
  - Select benchmarking partners (e.g., competitors, industry leaders).
- **Data Collection**
  - Gather quantitative and qualitative data on the benchmarked processes.
  - Use surveys, interviews, industry reports, and public data to collect relevant information.
- **Analysis**
  - Compare your performance data with that of the benchmarked organizations.
  - Identify **performance gaps** and analyze the root causes of differences.

- **Implementation**
  - Develop an action plan to close performance gaps based on insights from the benchmarking study.
  - Adopt best practices or process improvements learned from benchmarking.
  - Set targets and define metrics for measuring success.
- **Review and Monitor**
  - Monitor progress and results after implementing the changes.
  - Track whether the changes lead to improved performance over time.
  - Benchmark regularly to ensure continuous improvement.

- ***Benefits of Benchmarking***
- **Improved performance** by learning from the best in the industry.
- **Faster identification** of process inefficiencies and areas for improvement.
- **Competitive advantage** by adopting best practices before competitors.
- **Enhanced customer satisfaction** by ensuring products/services meet or exceed industry standards.
- **Cost reduction** by eliminating waste and optimizing processes.
- **Innovative ideas** by gaining insights into how other organizations approach challenges.

Examples

1. **Manufacturing:** Comparing production efficiency and defect rates with industry leaders.
2. **Retail:** Analyzing customer service practices and turnaround time for service-related inquiries.
3. **Software Development:** Benchmarking code quality and development speed against top tech companies.
4. **Logistics:** Comparing delivery speed, cost, and accuracy against leading distribution firms.

FMEA - Introduction

- Failure Modes and Effects Analysis (FMEA) is a proactive tool used to identify potential failure points in a product, process, or system before problems occur.
- It helps teams analyze the causes and effects of failures and prioritize which risks need action.
- FMEA improves reliability, safety, and customer satisfaction by preventing defects early.

Stages of FMEA

- **Identify the Scope and Team:**
  Define the system/process and assemble a cross-functional team.
- **List Potential Failure Modes:**
  What could go wrong at each step/component?
- **Analyze Effects of Each Failure:**
  What happens if the failure occurs?
- **Determine Causes and Mechanisms:**
  Why would this failure happen?
- **Assign Risk Priority Numbers (RPN):**
  Rate Severity, Occurrence, Detection (1-10 scale each).
- **Prioritize and Plan Actions:**
  Focus on high-RPN items for improvement.
- **Implement and Track Results:**
  Apply corrective actions and monitor effectiveness.

Types of FMEA

- **Design FMEA (DFMEA):**
  Focuses on potential failures in product design before manufacturing.
- **Process FMEA (PFMEA):**
  Focuses on failures that could happen in manufacturing or assembly processes.
- **System FMEA:**
  Focuses on failures at the system-level (interaction between subsystems).
- **Software FMEA:**
  Applied to software systems to find failure risks in code and programming logic.
- **Service FMEA:**
  Analyzes potential failures in service industries (e.g., healthcare, logistics).

Quality Circles

- **Definition:**
  Small groups of employees who voluntarily meet regularly to solve work-related problems.
- **Features:**
  - Voluntary participation
  - Regular meetings
  - Focus on quality and productivity improvements

Cost of Quality (CoQ)

- **Definition:**
  Total cost associated with preventing, detecting, and correcting defective work.
- **Categories:**
  - Prevention Costs
  - Appraisal Costs
  - Internal Failure Costs
  - External Failure Costs

Quality Function Deployment (QFD)

- **Definition:**
  A structured method to translate customer needs into specific product or process requirements.
- **Tool:**
  - House of Quality (matrix connecting customer needs to technical features)

Total Productive Maintenance (TPM) - Concepts

- **Goal:**
  Maximize equipment effectiveness.
- **Key Pillars:**
  - Autonomous Maintenance
  - Planned Maintenance
  - Quality Maintenance
  - Focused Improvement (Kobetsu Kaizen)

TPM - Improvement Needs

- **Needs:**
  - Reduce equipment breakdowns
  - Increase machine availability
  - Improve operator skills
  - Enhance preventive maintenance practices

Performance Measures

- **Definition:**

Quantitative indicators that measure performance against goals.

- **Examples:**
  - Overall Equipment Effectiveness (OEE)
  - Defects per Million Opportunities (DPMO)
  - Customer Satisfaction Index
  - First Pass Yield (FPY)

MAINTENANCE

BY:
Mr. VIJAY.PALLED
Assistant Professor

Introduction to Maintenance Management

- **Definition:**
  Maintenance management is the process of overseeing and controlling the upkeep of equipment, facilities, and infrastructure to ensure optimal performance, reliability, and safety.
- It involves planning, scheduling, executing, and tracking maintenance activities.
- Choosing the right type of maintenance depends on:
- Equipment criticality
- Budget
- Operational strategy
- A balanced approach often combines multiple types for best results.

Objectives of Maintenance Management

- Ensure equipment reliability and availability
- Minimize downtime and production interruptions
- Extend asset life and reduce depreciation
- Maintain safety standards
- Optimize maintenance costs
- Support continuous improvement and efficiency

Impact of Maintenance on Productivity

- Reduces unplanned equipment failures
- Increases machine uptime and output
- Supports consistent product quality
- Ensures smoother production schedules
- Enhances worker morale and operational efficiency

Impact of Maintenance on Costs

- **Positive Impact:**
- Reduces major repair costs through preventive care
- Lowers energy consumption
- Minimizes wastage and rework
- **Negative Impact (if poorly managed):**
- Increases operating and repair costs
- Leads to loss of production and revenue
- Higher costs due to emergency maintenance

Types of Maintenance (Overview)

- Preventive Maintenance (PM)
- Predictive Maintenance (PdM)
- Corrective Maintenance (CM)
- Breakdown or Reactive Maintenance
- Condition-Based Maintenance (CBM)
- Planned Maintenance
- Total Productive Maintenance (TPM)

Preventive Maintenance

- **Definition:** Scheduled maintenance activities performed at regular intervals to prevent equipment failure.
- **Purpose:** To reduce the risk of unexpected breakdowns and extend equipment lifespan.

- **Examples:**
  - Lubrication
  - Cleaning
  - Inspection
  - Part replacement
- **Advantages:**
  - Reduced downtime
  - Increased reliability
  - Lower repair costs

- **Elements of Preventive Maintenance**
- 3 Key Elements:
  - **Checklist**
  - **Schedule**
  - **Procedure**
- **Preventive Maintenance Checklist**
- A list of tasks to be performed during maintenance.
- **Typical Items Include:**
  - Visual inspection of parts
  - Lubrication of moving components
  - Tightening of bolts and fasteners
  - Cleaning of filters and vents
  - Safety device functionality
- Ensures nothing is overlooked.

- **Preventive Maintenance Schedule**
- Specifies **when** maintenance activities should occur.
- **Types of Schedules:**
  - Time-based (e.g., every 3 months)
  - Usage-based (e.g., every 500 hours of operation)
  - Condition-based (e.g., based on sensor data)
- **Tools Used:**
  - CMMS (Computerized Maintenance Management Systems)
  - Excel/Gantt charts
- **Preventive Maintenance Procedure**
- Step-by-step instructions to perform maintenance tasks.
- **Includes:**
  - Tools and materials required
  - Safety precautions
  - Task order and methods
  - Estimated duration
- Ensures standardization and safety.

Predictive Maintenance

- **Definition:** Maintenance based on the actual condition of equipment, using monitoring tools and data analytics.
- **Purpose:** To predict failures before they occur and perform maintenance only when needed.
- **Techniques:**
  - Vibration analysis
  - Thermal imaging
  - Oil analysis
- **Advantages:**
  - Optimized maintenance intervals
  - Cost savings by preventing over-maintenance
  - Minimizes unexpected failures

Corrective and Reactive Maintenance

- **Definition:** Maintenance carried out after a fault is detected to restore equipment to proper working condition.
- **Also Known As:** Reactive Maintenance
- **When Used:** When an issue is identified during operation or inspection.
- **Examples:**
- Replacing worn-out parts after failure is noticed
- Fixing a leaking valve
- **Advantages:**
- No initial investment in monitoring systems
- **Disadvantages:**
- Possible production delays
- May lead to costly repairs

Breakdown Maintenance

- **Definition:** Maintenance performed only after the equipment fails or breaks down completely.
- **Also Called:** Run-to-Failure Maintenance
- **Used For:** Non-critical equipment where downtime doesn't affect production significantly.
- **Examples:**
  - Replacing a broken light bulb
  - Fixing a failed exhaust fan
- **Advantages:**
  - Simple to implement
  - No planning required
- **Disadvantages:**
  - High downtime
  - Increased repair costs
  - Potential safety risks

MTBF (Mean Time Between Failures)

- MTBF is a **maintenance performance metric** that measures the **average time between one failure and the next** during normal operation of a system or piece of equipment. It is an indicator of **system reliability**..
- MTBF is only applicable to **repairable systems**.
- It **does not include repair time**—only measures the operational time between failures.
- A **higher MTBF** means **greater reliability** and fewer breakdowns over time.

$$\text{MTBF} = \frac{\text{Total Uptime}}{\text{Number of Failures}}$$

- **Total Uptime:** Total operating time of the system (excluding downtime)
- **Number of Failures:** Total count of system or component failures during that period

- **Applications of MTBF:**
- **Maintenance planning:** Helps in scheduling preventive maintenance before a failure is likely.
- **Product design:** Used to evaluate and improve the reliability of products.
- **Spare parts inventory:** Helps determine how often parts might need to be replaced.
- **Warranty analysis:** Predicts failure rates during the warranty period.
- **Benefits of Tracking MTBF:**
- Reduces unexpected downtime
- Identifies weak points in equipment
- Helps in cost control and asset management
- Supports decisions on equipment replacement or upgrade

Examples

✅ Example 1: Manufacturing Machine

- **Scenario:** A packaging machine operates 24 hours a day for 30 days.
- **Total operating time:** 24 × 30 = **720 hours**
- **Number of failures:** 3 times in a month
- **MTBF Calculation:**

$$\text{MTBF} = \frac{720 \text{ hours}}{3 \text{ failures}} = \mathbf{240} \text{ hours}$$

- **Interpretation:** On average, the machine runs for 240 hours between failures.

✅ Example 2: Computer Server

- **Scenario:** A data center monitors a server over 180 days.
- **Total uptime recorded:** 4,320 hours (180 days × 24 hours)
- **Number of failures:** 6 unexpected shutdowns
- **MTBF Calculation:**

$$\text{MTBF} = \frac{4320}{6} = \mathbf{720} \text{ hours}$$

- **Interpretation:** The server can be expected to run for 720 hours between failures.

Mean Time to Repair (MTTR).

- MTTR stands for **Mean Time to Repair**. It measures the **average time** taken to diagnose, repair, and return a failed system or equipment to full operational condition.
- MTTR includes:
  - Time to detect the problem
  - Time to access the system
  - Time to repair/replace faulty components
  - Time to test and restore to service
- It does **not** include waiting or shipping time **unless** those are part of the standard repair process.

Purpose of MTTR:

- Evaluate how quickly a system can recover from failure
- Measure **maintainability**
- Identify bottlenecks in the repair process
- Support decision-making for preventive maintenance and staffing

MTTR Formula:

$$\text{MTTR} = \frac{\text{Total Downtime}}{\text{Number of Repairs}}$$

- **Total Downtime:** The sum of all time spent fixing equipment
- **Number of Repairs:** How many times the equipment was repaired in the period

Applications of MTTR:

- Maintenance department performance benchmarking
- SLA (Service-Level Agreement) and uptime calculations
- Spare parts and staffing planning
- Continuous improvement initiatives

Benefits of Tracking MTTR:

- Identifies inefficiencies in repair processes
- Helps reduce unplanned downtime
- Improves response times to failures
- Supports preventive and predictive maintenance strategies

TOTAL PRODUCTIVE MAINTENANCE

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What is TPM?

The core idea of TPM is not just to fix equipment when it breaks but to **prevent breakdowns altogether** through **autonomous maintenance**, **planned maintenance**, and **continuous improvement activities**. TPM focuses equally on productivity, quality, safety, and employee morale, making it a key pillar in lean manufacturing and operational excellence.

- TPM stands for **Total Productive Maintenance.**
- Aims for **zero breakdowns, zero defects, and zero accidents.**
- Integrates **maintenance into the daily work** of all staff.
- Involves **every employee**, from top management to machine operators.
- A holistic approach to **equipment maintenance** that maximizes overall equipment effectiveness (OEE)

TOTAL PRODUCTIVE MAINTENANCE (TPM)

01 TPM is an extension of TQM (Total Quality Management).

02 To achieve this objective, preventive & predictive maintenance is required.

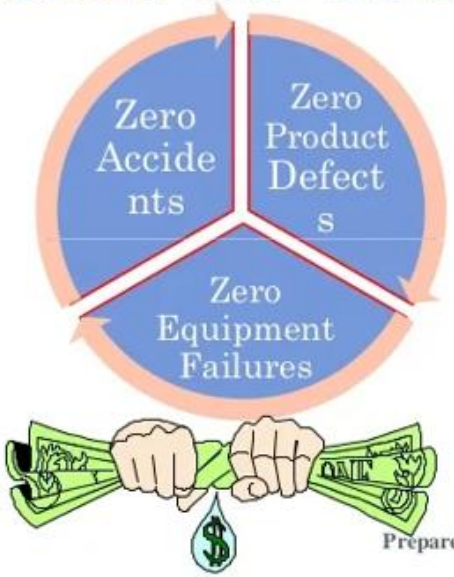
03 To implement TPM, the production unit and maintenance unit should work jointly.

04 By following the philosophy of TPM, we can minimize the unexpected failure of the equipment.

05 Objective of TPM is to maintain the plant or equipment in good condition without interfering with the daily process.

06 TPM is a management process developed for improving productivity by making processes more reliable & less wasteful.

GOAL OF TPM

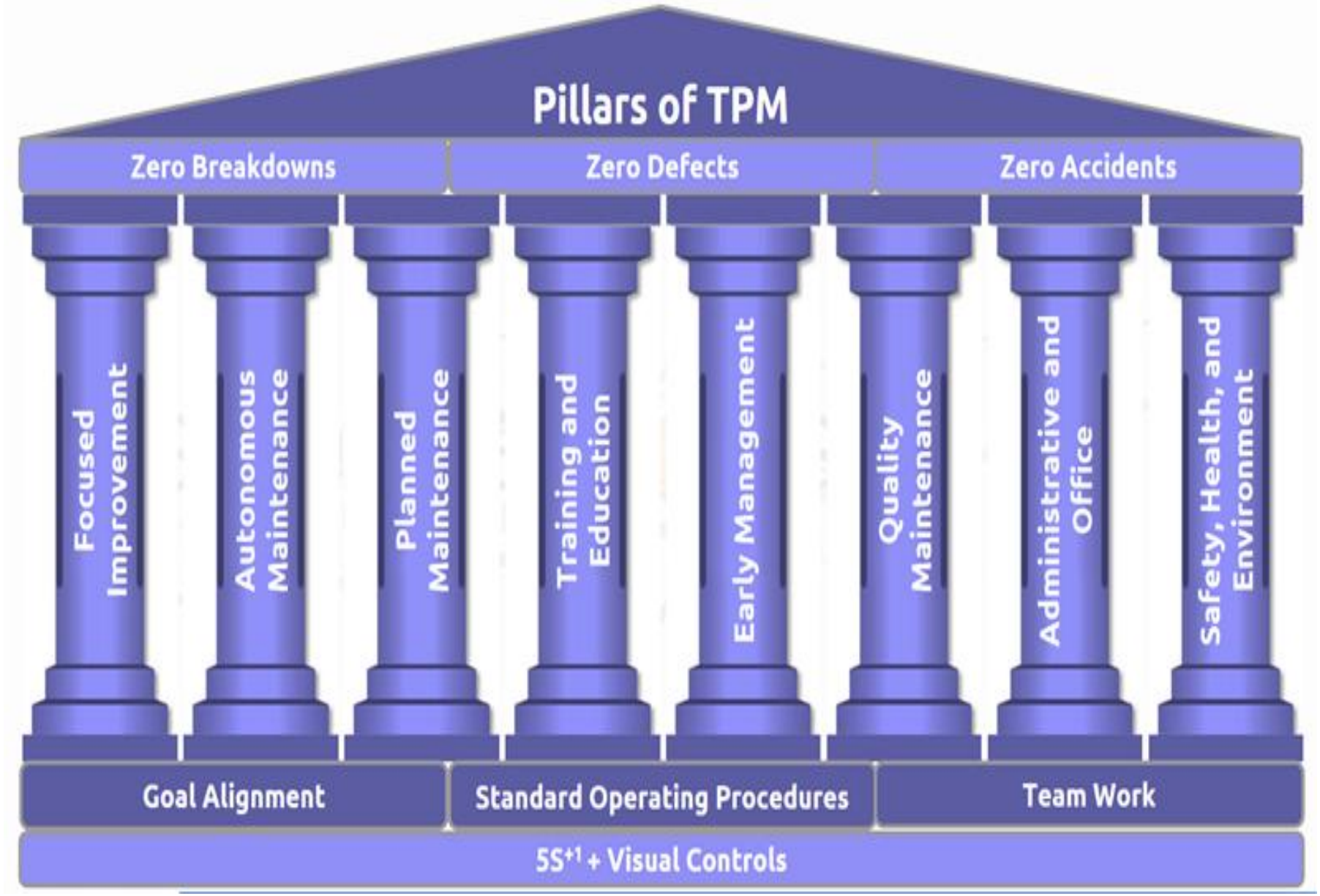


Prepared by : Chanda

TPM Principles

TPM Principles = **Productivity + Quality + Safety + People Involvement**

- The 8 pillars provide a structured approach to maximize equipment efficiency, empower employees, and drive sustainable improvement across the organization.
- Maximize equipment effectiveness (OEE)
- Autonomous maintenance by operators
- Planned maintenance to reduce downtime
- Training and education at all levels
- Early equipment management
- Quality maintenance to prevent defects
- TPM in all departments
- Safety, health, and environment (SHE) focus
- Total employee involvement


Pillars of TPM
Zero Breakdowns
Zero Defects
Zero Accidents
Focused Improvement
Autonomous Maintenance
Planned Maintenance
Training and Education
Early Management
Quality Maintenance
Administrative and Office
Safety, Health, and Environment
Goal Alignment
Standard Operating Procedures
Team Work
5S+1 + Visual Controls

1. Autonomous Maintenance (Jishu Hozen)

- Operators are trained to perform basic maintenance tasks
- Encourages ownership of equipment by frontline workers
- Tasks include cleaning, lubrication, inspection, and minor fixes
- Goal: Prevent deterioration and increase awareness

2.Planned Maintenance

- Scheduled preventive and predictive maintenance
- Reduces unexpected equipment failures
- Extends the lifespan of machinery
- Uses historical data to plan maintenance activities

3.Quality Maintenance

- Focus on **defect prevention**, not defect detection
- Identify root causes of quality issues using tools like FMEA
- Equipment settings and standards are fine-tuned for consistent output

4.Focused Improvement (Kobetsu Kaizen)

- Cross-functional teams work on **continuous improvement**
- Target chronic losses and inefficiencies
- Use tools like Pareto analysis and root cause analysis

5.Early Equipment Management (Initial Phase Management)

- Integrates maintenance insights into **equipment design and installation**
- Helps ensure new machines are reliable, maintainable, and easy to operate
- Reduces the time from setup to stable production (ramp-up time)

6. Training and Education

- Develop skills and knowledge at all levels
- Operators learn equipment basics, technicians learn advanced maintenance
- Builds a flexible, capable workforce

7. Safety, Health, and Environment (SHE)

- TPM aims for **zero accidents**, **zero health hazards**, and **zero environmental damage**
- Promote a safe and clean workplace
- Involves risk assessments and regular safety audits

8. TPM in Office Functions

- Apply TPM concepts to administrative and support departments
- Streamline processes like procurement, scheduling, and inventory management
- Eliminate waste and improve efficiency in office workflows

Preparatory Stage for TPM Implementation

- Top management commitment
- Announcement of TPM introduction
- Education and training for TPM awareness
- Establishment of TPM steering committee
- Formulation of TPM policies and goals
- Promotion of a pilot project

1. Top Management Commitment

- TPM must start with **strong leadership support**
- Management defines the **vision, goals, and priorities**
- TPM is promoted as a **strategic initiative**, not just a maintenance program
- Leaders allocate necessary **resources, time, and authority**

2. TPM Kickoff Announcement

- Official company-wide **declaration** of TPM launch
- Creates **visibility and motivation** across departments
- Sets expectations for **involvement from all levels**
- Often includes a launch event, banners, and internal communications

3. Education and Awareness

- Conduct training for:
  - Senior management (TPM philosophy & strategy)
  - Middle management (implementation roles)
  - Shop floor employees (basic TPM knowledge)
- Emphasize **benefits, roles, and contribution of each employee**
- Use workshops, posters, videos, and case studies

4. Establish TPM Steering Committee

- Form a **TPM Promotion Team** or Steering Committee
- Typically includes leaders from maintenance, production, quality, HR, etc.
- Responsible for **planning, guiding, and monitoring** TPM implementation
- Acts as a communication bridge between leadership and operations

5. Define TPM Policies and Goals

- Draft **TPM policy statement** aligned with company vision
- Set clear and measurable goals:
  - Increase OEE
  - Reduce downtime and breakdowns
  - Achieve zero accidents/defects
- Define short-term (pilot) and long-term targets

6. Select a Model Machine or Pilot Area

- Start small with a **pilot project (model machine or line)**
- Allows testing of TPM methods before full-scale deployment
- Choose based on:
  - Equipment criticality
  - Availability of committed staff
  - Improvement potential
- Pilot success becomes a **learning ground** and reference for expansion

TPM Organization Structure

- TPM Steering Committee (Top Management)
- TPM Promotion Office (Facilitates initiatives)
- Focused Improvement Teams
- Autonomous Maintenance Groups
- Planned Maintenance Group
- Training & Education Team
- Quality Maintenance Team
- Safety and Environment Team

THE STRUCTURE OF TOTAL PRODUCTIVE MAINTENANCE

TPM Policy Creation

- Based on company vision and goals
- Focus on zero breakdowns, zero defects, and zero accidents
- Define clear KPI targets (OEE, MTBF, MTTR)
- Align with continuous improvement (Kaizen) principles

Aids and Tools for TPM

- 5S methodology for workplace organization
- Root Cause Analysis (RCA)
- Fishbone diagram
- Pareto analysis
- Autonomous Maintenance Checklists
- OEE Calculation Sheets
- Daily Management Boards

TPM Master Plan

Phase 1: Preparatory Phase

Phase 2: Introduction of TPM and training

Phase 3: Pilot implementation (Model area)

Phase 4: Full-scale implementation

Phase 5: Continuous improvement evaluation

Phase 6: Standardization and horizontal deployment

Expected Outcomes

- Improved **equipment reliability**
- Increased **productivity and quality**
- Reduced **downtime and maintenance cost**
- Greater **employee involvement**
- Enhanced **safety and morale**

The next major steps in TPM implementation, focusing on

- Small Group Activities (SGA)
- Autonomous Maintenance
- Establishing Planned Maintenance
- Training
- Developing an Equipment Management Program

- SGA fosters involvement and problem-solving
- Autonomous maintenance builds ownership
- Planned maintenance reduces unplanned downtime
- Training supports sustainable TPM culture
- Equipment management aligns long-term performance with TPM goals

Small Group Activities (SGA)

- Cross-functional teams (operators, maintenance, quality, etc.)
- Problem-solving and continuous improvement (Kaizen)
- Use tools like **5 Whys**, **Fishbone Diagram**, **PDCA cycle**
- Benefits:
  - Increases employee involvement
  - Boosts morale and innovation
  - Strengthens teamwork

Key Features of SGA

- Voluntary participation
- Structured problem-solving approach
- Regular meetings and reporting
- Linked to company goals and TPM targets
- Recognitions for achievements

Autonomous Maintenance (Jishu Hozen)

- Operators take ownership of equipment
- **7 Steps of Autonomous Maintenance:**
  - Initial cleaning
  - Eliminate contamination sources
  - Set cleaning & lubrication standards
  - Conduct general inspection
  - Autonomous inspection
  - Standardize visual controls
  - Full self-management

Benefits of Autonomous Maintenance

- Prevents minor issues from becoming major
- Reduces equipment downtime
- Increases operator skills and awareness
- Frees maintenance staff for complex tasks

Establishing Planned Maintenance

- **Goal:** Prevent breakdowns and extend equipment life
- Types of Planned Maintenance:
  - Time-based maintenance
  - Condition-based maintenance
  - Predictive maintenance
- Develop a maintenance calendar & task checklist
- Monitor KPIs: **MTBF**, **MTTR**

Steps in Planned Maintenance

- Categorize equipment based on criticality
- Analyze failure history
- Create maintenance schedules
- Develop PM checklists
- Use CMMS tools for tracking and history

Training & Skill Development

- Purpose: Empower all employees to handle TPM roles
- Training Areas:
  - TPM principles
  - Equipment knowledge
  - Maintenance techniques
  - Safety and quality control
- Training Tools:
  - On-the-job training (OJT)
  - Visual manuals
  - Skill matrix tracking

Developing Equipment Management Program

- A systematic approach to control the equipment life cycle
- Includes:
  - Equipment history tracking
  - Design for maintainability
  - Spare parts management
  - Equipment performance analysis
- Integration with TPM pillars

Benefits of Equipment Management

- Data-driven decisions
- Lower total cost of ownership (TCO)
- Improved planning for replacements and upgrades
- Enhanced reliability and safety