Unit – 4

Quality Tools and Techniques

Quality Functions Development (QFD)

Quality Function Deployment (QFD) is a methodology used to translate customer requirements into design specifications and manufacturing processes. It is a structured approach to ensure that the voice of the customer is accurately deployed throughout the product development process.

Key Elements of QFD

1. Customer Requirements: Identify and prioritize customer needs and expectations.

2. Design Requirements: Translate customer requirements into technical specifications.

3. Relationship Matrix: Develop a matrix to relate customer requirements to design requirements.

4. House of Quality: A graphical representation of the relationship matrix, showing the relationships between customer requirements, design requirements, and technical specifications.

Benefits of QFD

1. Improved Customer Satisfaction: Ensures that customer needs are accurately understood and met.

2. Reduced Development Time: Streamlines the product development process by identifying critical design parameters.

3. Increased Efficiency: Minimizes rework and reduces the need for costly design changes.

4. Enhanced Competitiveness: Enables companies to develop products that meet customer needs and expectations, leading to increased market share.

QFD Process

1. Identify Customer Requirements: Gather customer feedback through surveys, interviews, and focus groups.

2. Prioritize Customer Requirements: Determine the relative importance of each customer requirement.

3. Develop Design Requirements: Translate customer requirements into technical specifications.

4. Create Relationship Matrix: Develop a matrix to relate customer requirements to design requirements.

5. Analyze and Refine: Analyze the relationship matrix and refine the design requirements as needed.

Applications of QFD

1. Product Development: QFD is widely used in product development to ensure that customer needs are met.

2. Service Development: QFD can be applied to service development to ensure that customer expectations are met.

3. Process Improvement: QFD can be used to improve existing processes by identifying areas for improvement.

Tools and Techniques Used in QFD

1. House of Quality: A graphical representation of the relationship matrix.

2. Relationship Matrix: A matrix that relates customer requirements to design requirements.

3. Prioritization Techniques: Techniques such as Pareto analysis and paired comparison analysis are used to prioritize customer requirements.

4. Brainstorming: Used to generate ideas for design requirements.

House of Quality (HOQ)

The House of Quality (HOQ) is a graphical representation of the relationship between customer requirements and design requirements in Quality Function Deployment (QFD). It is a matrix-based tool that helps to identify the relationships between customer needs, design parameters, and technical specifications.

Benefits of the HOQ

1. Improved Communication: Enhances communication between customers, designers, and manufacturers.

2. Clearer Customer Requirements: Helps to clarify customer needs and expectations.

3. Optimized Design: Enables designers to optimize design parameters to meet customer requirements.

4. Reduced Development Time: Streamlines the product development process by identifying critical design parameters.

5. Increased Customer Satisfaction: Ensures that customer needs are accurately understood and met.

Steps to Construct the HOQ

1. Identify Customer Requirements: Gather customer feedback through surveys, interviews, and focus groups.

2. Prioritize Customer Requirements: Determine the relative importance of each customer requirement.

3. Develop Design Requirements: Translate customer requirements into technical specifications.

4. Create Relationship Matrix: Develop a matrix to relate customer requirements to design requirements.

5. Analyze and Refine: Analyze the relationship matrix and refine the design requirements as needed.

Example of the HOQ

Suppose a company wants to design a new smart phone. The customer requirements might include "long battery life," "high-quality camera," and "fast processor." The design requirements might include "battery capacity," "camera resolution," and "processor speed." The relationship matrix would show the relationships between these customer requirements and design requirements.

Failure mode effect analysis (FMEA)

Failure Mode and Effects Analysis (FMEA) is a systematic approach to identify, evaluate, and prioritize potential failures in a product, process, or system. It is a proactive tool used to analyze and mitigate risks, ensuring that failures are identified and addressed before they occur.

FMEA Stages

Stage 1: Planning and Preparation

1. Define the Problem or Process: Identify the product, process, or system to be analyzed.

2. Gather Information: Collect relevant data, including design specifications, process maps, and historical data.

3. Assemble the FMEA Team: Form a multidisciplinary team with expertise in design, process, quality, reliability, and operations.

Stage 2: Identify Failure Modes

1. Brainstorm Failure Modes: Identify potential failure modes using techniques such as brainstorming, mind mapping, or fishbone diagrams.

2. Categorize Failure Modes: Group failure modes into categories, such as design, process, or material-related failures.

Stage 3: Assess the Effects of Failure

1. Evaluate the Effects of Failure: Assess the potential consequences of each failure mode, including safety risks, environmental impacts, and financial losses.

2. Determine the Severity of Failure: Assign a severity rating to each failure mode, based on its potential impact.

Stage 4: Determine the Causes of Failure

1. Identify the Causes of Failure: Determine the root causes of each failure mode, using techniques such as the 5 Whys or fishbone diagrams.

2. Evaluate the Occurrence of Failure: Assess the likelihood of each failure mode occurring, based on its causes.

Stage 5: Evaluate the Risk

1. Calculate the Risk Priority Number (RPN): Assign an RPN to each failure mode, based on its severity, occurrence, and detection ratings.

2. Prioritize Failure Modes: Rank failure modes based on their RPN, to identify the most critical ones.

Stage 6: Implement Actions

1. Develop Action Plans: Create action plans to mitigate or eliminate the most critical failure modes.

2. Assign Responsibilities: Assign responsibilities for implementing action plans to team members.

3. Establish Timelines: Establish timelines for completing action plans.

Stage 7: Review and Revision

1. Review Progress: Regularly review progress on action plans and assess their effectiveness.

2. Revise the FMEA: Revise the FMEA as necessary, based on new information or changes to the product, process, or system.

By following these stages, organizations can effectively identify, evaluate, and prioritize potential failures, and implement actions to mitigate or eliminate them.

FEMA Design

Steps in Design FMEA

1. Define the Design: Identify the design parameters and boundaries.

2. Gather Information: Collect relevant data, including design specifications, material properties, and historical data.

3. Identify Failure Modes: Determine potential failure modes using techniques such as brainstorming, mind mapping, or fishbone diagrams.

4. Assess the Effects of Failure: Evaluate the potential consequences of each failure mode.

5. Determine the Causes of Failure: Identify the root causes of each failure mode.

6. Evaluate the Risk: Calculate the Risk Priority Number (RPN) for each failure mode.

7. Prioritize and Implement Actions: Prioritize failure modes based on their RPN and implement actions to mitigate or eliminate them.

FEMA Process and Documentation

FMEA Process Steps

1. Define the Problem or Process: Identify the product, process, or system to be analyzed.

2. Gather Information: Collect relevant data, including design specifications, process maps, and historical data.

3. Identify Failure Modes: Determine potential failure modes using techniques such as brainstorming, mind mapping, or fishbone diagrams.

4. Assess the Effects of Failure: Evaluate the potential consequences of each failure mode.

5. Determine the Causes of Failure: Identify the root causes of each failure mode.

6. Evaluate the Risk: Calculate the Risk Priority Number (RPN) for each failure mode.

7. Prioritize and Implement Actions: Prioritize failure modes based on their RPN and implement actions to mitigate or eliminate them.

FMEA Documentation

FMEA documentation typically includes:

1. FMEA Form: A standardized form used to document the FMEA process, including the identification of failure modes, effects, causes, and recommended actions.

2. FMEA Report: A summary report of the FMEA process, including the results of the analysis and recommended actions.

3. FMEA Matrix: A matrix used to evaluate the risk of each failure mode, based on its severity, occurrence, and detection.

4. Action Plan: A plan outlining the actions to be taken to mitigate or eliminate each failure mode.

Seven Tools

The Seven Tools of Quality, also known as the "Old Seven," are a set of graphical and statistical techniques used to improve quality and solve problems. The original Seven Tools were:

Old Seven Tools

1. Cause-and-Effect Diagram (Fishbone Diagram): A visual tool used to identify and organize the possible causes of a problem.

2. Check Sheet: A simple data collection tool used to gather information about a process or problem.

3. Control Chart: A statistical tool used to monitor and control processes.

4. Histogram: A graphical tool used to display the distribution of data.

5. Pareto Chart: A graphical tool used to identify the most common problems or causes of problems.

6. Scatter Diagram: A graphical tool used to analyze the relationship between two variables.

7. Stratification: A technique used to divide data into subgroups to identify patterns or trends.

New Seven Tools

In the 1970s, a new set of tools was developed to complement the original Seven Tools. The New Seven Tools are:

1. Affinity Diagram: A tool used to organize and group ideas or data.

2. Interrelationship Digraph: A tool used to identify and analyze the relationships between different ideas or variables.

3. Matrix Diagram: A tool used to evaluate and prioritize relationships between different variables.

4. Prioritization Matrix: A tool used to prioritize tasks or projects based on their importance and urgency.

5. Process Decision Program Chart (PDPC): A tool used to identify and evaluate potential problems in a process.

6. Root Cause Analysis (RCA): A method used to identify the underlying causes of a problem.

7. Tree Diagram: A tool used to break down complex problems into smaller, more manageable parts.

These tools are widely used in quality management, problem-solving and continuous improvement initiatives.

Bench Marking and POKAYOKE

Benchmarking and Poka-Yoke are two quality management tools used to improve processes and reduce defects.

Benchmarking

Benchmarking is the process of comparing an organization's processes, products, or services with those of other organizations, typically industry leaders or best-in-class companies. The goal of benchmarking is to identify gaps and opportunities for improvement.

Types of Benchmarking

1. Internal Benchmarking: Comparing processes or performance within an organization.

2. External Benchmarking: Comparing processes or performance with other organizations.

3. Competitive Benchmarking: Comparing processes or performance with direct competitors.

4. Functional Benchmarking: Comparing specific functions or processes with other organizations.

Benefits of Benchmarking

1. Identifies Gaps and Opportunities: Helps identify areas for improvement.

2. Improves Performance: Encourages organizations to strive for excellence.

3. Enhances Innovation: Fosters creativity and innovation.

4. Reduces Costs: Helps eliminate waste and reduce costs.

Poka-Yoke

Poka-Yoke is a Japanese term that means "mistake-proofing" or "error-proofing." It is a quality control technique used to prevent defects by designing processes or products that prevent human error.

Types of Poka-Yoke

1. Contact Method: Uses physical contact to prevent errors.

2. Fixed-Value Method: Uses fixed values or settings to prevent errors.

3. Motion-Step Method: Uses sequential motions to prevent errors.

Benefits of Poka-Yoke

1. Reduces Defects: Prevents human error and reduces defects.

2. Improves Quality: Enhances overall quality of products or services.

3. Increases Efficiency: Reduces waste and increases efficiency.

4. Enhances Safety: Prevents accidents and enhances safety.

Examples of Poka-Yoke

1. Automated Machines: Machines that automatically detect and prevent errors.

2. Error-Proofing Devices: Devices that prevent incorrect assembly or installation.

3. Warning Systems: Systems that alert operators to potential errors.

4. Checklists: Checklists that ensure tasks are completed correctly.