

5. Quality and Reliability Engineering

Quality Engineering covers the tools and techniques employed in manufacturing and service industries. In product manufacturing, these techniques help prevent mistakes or defects in products. In service processes, these tools are used to avoid problems when delivering solutions or services to customers. A closely related knowledge area is Reliability Engineering. These concepts are used to determine the ability of a system or component to function under stated conditions for a specified period.

5.1. Quality Definition and Fundamentals

5.1.1. Quality Concepts

- 5.1.1.1. Design for quality
- 5.1.1.2. Manufacturing quality
- 5.1.1.3. Marketing/service quality

5.1.2. Fundamentals

- 5.1.2.1. Probability
- 5.1.2.2. Sample data
- 5.1.2.3. Distributions
- 5.1.2.4. Basic statistics
- 5.1.2.5. Hypothesis testing
- 5.1.2.6. Analysis of variance
- 5.1.2.7. Regression analysis
- 5.1.2.8. Histogram, box plot and probability plot

5.2. On-line Quality Engineering Methods

5.2.1. Control Charts and Process Capability

5.2.1.1. Variable control charts

- 5.2.1.1.1. \bar{X} - chart
- 5.2.1.1.2. R-chart
- 5.2.1.1.3. S-chart
- 5.2.1.1.4. S^2 -chart
- 5.2.1.1.5. Exponentially weighted moving average (EWMA) chart
- 5.2.1.1.6. Cumulative sum control (CUSUM) chart
- 5.2.1.1.7. Moving range (MR) chart
- 5.2.1.1.8. Multivariate control chart
- 5.2.1.1.9. Single stage production processes
- 5.2.1.1.10. Multi-stage production processes

5.2.1.2. Attribute control charts

- 5.2.1.2.1. Fraction defective (p-chart, np-chart)
- 5.2.1.2.2. Number of defects per unit (c-chart, u-chart)
- 5.2.1.2.3. CUSUM chart
- 5.2.1.2.4. EWMA chart

5.2.2. Lot Acceptance Sampling

5.2.2.1. Attributes

- 5.2.2.1.1. Single-sample plans
 - 5.2.2.1.2. Double and sequential fraction-defective sampling
 - 5.2.2.1.3. Multiple fraction-defective
 - 5.2.2.1.4. DoD sampling plans
 - 5.2.2.2. Variables
 - 5.2.2.2.1. Fraction defective
 - 5.2.2.2.1.1. Standard deviation known
 - 5.2.2.2.1.2. Standard deviation unknown
 - 5.2.2.2.1.3. DoD plans
 - 5.2.2.3. Process/lot fraction defective
 - 5.2.2.4. Mean or standard deviation of a process/lot
- 5.2.3. Rectifying inspection/auditing
- 5.2.3.1. Lot-by-lot sampling
 - 5.2.3.2. Continuous production
 - 5.2.3.3. Toward eliminating inspection
 - 5.2.3.4. Mistake proofing
 - 5.2.3.5. Gauge repeatability and reproducibility (R&R)

5.3. Off-line Quality Engineering Methods

5.3.1. Design of Experiments

- 5.3.1.1. Strategy of experimentation
- 5.3.1.2. Basic analysis techniques, analysis of variance (ANOVA)
- 5.3.1.3. Experimental principles: replication, randomization, and blocking
- 5.3.1.4. Factorial designs
- 5.3.1.5. Two-level factorial designs, blocking, and confounding
- 5.3.1.6. Fractional factorial designs
- 5.3.1.7. Random factors in experiments
- 5.3.1.8. Nested and split-plot designs

5.3.2. Regression

- 5.3.2.1. Simple linear regression models
- 5.3.2.2. Inference in simple linear regression
- 5.3.2.3. Residual analysis and model adequacy checking
- 5.3.2.4. Multiple linear regression model fitting
- 5.3.2.5. Inference in multiple regression
- 5.3.2.6. Model adequacy checking
- 5.3.2.7. Variable selection techniques, stepwise regression, and related methods

5.3.3. Response Surface Methodology

- 5.3.3.1. One factor at a time
- 5.3.3.2. Central composite design
- 5.3.3.3. Robust design
- 5.3.3.4. Control factor and noise factor
- 5.3.3.5. Cross array design

5.3.3.6. Taguchi method

5.4. Quality Management and Training

5.4.1. Lean Six Sigma

- 5.4.1.1. Customer focused quality
- 5.4.1.2. Defects per million opportunities (DPMO)
- 5.4.1.3. Process capability
- 5.4.1.4. Value stream mapping
- 5.4.1.5. Types of wastes
- 5.4.1.6. Business diagnostic
- 5.4.1.7. Decision making based on data
- 5.4.1.8. DMAIC
 - 5.4.1.8.1. Define
 - 5.4.1.8.2. Measure
 - 5.4.1.8.3. Analyze
 - 5.4.1.8.4. Improve
 - 5.4.1.8.5. Control
- 5.4.1.9. DMADV
 - 5.4.1.9.1. Define
 - 5.4.1.9.2. Measure
 - 5.4.1.9.3. Analyze
 - 5.4.1.9.4. Design
 - 5.4.1.9.5. Verify

5.4.2. Change Management

- 5.4.2.1. Building Support

5.5. Reliability Engineering

5.5.1. Fundamentals

- 5.5.1.1. Definition: reliability, availability, maintainability
- 5.5.1.2. Failure time distributions
- 5.5.1.3. Basic system configurations
 - 5.5.1.3.1. Series systems
 - 5.5.1.3.2. Parallel systems
 - 5.5.1.3.3. K-out-of-n systems
 - 5.5.1.3.4. Network systems

5.5.2. Reliability Testing

- 5.5.2.1. Burn-in testing
- 5.5.2.2. Demonstration testing
- 5.5.2.3. Acceptance testing
- 5.5.2.4. Accelerated testing
- 5.5.2.5. Degradation testing

5.5.3. Failure Analysis

- 5.5.3.1. Failure modes

- 5.5.3.2. Failure mechanisms
- 5.5.3.3. Fault tree analysis
- 5.5.3.4. Failure modes and effects analysis (FMEA)

- 5.5.4. Maintenance
 - 5.5.4.1. Sensors and applications in maintenance
 - 5.5.4.2. Preventative maintenance
 - 5.5.4.3. Failure replacement
 - 5.5.4.4. Condition-based maintenance
 - 5.5.4.5. Group replacement
 - 5.5.4.6. Maintenance and warranty

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