**FAILURE MODE EFFECT ANALYSIS (FMEA)**

**MEANING**

FMEA also known as risk analysis, is a preventive measure to systematically display the causes, effects, and possible actions regarding observed failures.

The objective of FEMA is to anticipate failures and prevent them from occurring. FEMA prioritizes failures and attempts to eliminate their causes.

**BENEFITS OF FMEA**

- Improve product/process reliability and quality
- Increase customer satisfaction
- Early identification and elimination of potential product.
- Document and track the actions taken to reduce risk
- Provide focus for improved testing and development
- Minimize late changes and associated cost
- Act as catalyst for teamwork and idea exchange between functions.

**STAGES OF FEMA (FEMA METHODOLOGY)**

- Stage I. Specifying possibilities
- Stage II. Quantifying work
- Stage III. Correcting high risk causes
- Stage IV. Re-evaluation of risk

**STAGE 1 Specifying possibilities**

In this stage all possible failure modes are identified. The causes and effects of each possible failure are listed, this stage focuses on brainstorming and identification not numbers.

**\STAGE 2 Quantifying work**

In this stage each failure mode is evaluated numerically usually involves assigning ratings such as,

1. Severity
2. Occurrence
3. Detection

**STAGE 3 Correcting high risk causes**

Focuses on failure modes with high risk. This stage is about implementing corrective and preventive measures

**STAGE 4 Re-Evaluation of Risk**

- After corrective actions are implemented the risks are reassessed.
- New severity, occurrence and detection ratings are calculated.

**Define the scope and team.**

- Clearly define the boundaries of the process, product, or system you are analyzing, assemble a multidisciplinary team consisting of experts from different areas to ensure a comprehensive analysis.

**2: Break down the process.**

- Divide the process into manageable steps or components. This helps to identify potential failure modes at each stage.

**3: Identify potential failure modes.**

- Brainstorm all potential failure modes for each process step. These are the ways in which the process or component could fail to perform its intended function.

**4: Assess the severity.**

- Assign a severity rating to each failure mode based on its potential impact on the customer, product, or process. This helps prioritize which failure modes require immediate attention.

**5: Determine the causes.**

- Identify the root causes or factors contributing to each failure mode. This requires conducting thorough analysis and gathering relevant data.

**6: Evaluate the current detection controls.**

- Assess the effectiveness of the current controls in place to detect or prevent failure modes from occurring. Identify any gaps or weaknesses that need to be addressed.

**7: Calculate the risk priority number RPM.**

- The RPM is a numerical score obtained by multiplying severity, occurrence, and detection ratings. This allows you to prioritize which failure modes require immediate action.

**SEVEN TOOLS (OLD AND NEW)**

Japanese professor Kaoru Ishikawa originally developed the seven quality tools. These quality tools were simple to use and can be applied by anyone in the organization.

Later, these seven new quality tools were used to plan the quality improvement process. These tools are called the seven advanced quality tools or seven management and planning tools. These include:

1. Affinity diagrams
2. Tree diagrams
3. Process decision program charts (PDPC)

4. Matrix diagrams

5. Interrelationship digraphs

6. Prioritization matrices

7. Activity network diagrams

This post will look at the high-level overview of these seven tools.

**1. Affinity diagrams**

An affinity diagram is used along with the brainstorming. It is used to organize large amounts of poorly organized or unorganized data into groups that reflect natural relationships. This tool can help you identify patterns in the data.

**2. Tree Diagrams**

A tree diagram is usually used to break down complex concepts or broad categories into smaller parts, making them easier to understand. A tree diagram shows a hierarchical structure of ideas. It helps organize information into categories.

**3. Process Decision Program Chart (PDPC)**

PDPC is used to identify what may go wrong in a new plan. This tool is somewhat similar to FMEA. You start with a tree diagram to break down the objective into tasks. Draw the next level as what could go wrong, and at the end, the countermeasures to address issues.

Then draw another layer above it to show how things get to the root cause. The PDPC helps you determine where the problems lie and why they occur. It also enables you to determine if an issue has been identified correctly.

**4. Matrix Diagram**

A matrix diagram is a tool that helps you to analyze your data. This tool allows you to compare two or more sets of information. It gives visual representations of comparisons between different parameters, such as costs vs. benefits.

The types of matrices include: L- shaped, T–shaped, Y-shaped, X-shaped, C–shaped, and Roof shaped matrices.

**5. Interrelationship Digraph or Interrelationship Diagram**

The interrelationship digraph is a graphical representation of the interdependencies among activities. It shows the dependencies between the activities.

An interrelationship graph shows the cause-and-effect relationship among various factors involved in an issue. It helps analysts understand why certain things happen.

**6. Prioritizing Matrices**

Prioritizing matrix is an L-shaped matrix that helps to prioritize the project based on its importance. It is used to compare various choices.

**7. Activity Network Diagram (also known as Arrow Diagram)**

An activity network diagram is a tool that visualizes all the activities involved in a particular project. It represents the relationships between the different activities. Each box represents an activity, and the arrows represent the flow.

Activity Network Diagrams manage a number of tasks in a sequence and identify bottlenecks or the critical path in the project execution.

**OLD TOOLS**

The seven basic quality tools—also known as the old seven, the first seven, the basic seven, the classic seven, and the seven quality control tools—are simple yet effective and should be included in every quality professional's toolbox. The tools are:

1. Cause and effect diagram (also known as a fishbone diagram or an Ishikawa diagram)
2. Check sheet
3. Control chart (also known as a Shewhart chart)
4. Histogram
5. Pareto chart

6. Scatter diagram
7. Stratification or Flowchart or Run chart

The seven basic quality tools were first highlighted in Kaoru Ishikawa's classic book *Guide to Quality Control*. **Cause and effect diagram:** Also known as an Ishikawa diagram or a fishbone diagram, this tool analyzes process dispersion. It illustrates the main causes and subcauses leading to an effect.

1. **Check sheet:** Not to be confused with checklists, a check sheet is a simple data recording tool. It consists of a list of problems and the number of occurrences indicated by tally marks.
2. **Control chart:** This is a time sequenced chart with upper and lower control limits on which values of some statistical measure for a series of samples or subgroups are plotted. Often, the chart shows a central line to help detect a trend of plotted values toward either control limit. Control charts are used to study how a process changes over time and whether a process is consistent or in control, or unpredictable and out of control.
3. **Histogram:** A histogram is used for displaying the distribution of data graphically. The pictorial nature of a histogram helps people more easily identify patterns that are difficult to detect in a table of numbers, as well as understand the frequency of distributions.
4. **Pareto chart:** Based on the Pareto principle or 80/20 rule—which states that 80% of outcomes result from 20% of causes—this chart graphically displays the relative importance of differences among groups of data within a set, from most to least significant.
5. **Scatter plot or diagram:** A scatter plot is a simple visual form of graphical analysis used to analyze and identify potential relationships between two variables plotted along the x-axis and y-axis.

6. **<u>Stratification</u>:** Stratification refers to breaking down data into categories to more easily make sense of them.

## BENCHMARKING

Benchmarking can be defined as measuring an organizations performance against that of best in class companies, determining how the best in class achieve those performance levels.

## DEFINITION

American productivity and quality centre has defined the bench marking as the process of identifying, understanding, and adopting outstanding practices and processes from organizations anywhere in the world to an organization to improve its performance.

**Benchmarking Types :** There are several types of benchmarking that organizations can utilize:

1. **Internal Benchmarking**: Internal benchmarking involves comparing different departments or divisions within the same organization. This type of benchmarking helps identify best practices and encourages collaboration and knowledge sharing among other teams.
2. **Competitive Benchmarking**: Competitive benchmarking involves comparing an organization's performance against its direct competitors. By analyzing competitors' strategies, processes, and performance metrics, organizations can gain insights into their relative strengths and weaknesses.
3. **Functional Benchmarking**: Functional benchmarking involves comparing processes or practices with those of organizations in different industries but with similar functions. This type of benchmarking encourages cross-industry learning and the adoption of innovative practices.

## OBJECTIVES OF BENCHMARKING

1. **Continuous Improvement:** Driving an ongoing cycle of improvement rather than a one-time exercise to enhance processes.
2. **Performance Measurement:** Establishing quantifiable metrics (KPIs) to evaluate internal processes against industry standards or best-in-class organizations.
3. **Competitive Advantage:** Identifying areas where the organization lags behind and spotting opportunities to outperform competitors.
4. **Gap Identification:** Pinpointing specific gaps between current performance levels and potential, optimized performance.
5. **Strategic Decision Making:** Supporting management with data-driven insights to refine business strategies and long-term goals.
6. **Adopting Best Practices:** Learning and implementing proven methods from industry leaders to increase efficiency and quality.
7. **Cost and Quality Optimization:** Improving financial, operational, and service quality, such as reducing production costs or improving customer satisfaction

## POKA YOKE

Poka-yoke is a Japanese term that means "error-proofing" by implementing simple and inexpensive devices that help operators avoid mistakes in their work caused by the wrong parts, leaving out a part, installing a part backwards, *etc*. In Japanese, "Poka" means inadvertent error, and "yoke" means prevention.

The purpose of poka-yoke is to achieve 100% quality by finding defects at their source. This prevents an operator from passing on defects and enables the team to problem-solve so the defect stops recurring. In contrast, quality by sampling inspection guarantees defects because samples of parts or products will not always contain defects that exist in total production. And quality by 100% inspection is not only costly but finds defects from their source, which makes it difficult to permanently eliminate their cause.

There are two types of poka-yoke:

1. **Shutdown**: These are the most powerful error- proofing devices. For example, a machine will not start if a work piece is set incorrectly.
2. **Warning**: These alert us to something abnormal by a buzzer or light.

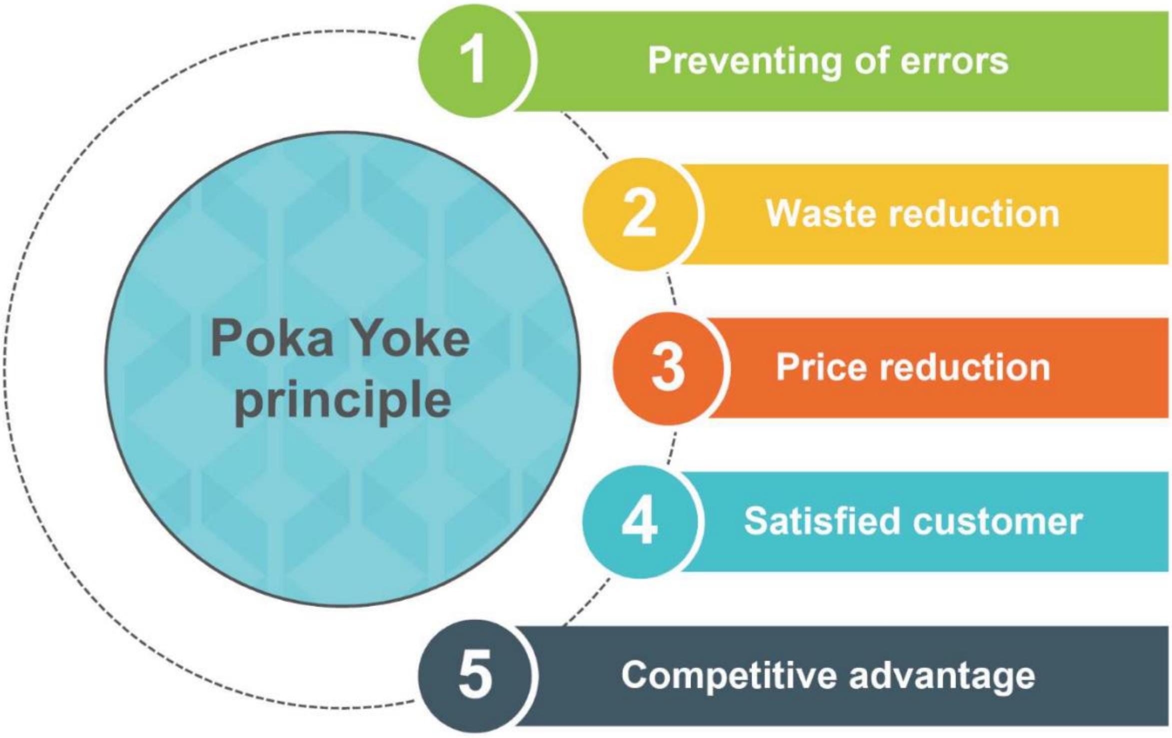
Good poka-yoka meet the following criteria:

- simple, with long life and low maintenance has high reliability
- inexpensive
- designed for the workplace situation

Common examples of error-proofing include:

- Product designs with physical shapes that make it impossible to install parts in any but the correct orientation.
- Photocells above parts containers to prevent a product from moving to the next stage if the operator's hands have not broken the light to obtain necessary parts.
- A more complex parts monitoring system, again using photocells, but with additional logic to make sure the right combination of parts was selected for the specific product being assembled.

## Implementing Poka Yoke in Six Sigma




**Benefits of Poka-Yoke**

**Reduces Defects and Waste**

By preventing errors from occurring in the first place, poka-yoke effectively reduces process defects and associated waste.

Every defect that reaches customers leads to rework, replacements, or lost business. Poka-yoke makes causes visible sooner to minimize impact.

**Lowers Costs**

In addition to materials wasted through scrapping defective outputs, costs get driven higher by excess process time, capacity overload, administrative burden, and opportunity costs from diverted resources.

**Improves Quality**

Preventing defects upfront with poka-yoke means fewer make it downstream to inspectors or customers, directly improving quality. Well-designed mistake-proofing facilitates right-first-time results.

**Increases Efficiency**

Properly implemented poka-yoke woven as standard work enhances process flow, frees up capacity, and boosts productivity.

Smoother operations with minimal control are needed to maximize asset utilization.

**Fosters Continuous Improvement**

Poka-yoke inherently takes a continuous view on learning from problems and redesigns systems to steer better outcomes. As processes evolve, so can the application of mistake-proofing mechanisms in a positive feedback loop.

The process can be divided into seven key steps:

**1. Identify the problem**

The first step is to detect the recurring error or defect in the process. This analysis can be based on data related to defects, rework, or customer complaints.

**2. Analyze the root cause**

Identifying the error alone is not enough; it's essential to investigate the origin of the issue to understand what is causing the error to occur.

**3. Define the type of Poka Yoke to apply**

Based on the previous analysis, determine whether the solution should be preventive (stops the error from occurring) or whether it will have to be detected (flags the error immediately after it occurs, before it causes defects).

**4. Design the Poka Yoke system**

In this step, the most suitable solution is developed, ensuring simplicity, effectiveness, and integration into the process.

**5. Test the system**

Before scaling the solution, the device or method must be tested under real conditions to confirm that it works properly and effectively eliminates the error.

**6. Train employees**

Once the solution is validated, it's critical to train the operators and teams involved to ensure they understand how the Poka Yoke works and why it matters.

**7. Evaluate performance and measure success**

After implementation, the solution's impact is monitored using quality, safety, and productivity indicators. If necessary, adjustments are made to support continuous improvement.