

SOFTWARE QUALITY MANAGEMENT

ANGÉLICA DE ANTONIO

COURSE OUTLINE

- PART 1: INTRODUCTION TO SOFTWARE QUALITY
- PART 2: SOFTWARE QUALITY CONTROL ACTIVITIES
- PART 3: QUALITY METRICS
- PART 4: QUALITY MANAGEMENT AND QUALITY SYSTEMS
- PART 5: SOFTWARE QUALITY ASSURANCE ACTIVITIES
- PART 6: SOFTWARE CONFIGURATION MANAGEMENT

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WHAT IS A QUALITY MANAGEMENT SYSTEM

ISO 9000

QMS ASSESSMENT

THE 7 TOOLS OF QUALITY MANAGEMENT

THE COST OF QUALITY

QUALITY MANAGEMENT SYSTEM

- QUALITY MANAGEMENT:
 - ORGANIZATIONAL LEVEL
 - REFLECTED ON A QUALITY SYSTEM
- QUALITY SYSTEM
 - A SET OF CO-ORDINATED ACTIVITIES TO DIRECT AND CONTROL AN ORGANIZATION IN ORDER TO **CONTINUALLY IMPROVE** THE EFFECTIVENESS AND EFFICIENCY OF ITS PERFORMANCE
 - FOCUS ON DEFINING THE **PROCESSES**, WHICH WILL RESULT IN THE PRODUCTION OF QUALITY PRODUCTS AND SERVICES, RATHER THAN IN DETECTING DEFECTIVE PRODUCTS OR SERVICES AFTER THEY HAVE BEEN PRODUCED (PREVENTIVE, NOT CORRECTIVE)

CONTINUOUS IMPROVEMENT

- PDCA (PLAN-DO-CHECK-ACT) CYCLE
 - PROPOSED BY SHEWHART AND EXPANDED BY DEMING

PLAN

- What can be improved?
- What should we do to improve?

DO

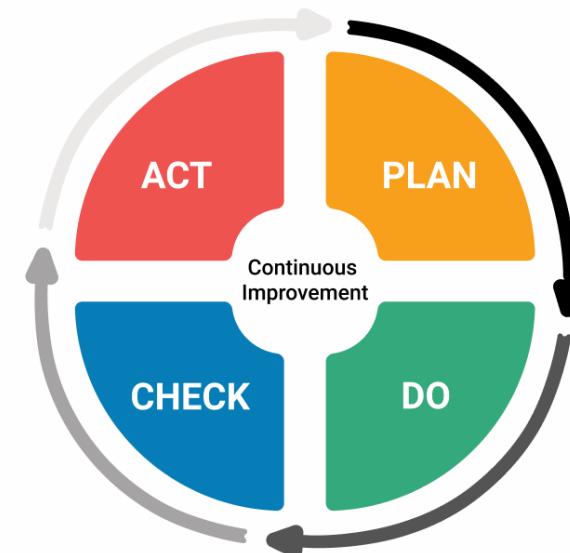
- Execute the plan

CHECK

- Did the plan work?

ACT

- If the plan worked, institutionalize
- If not, look for alternatives



QUALITY MANAGEMENT SYSTEM

- A QUALITY SYSTEM DEFINES:
 - POLICIES AND GOALS
 - ORGANIZATIONAL STRUCTURE
 - TASK AND RESPONSIBILITY ALLOCATION
 - PROCESSES AND PROCEDURES
 - INTEGRATION OF QUALITY-RELATED ACTIVITIES IN THE PROCESS MODEL

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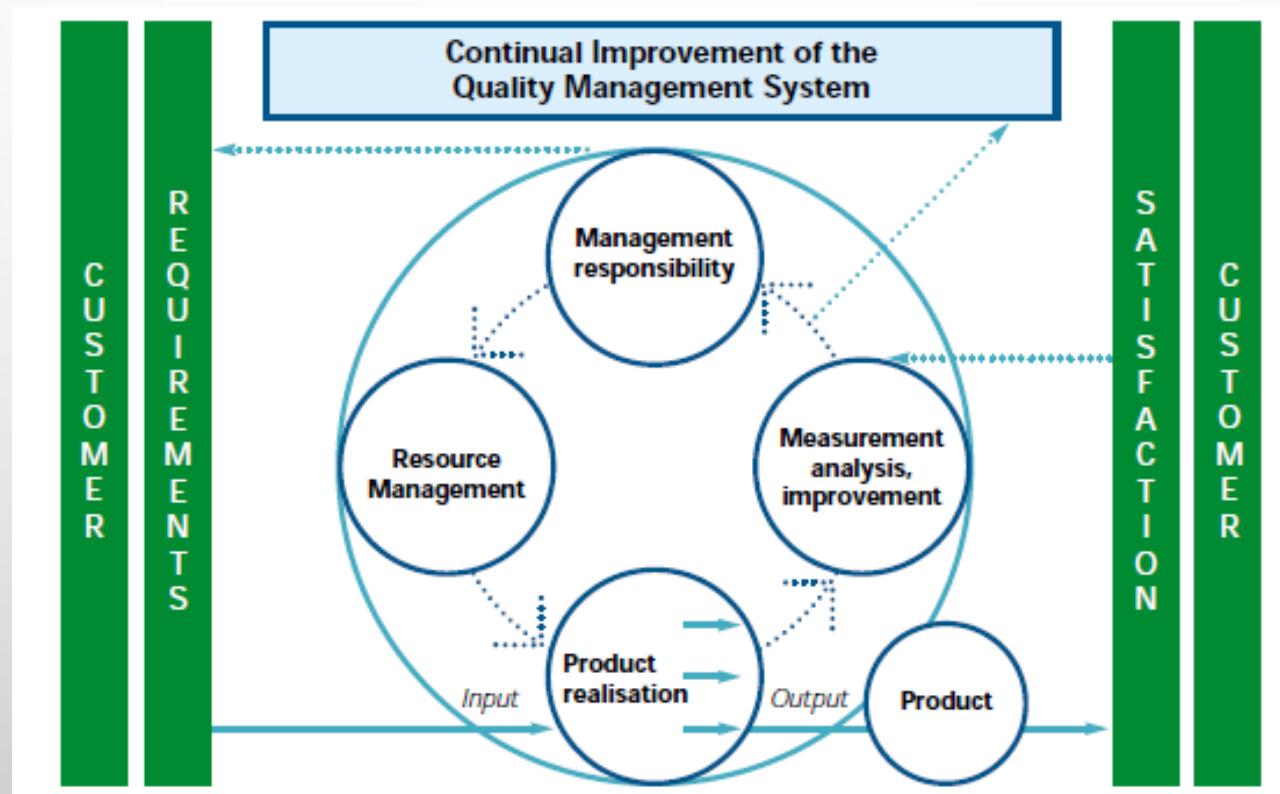
ISO 9000

- A FAMILY OF INTERNATIONAL STANDARDS THAT MANY ORGANIZATIONS USE TO ENSURE THAT THEIR QUALITY MANAGEMENT SYSTEM IS **IN PLACE AND EFFECTIVE**
- CONFORMANCE TO ISO 9000 IS EXPECTED TO GUARANTEE THAT A COMPANY DELIVERS QUALITY PRODUCTS AND SERVICES.
- OVER ONE MILLION COMPANIES AND ORGANIZATIONS IN OVER 170 COUNTRIES CERTIFIED TO ISO 9001

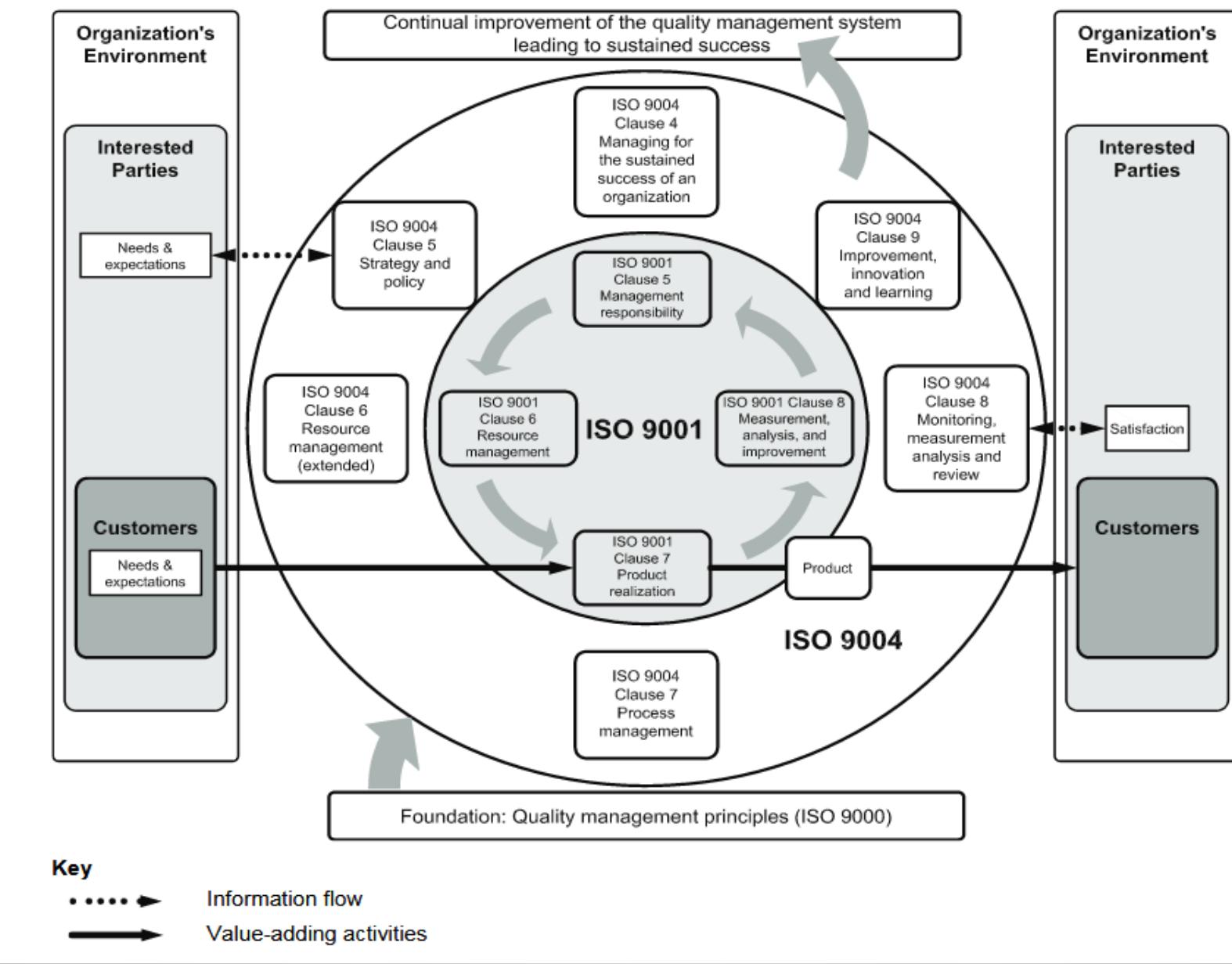
ISO 9000

- PARTS
 - ISO 9000:2015 - QUALITY MANAGEMENT SYSTEMS – FUNDAMENTALS AND VOCABULARY
 - ISO 9001:2015 - QUALITY MANAGEMENT SYSTEMS – REQUIREMENTS
 - SECTOR-SPECIFIC ADAPTATIONS:
 - ISO/IEC 90003:2014 – SOFTWARE ENGINEERING (FOR ISO 9001:2008)
 - ISO 9004:2009 – MANAGING FOR THE SUSTAINED SUCCESS OF AN ORGANIZATION -- A QUALITY MANAGEMENT APPROACH

PROCESS-BASED QUALITY MANAGEMENT SYSTEM



4 Process Areas



CONFORMANCE TO ISO 9001

1

Decides quality policies and objectives.

2

Formally writes down the company's policies and requirements and how the staff can implement the quality management system.

3

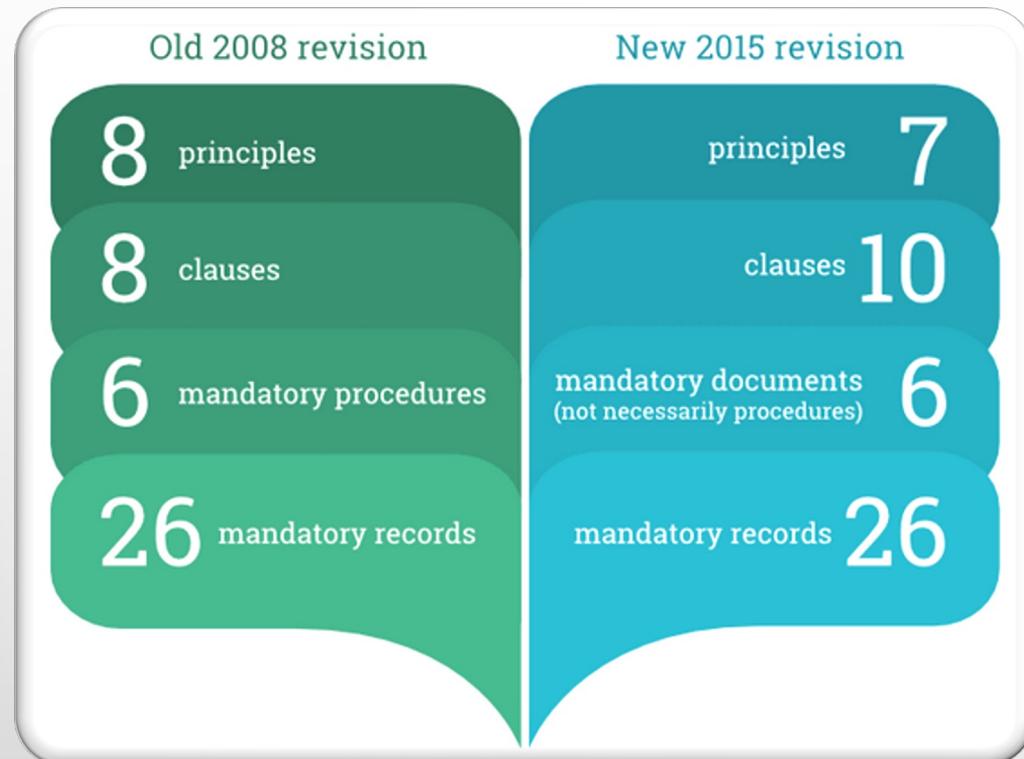
Once the procedures are implemented, an outside assessor examines the company's quality management system to make sure it complies with ISO 9001

4

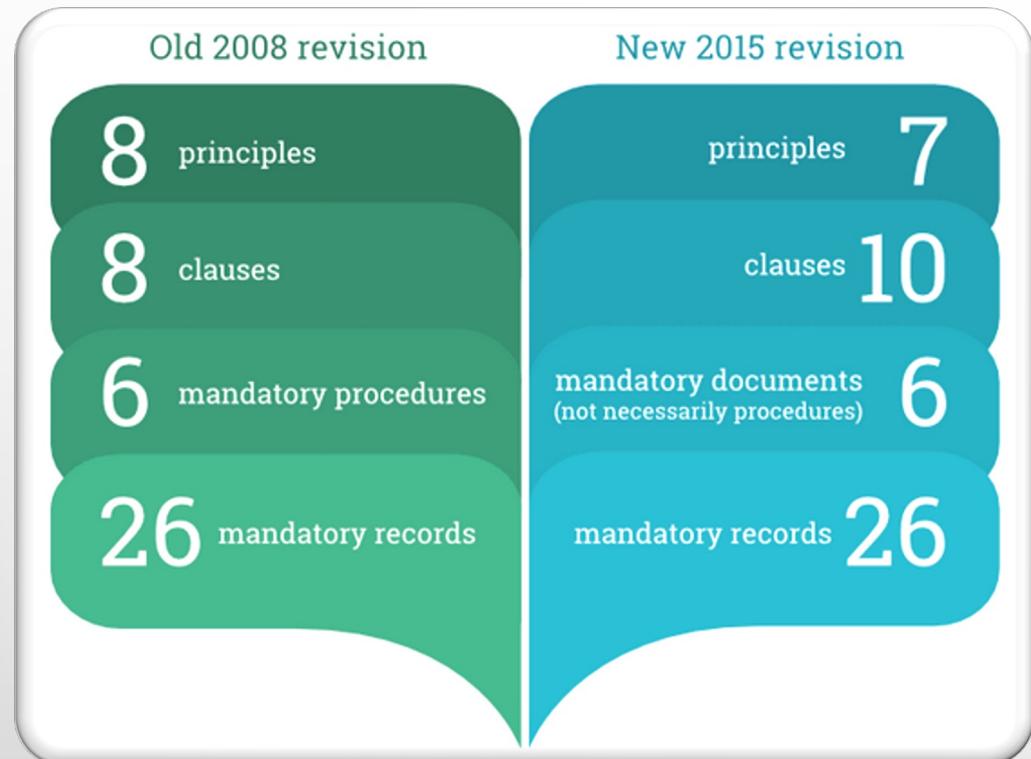
A detailed report describes the parts of the standard the company missed, and the company agrees to correct any problems within a specific time.

5

Once the problems are corrected, the company is certified as in conformance with the standard.



ISO 9001 EVOLUTION

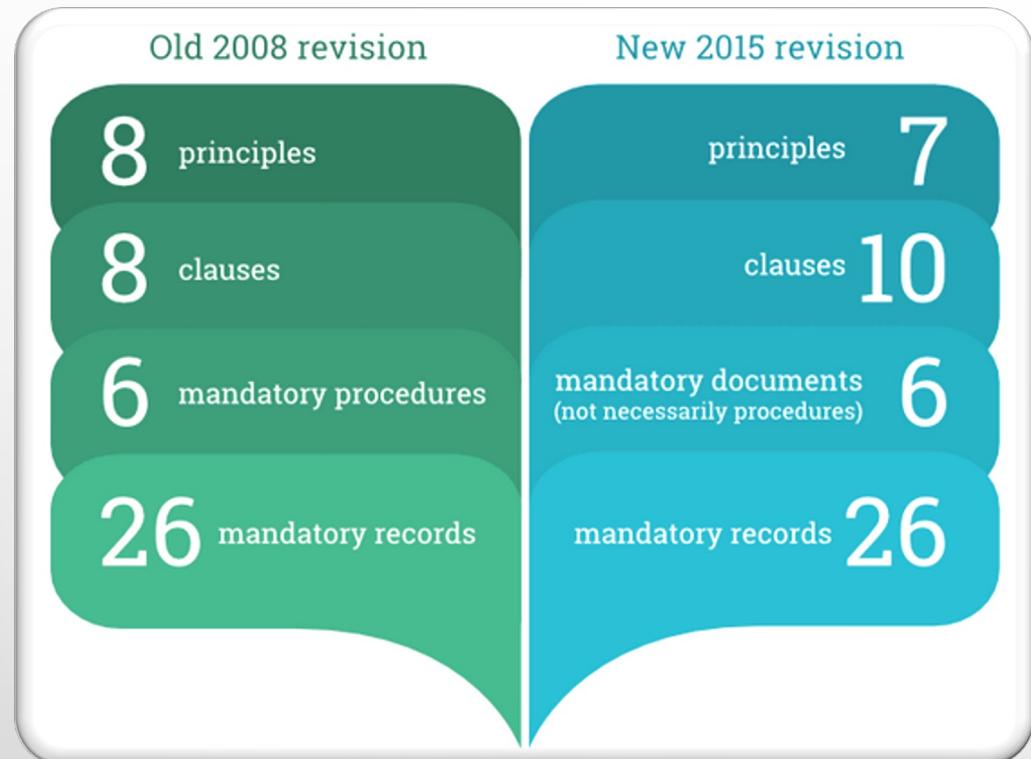


ISO 9001 EVOLUTION



7 QUALITY MANAGEMENT PRINCIPLES

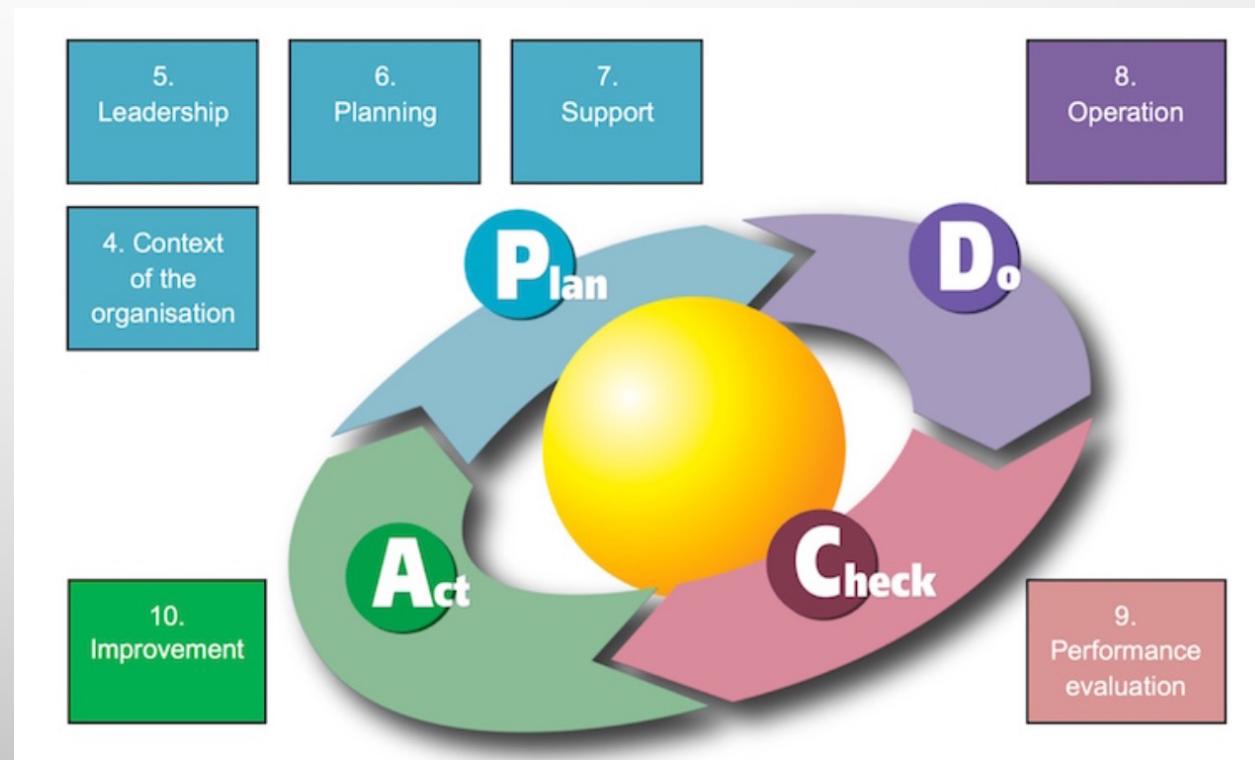
- CUSTOMER FOCUS
- LEADERSHIP
- ENGAGEMENT OF PEOPLE
- PROCESS APPROACH
- IMPROVEMENT
- EVIDENCE-BASED DECISION MAKING
- RELATIONSHIP MANAGEMENT



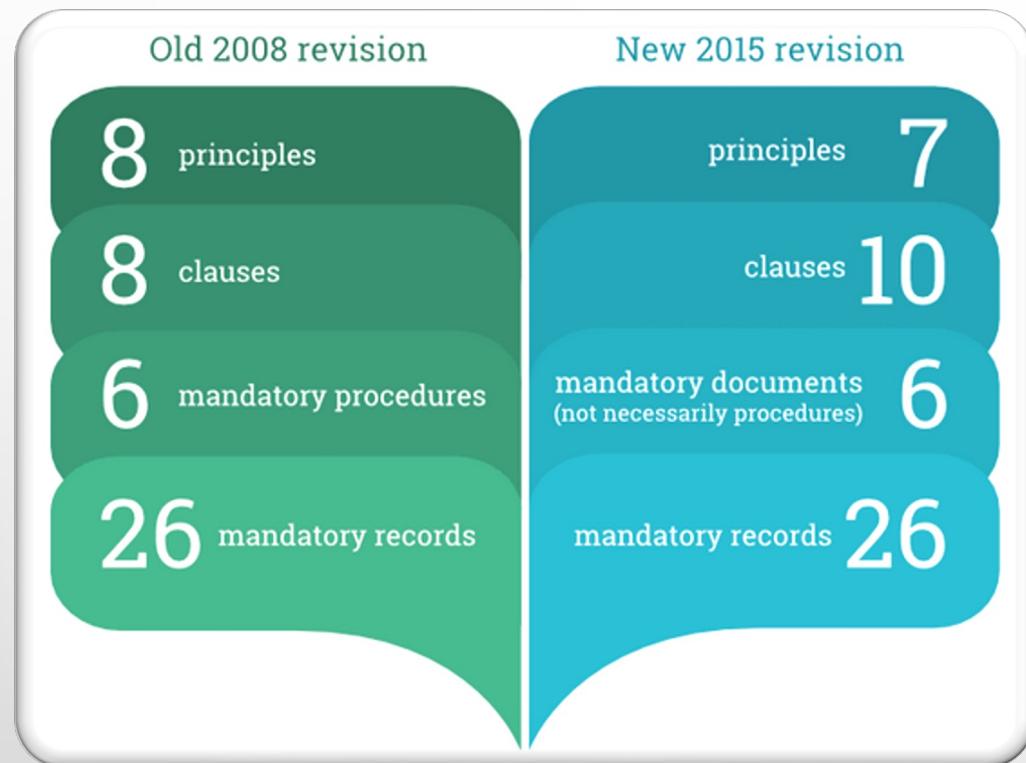
ISO 9001 EVOLUTION

CLAUSES IN A QUALITY SYSTEM (ISO 9001:2015)

1. SCOPE
2. NORMATIVE REFERENCE
3. TERMS AND DEFINITIONS
4. CONTEXT OF THE ORGANIZATION
5. LEADERSHIP
6. PLANNING
7. SUPPORT
8. OPERATION
9. PERFORMANCE EVALUATION
10. IMPROVEMENT



ISO 9001 EVOLUTION





QS DOCUMENTATION REQUIREMENTS

- ISO 9001:2015 REQUIRES:
 - SCOPE OF THE QMS (CLAUSE 4.3)
 - QUALITY POLICY (CLAUSE 5.2)
 - QUALITY OBJECTIVES (CLAUSE 6.2)
 - CRITERIA FOR EVALUATION AND SELECTION OF SUPPLIERS (CLAUSE 8.4.1)



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QS DOCUMENTATION REQUIREMENTS

- SCOPE OF THE QMS (CLAUSE 4.3)
 - HOW FAR THE QMS EXTENDS WITHIN THE COMPANY'S OPERATIONS
 - PHYSICAL LOCATIONS
 - PRODUCTS OR SERVICES
 - ANY EXCLUSION FROM THE ISO 9001 REQUIREMENTS AND THE JUSTIFICATION FOR THESE

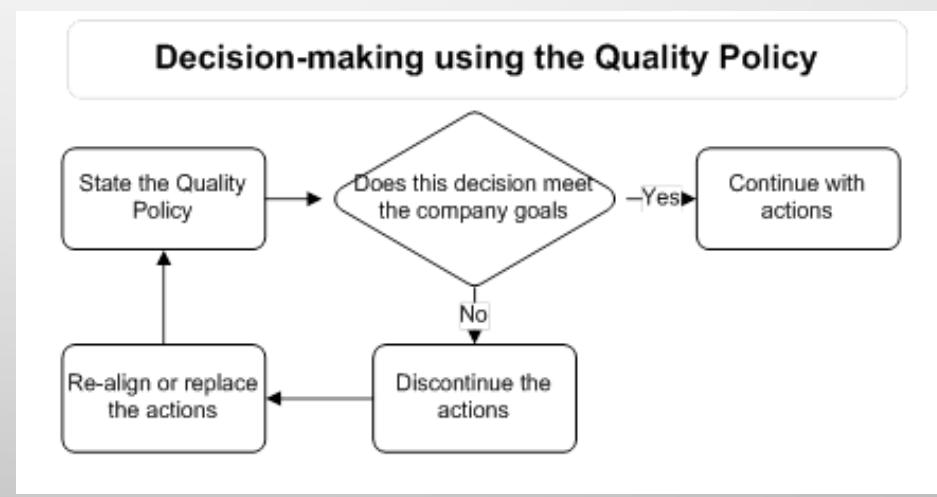


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QS DOCUMENTATION REQUIREMENTS

- **QUALITY POLICY:**
 - A REFLECTION OF THE GOALS OF THE ORGANIZATION
 - A FORMAL STATEMENT FROM MANAGEMENT
 - FOCUSES ON THE IMPORTANT ELEMENTS TO ATTAIN CUSTOMER SATISFACTION
 - IT CAN BE USED AS A FILTER FOR BUSINESS DECISIONS



QS DOCUMENTATION REQUIREMENTS

- **QUALITY POLICY**
 - IMPORTANT THAT ALL EMPLOYEES
 - KNOW THE POLICY
 - UNDERSTAND WHAT IT MEANS
 - KNOW HOW THEIR JOB SUPPORTS MEETING THE QUALITY POLICY

Quality Policy ISO 9001:2008 Certified

At Berlin Packaging, we strive to have a positive impact on the income of our customers. This is done through providing packaging and service solutions that increase customer's revenue, decrease their costs and/or improve their productivity. Along with having a positive impact on income, we are committed to providing accurate and timely information and product to our customers while continuously looking for ways to improve our processes.



QS DOCUMENTATION REQUIREMENTS

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QS DOCUMENTATION REQUIREMENTS

- **QUALITY OBJECTIVES (CLAUSE 6.2)**
 - TAKE THE GOAL(S) STATED IN THE QUALITY POLICY AND TURN THESE INTO STATEMENTS FOR IMPROVEMENT AGAINST WHICH PLANS CAN BE MADE
 - EXAMPLE:
 - QUALITY POLICY:
 - “TO DELIVER WIDGETS TO OUR SUPPLIERS WHEN THEY NEED THEM, WITH NO DEFECTS, EVERY TIME.”
 - QUALITY OBJECTIVES:
 - “TO IMPROVE ON-TIME DELIVERY FROM 90% TO 95% WITHIN THE NEXT YEAR”
 - “TO REDUCE FIELD ESCAPES TO THE CUSTOMER FROM 4% TO 3% WITHIN THE NEXT YEAR”

QS DOCUMENTATION REQUIREMENTS

- **QUALITY MANUAL:** ISO 9001:2015 DOES NOT REQUIRE IT (ISO 9001:2008 DID)
 - SCOPE OF QMS
 - EXCLUSIONS, IF ANY, AND JUSTIFICATIONS FOR THEM
 - INTERACTIONS BETWEEN PROCESSES (PREFERABLY THROUGH A PROCESS FLOWCHART)
 - LIST OF ALL THE QMS PROCEDURES IN USE
- HOWEVER, IT IS REQUIRED TO KEEP SOME FORM OF DOCUMENT THAT DESCRIBE THE QMS, TO BE SENT TO THE CERTIFICATION BODY, OR CLIENTS:
 - FOR EACH REQUIREMENT OF THE ISO 9001:2015 STANDARD
 - WHAT DOES THE REQUIREMENT MEAN FOR US?
 - WHO DOES THE REQUIREMENT APPLY TO?
 - WHAT PROCESSES DOES THE REQUIREMENT APPLY TO?
 - ANY SUPPORTING DOCUMENTATION THAT MAY GO INTO GREATER DETAIL ON THE REQUIREMENT (E.G. DOCUMENTED **OPERATIONAL PROCEDURES**)

ISO 9001 Requirement:

7.1.2 People: *To ensure that the organization can consistently meet customer and applicable statutory and regulatory requirements, the organization shall provide the persons necessary for the effective operation of the quality management system, including the processes needed.*

Interpretation:

Ape-X interprets this requirement as to apply to all employees within the company, excluding those in the Legal Department in our Washington DC facility, as this is out of scope of our QMS.

Ape-X interprets this as a requirement for it to maintain adequate staffing levels for each process area, to the best of its ability, giving consideration to local labor limitations.

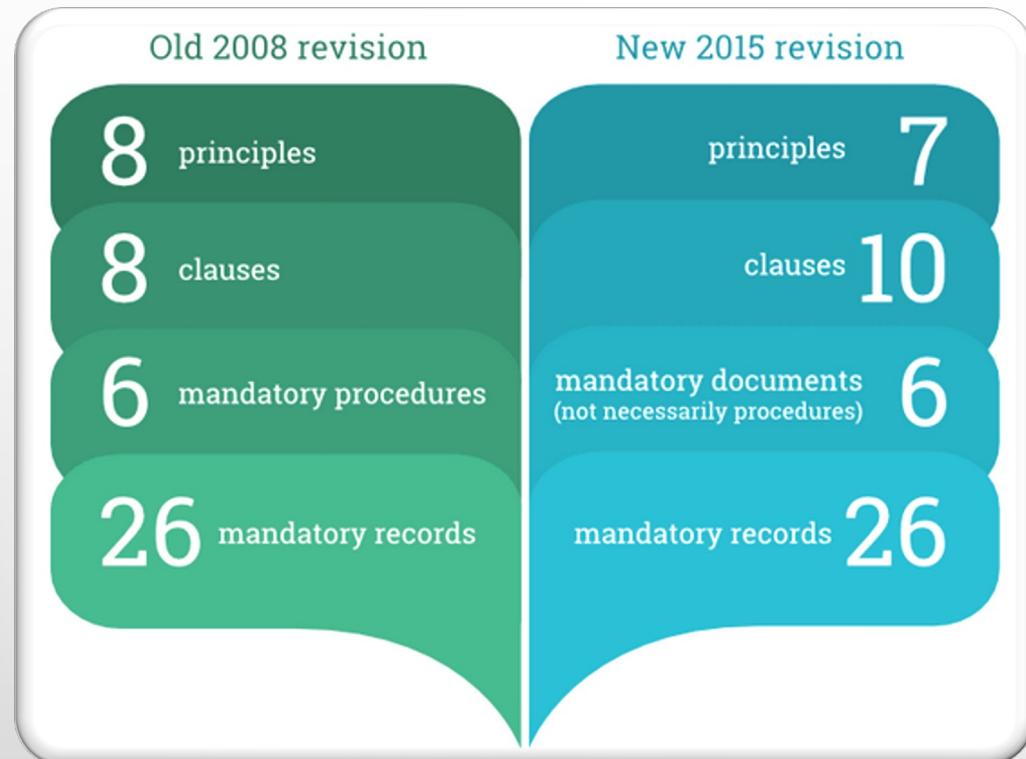
Process Area(s) Affected:

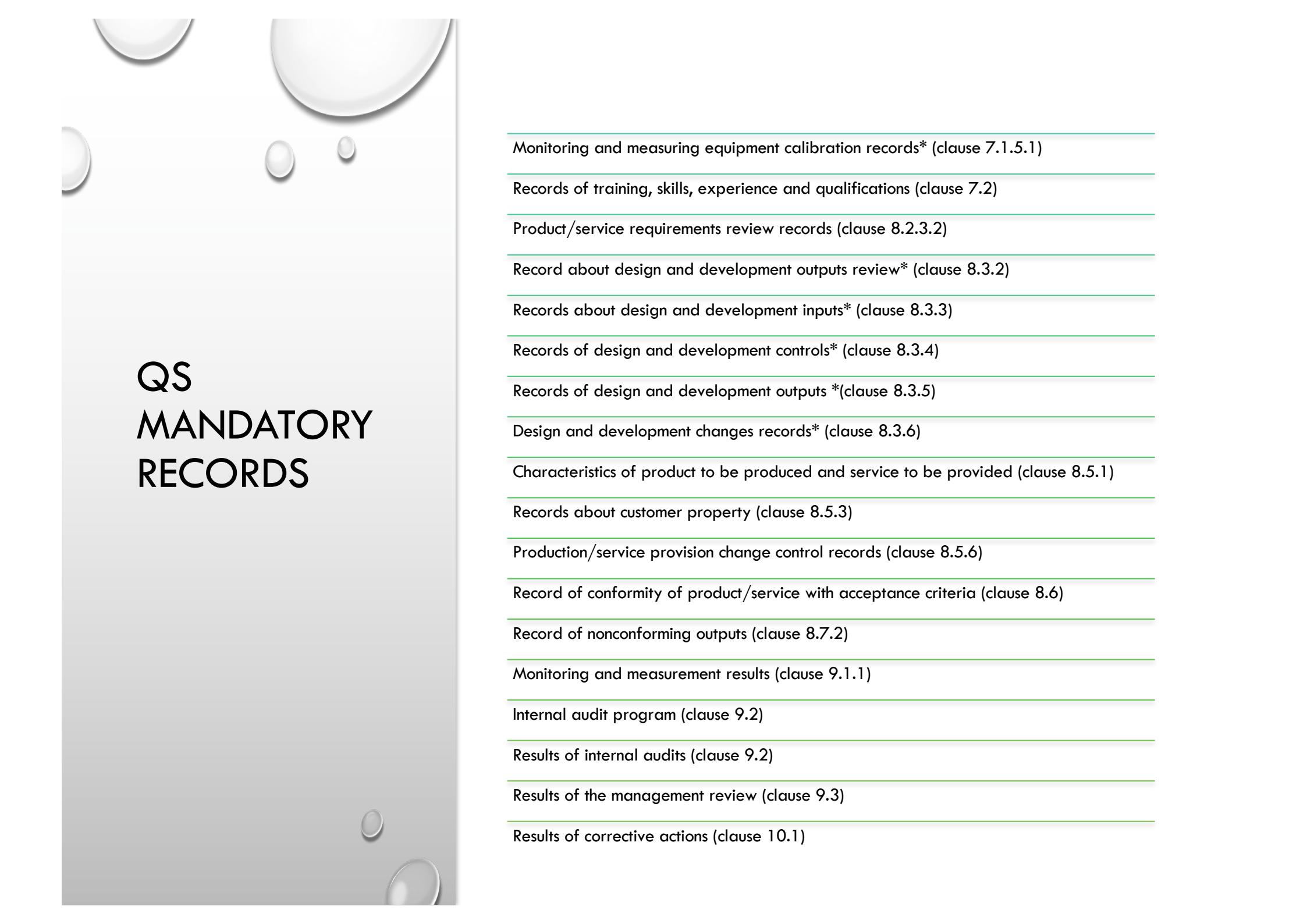
Resource Management

Supporting Documents:

- **SOP Hiring, Training and On-Boarding**

ISO 9001 EVOLUTION





QS MANDATORY RECORDS

-
- Monitoring and measuring equipment calibration records* (clause 7.1.5.1)
 - Records of training, skills, experience and qualifications (clause 7.2)
 - Product/service requirements review records (clause 8.2.3.2)
 - Record about design and development outputs review* (clause 8.3.2)
 - Records about design and development inputs* (clause 8.3.3)
 - Records of design and development controls* (clause 8.3.4)
 - Records of design and development outputs *(clause 8.3.5)
 - Design and development changes records* (clause 8.3.6)
 - Characteristics of product to be produced and service to be provided (clause 8.5.1)
 - Records about customer property (clause 8.5.3)
 - Production/service provision change control records (clause 8.5.6)
 - Record of conformity of product/service with acceptance criteria (clause 8.6)
 - Record of nonconforming outputs (clause 8.7.2)
 - Monitoring and measurement results (clause 9.1.1)
 - Internal audit program (clause 9.2)
 - Results of internal audits (clause 9.2)
 - Results of the management review (clause 9.3)
 - Results of corrective actions (clause 10.1)

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THE COST OF QUALITY

ASSESSMENT OF A QMS

<i>First-party</i>	<i>Second-party</i>	<i>Independent third-party</i>
<ul style="list-style-type: none">• Assessment of a QMS against a standard or set of requirements by internal audit and review	<ul style="list-style-type: none">• An external customer makes the assessment of a supplier, against either its own, or a national or international, standard	<ul style="list-style-type: none">• Assessment by an independent organisation, not connected with any contract between the customer and supplier, but acceptable to them both

INTERNAL AUDITS AND REVIEWS

- **AUDITS** ARE CARRIED OUT TO ENSURE THAT ACTUAL METHODS ARE ADHERING TO THE DOCUMENTED PROCEDURES
- **REVIEWS** SHOULD BE CARRIED OUT PERIODICALLY AND SYSTEMATICALLY, TO ENSURE THE SYSTEM ACHIEVES THE REQUIRED EFFECT, COVERING:
 - RESULTS OF AUDITS
 - CUSTOMER FEEDBACK
 - PROCESS AND PRODUCT CONFORMITY
 - STATUS OF PREVENTIVE AND CORRECTIVE ACTIONS
 - FOLLOW UP ACTIONS FROM PREVIOUS REVIEWS
 - CHANGES THAT COULD AFFECT THE QMS
 - RECOMMENDATIONS FOR IMPROVEMENTS

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THE 7 TOOLS OF QUALITY MANAGEMENT

- “95% OF THE PROBLEMS IN AN ORGANIZATION CAN BE SOLVED WITH A SELECTED SET OF QUALITY TOOLS” (ISHIKAWA, THE OLD SEVEN):
 - HISTOGRAMS
 - CONTROL CHARTS
 - PARETO ANALYSIS
 - CAUSE-EFFECT DIAGRAMS
 - CHECK SHEETS
 - SCATTER PLOTS
 - STRATIFICATION

GROUP EXERCISE

- READING 5 – THE BASIC TOOLS OF QUALITY MANAGEMENT
- PRESENTATION OF THE BASIC QUALITY TOOLS:
 - GROUP 1: HISTOGRAMS AND PARETO ANALYSIS
 - GROUP 2: DATA TABLES AND STRATIFICATION
 - GROUP 3: CAUSE-EFFECT ANALYSIS
 - GROUP 4: TREND ANALYSIS AND CONTROL CHARTS
- EACH GROUP SHOULD PREPARE A PRESENTATION OF ABOUT 15 MINUTES AND UPLOAD THE PRESENTATION FILE.
- ALL GROUP MEMBERS SHOULD PARTICIPATE IN THE PRESENTATION.
- ADDITIONAL MATERIAL IN MOODLE (BASIC QUALITY TOOLS FOLDER)



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THE COST OF QUALITY

THE COST OF QUALITY (COQ) CROSBY MODEL

- ANY SERIOUS ATTEMPT TO IMPROVE QUALITY MUST TAKE INTO ACCOUNT THE COSTS ASSOCIATED
- FOR CROSBY, QUALITY = CONFORMANCE TO REQUIREMENTS

Price of
Conformance

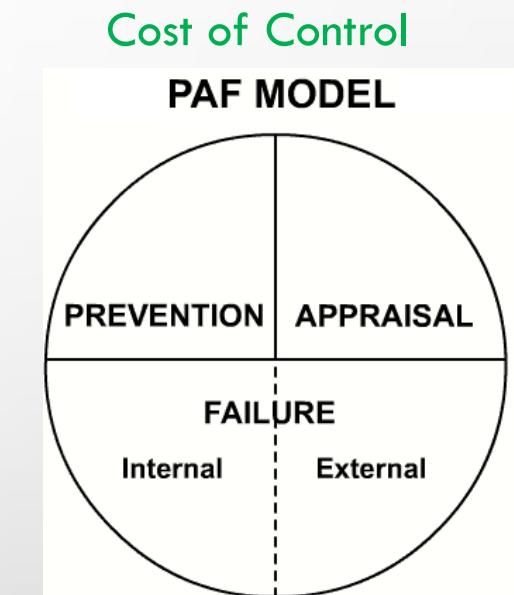
The price paid for avoidance of poor quality (including prevention, for example, training, and quality appraisal)

Price of Non
conformance

The cost of poor quality caused by product and service failure (for example, rework, returns, client loss, civil responsibility)

P-A-F MODELS (FEIGENBAUM)

- **PREVENTION COSTS**
 - ASSOCIATED WITH ACTIONS TAKEN TO ENSURE THAT A PROCESS PROVIDES QUALITY PRODUCTS AND SERVICES
- **APPRAISAL COSTS**
 - ASSOCIATED WITH MEASURING THE LEVEL OF QUALITY ATTAINED BY THE PROCESS
- **FAILURE COSTS**
 - INCURRED TO CORRECT QUALITY IN PRODUCTS AND SERVICES BEFORE (INTERNAL) OR AFTER (EXTERNAL) DELIVERY TO THE CUSTOMER

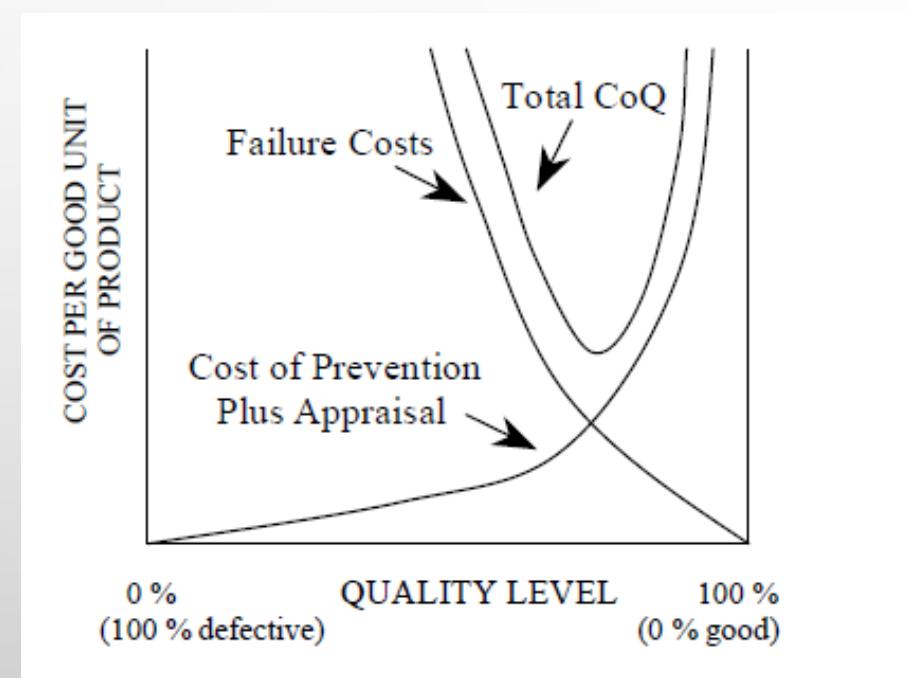


**Cost of Failure
of Control**

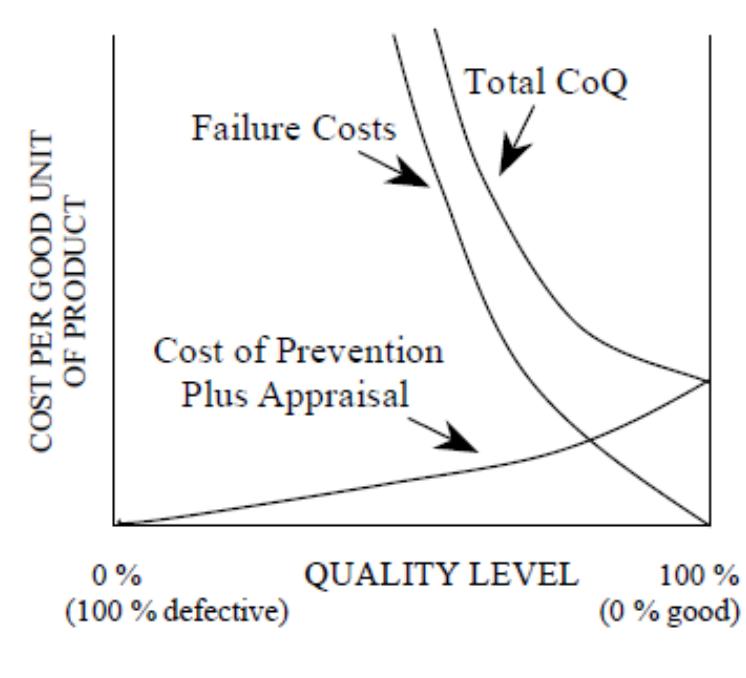
P-A-F MODELS

- ASSUMPTIONS:
 - INVESTMENT IN PREVENTION AND APPRAISAL ACTIVITIES WILL REDUCE FAILURE COSTS
 - FURTHER INVESTMENT IN PREVENTION ACTIVITIES WILL REDUCE APPRAISAL COSTS
 - THERE EXISTS AN **OPTIMUM ECONOMIC QUALITY** THAT MINIMIZES TOTAL COST OF QUALITY
- THE OBJECTIVE OF A COQ SYSTEM IS TO FIND THE OPTIMUM ECONOMIC QUALITY:
 - THE LEVEL AT WHICH THE **COST** OF SECURING HIGHER QUALITY WOULD EXCEED THE **BENEFITS** OF THE IMPROVED QUALITY

THE ECONOMIC LEVEL OF QUALITY

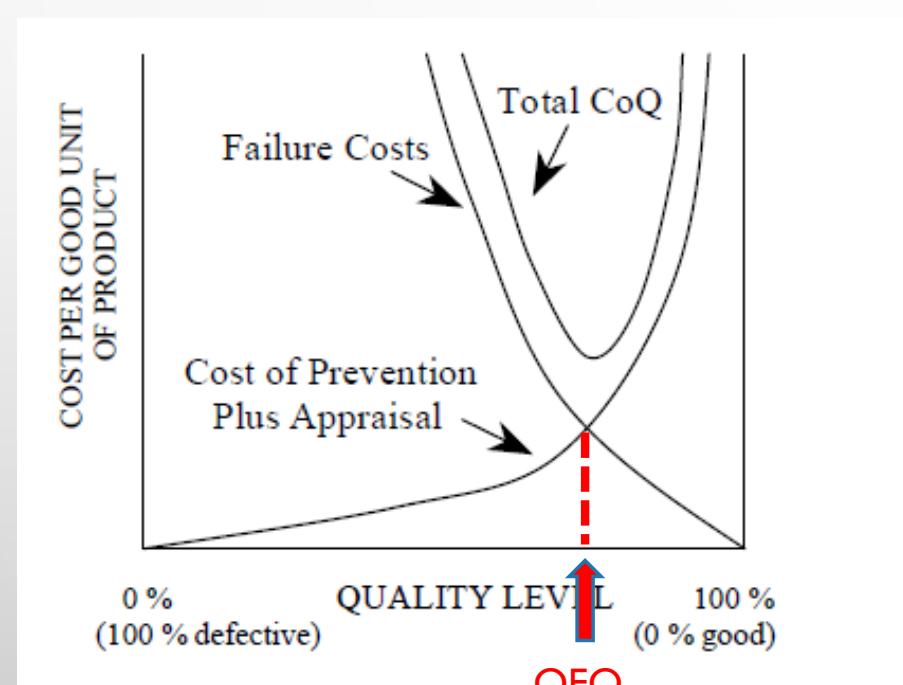


CLASICAL VIEW

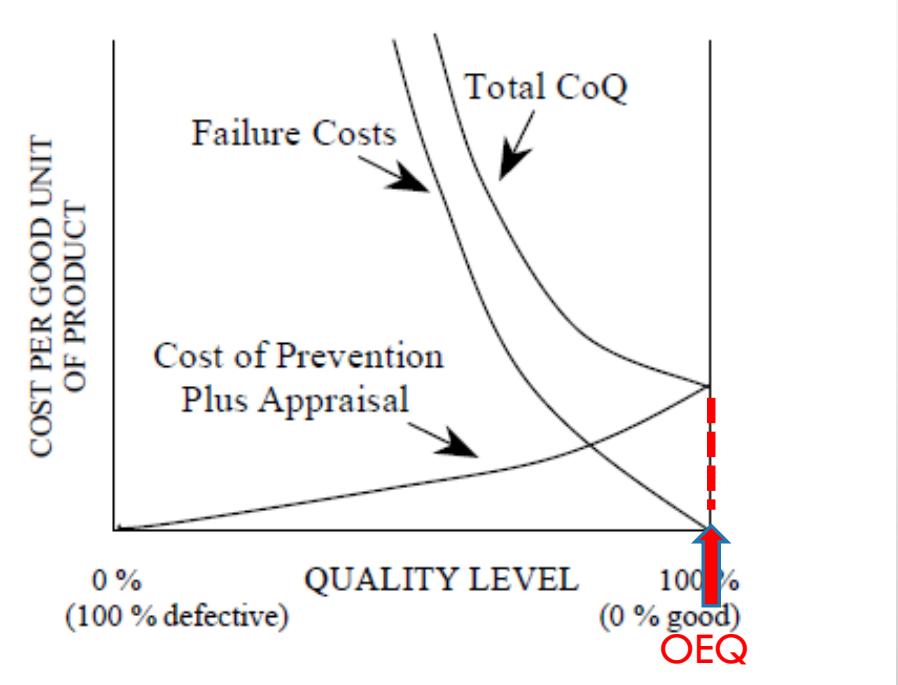


MODERN VIEW

THE ECONOMIC LEVEL OF QUALITY



CLASICAL VIEW



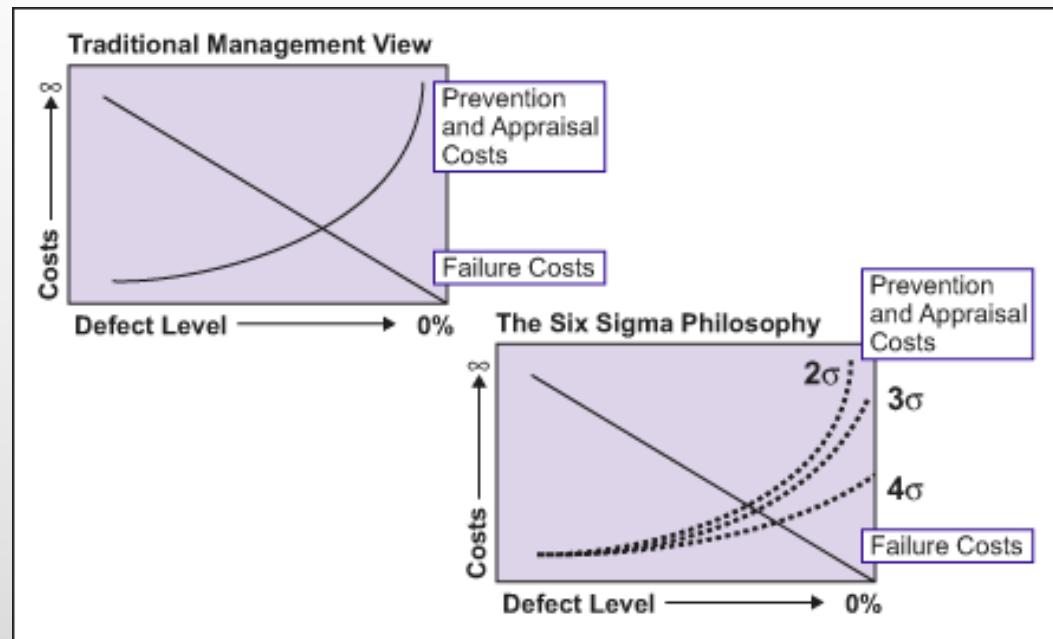
MODERN VIEW

THE ECONOMIC LEVEL OF QUALITY

- TWO CONFLICTING VIEWS:
 - P-A-F APPROACH
 - OPTIMUM QUALITY LEVEL = ZERO DEFECTS
- FAILURE COSTS CAN CONTINUE TO DECLINE OVER TIME
- YOU WILL NEVER FULLY ELIMINATE APPRAISAL AND PREVENTION COSTS, BUT THEIR REDUCTION DUE TO BETTER PROCESS PERFORMANCE WILL BE SIGNIFICANT

SIX-SIGMA VIEW OF COQ

- DOING THINGS RIGHT THE FIRST TIME, THE INCREASE OF THE COST OF GOOD QUALITY CAN BE SMOOTHED IF PROCESSES GET BETTER
- BUSINESS PROCESSES WITH BETTER PROCESS SIGMA WILL HAVE SIGNIFICANTLY LOWER PREVENTION AND APPRAISAL COSTS.



CALCULATING PROCESS SIGMA

- A COMPANY'S PERFORMANCE IS MEASURED BY THE SIGMA LEVEL OF THEIR BUSINESS PROCESSES
 - DEFECT = ANY INSTANCE OF FAILING TO MEET CUSTOMER REQUIREMENTS
 - DEFECT MEASUREMENT = ON A SCALE OF DEFECTS PER MILLION OPPORTUNITIES (DPMO)
 - PROCESS SIGMA = ONCE YOU HAVE DETERMINED THE DPMO, YOU CAN NOW USE A SIX SIGMA TABLE TO FIND IT
 - PROCESS SIGMA GOAL = 6.0, IT CORRESPONDS TO ONLY 3.4 DPMO
 - IN NON-MANUFACTURING OPERATIONS, THE GOAL IS TYPICALLY SET AT FOUR OR FIVE SIGMA

SIX-SIGMA

- SIX SIGMA IS A METHODOLOGY FOCUSED ON CREATING BREAKTHROUGH IMPROVEMENTS BY **MANAGING VARIATION AND REDUCING DEFECTS** IN PROCESSES ACROSS THE ENTERPRISE.
- THE TARGET IS TO DELIVER CONSISTENT SERVICES AND/OR PRODUCTS WITH NEAR ZERO DEFECTS
- SIGMA IS A STATISTICAL TERM THAT MEASURES PROCESS DEVIATION FROM THE PROCESS MEAN OR TARGET
- IF WE CAN MEASURE PROCESS VARIATIONS THAT CAUSE DEFECTS (UNACCEPTABLE DEVIATION FROM THE MEAN OR TARGET), WE CAN WORK TOWARDS SYSTEMATICALLY MANAGING THE VARIATION TO ELIMINATE DEFECTS.

SIX SIGMA TOOLS

Six Sigma takes a handful of proven methods

Total Quality Management (TQM) includes over 400 tools and techniques

- Gemba Study
- Benchmarking
- Quality Function Deployment (QFD)
- Critical to Quality (CTQ)
- Performance scorecards
- Project Charter
- RACI Matrix
- KANO model
- Function Analysis Systems Technique (FAST)
- Morphological Mapping
- Analytical Hierarchy Process (AHP)
- System Failure Mode Effects Analysis (SFMEA)
- Design for Manufacture & Assembly (DFMA)....

Six Sigma Black Belts

- A small set of in-house technical leaders trained to a high level of proficiency in the application of these techniques



SIX-SIGMA APPLICATION

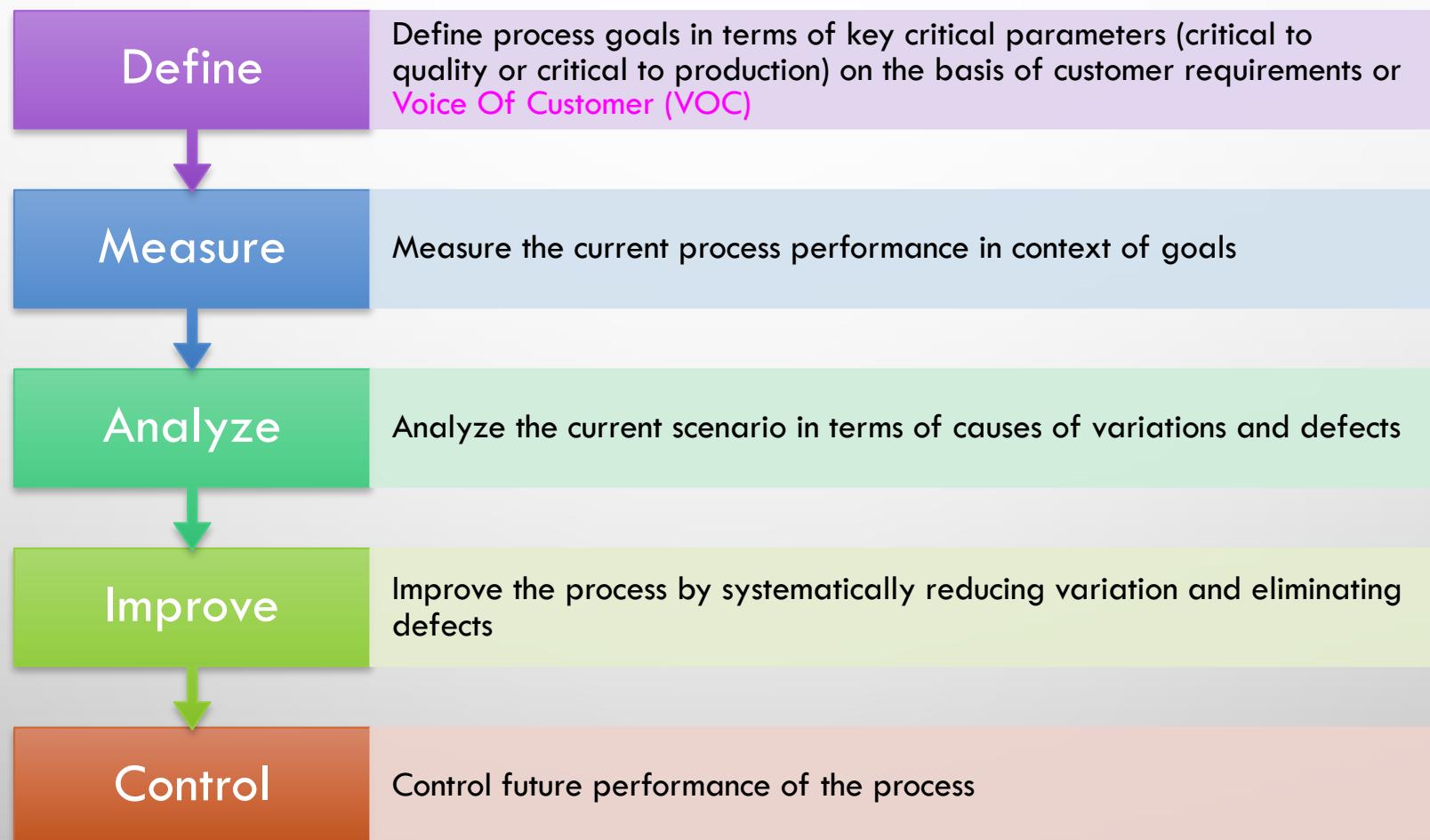
POTENTIAL SCENARIOS

There is already an existing process(s) that is working "reasonably" well

There is no process at all. A bad process is as good as no process.

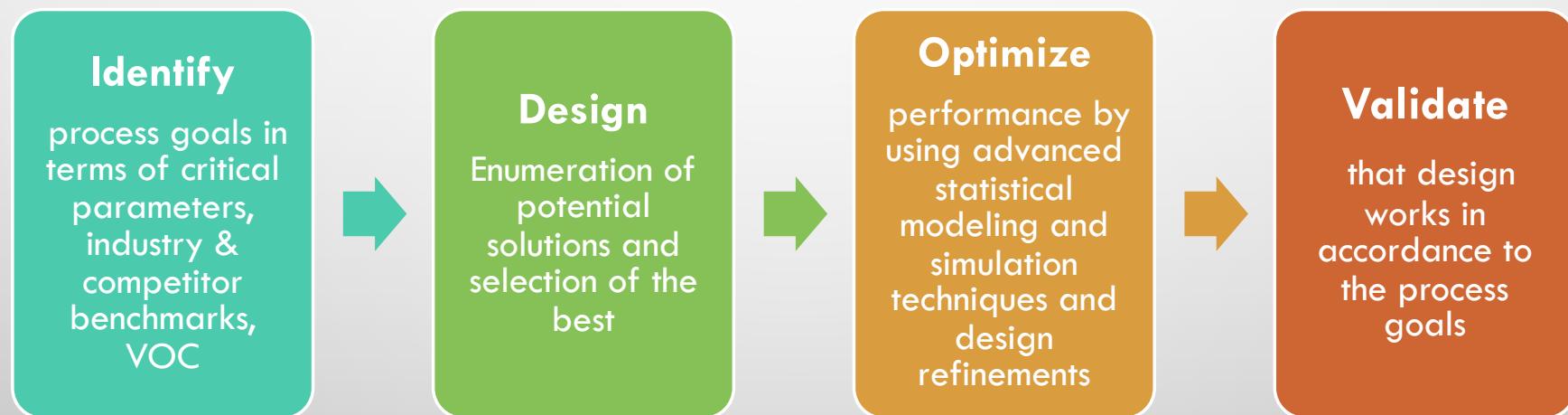
SIX-SIGMA: EXISTING PROCESS

REQUIRES USE OF **DMAIC**



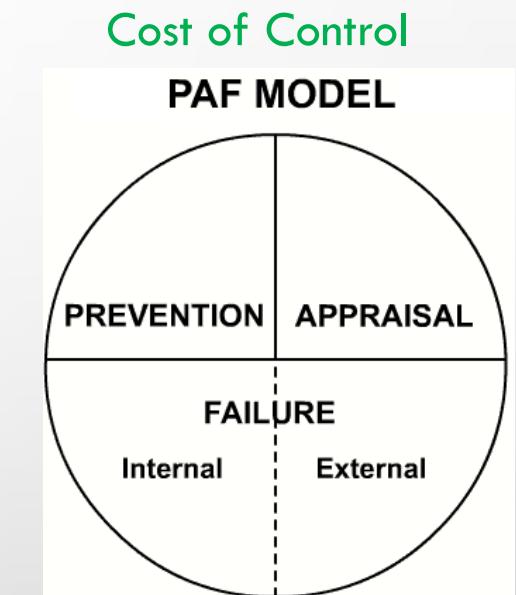
SIX-SIGMA: NON EXISTING PROCESS

- FOCUSES ON PROCESS DESIGN USING **DESIGN FOR SIX SIGMA (DFSS)**
- DFSS TYPICALLY REQUIRES **IDOV**



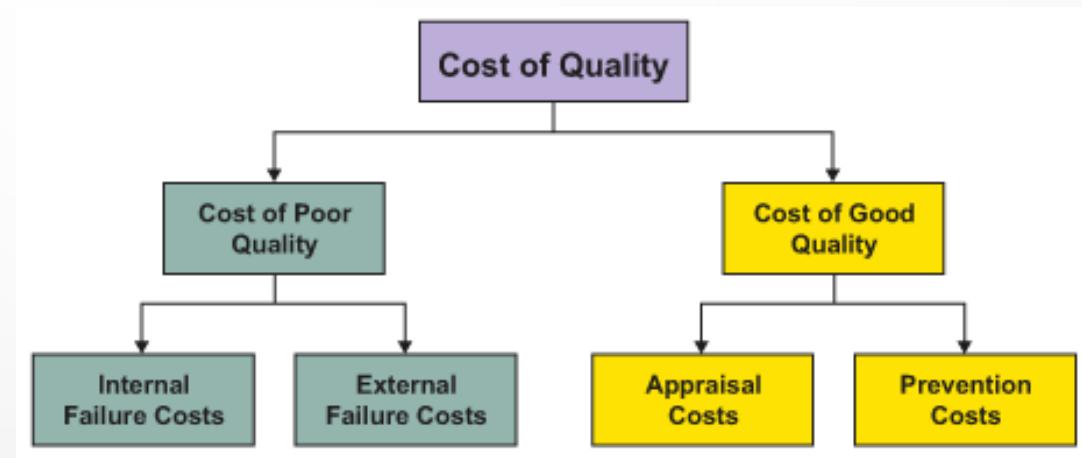
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**Cost of Failure
of Control**

THE COST OF QUALITY (COQ)



- INTERNAL FAILURE:
 - CAUSED BY DEFICIENCIES FOUND BEFORE DELIVERY OF PRODUCTS AND SERVICES TO EXTERNAL CUSTOMERS
- EXTERNAL FAILURE:
 - CAUSED BY DEFICIENCIES FOUND AFTER DELIVERY OF PRODUCTS AND SERVICES TO EXTERNAL CUSTOMERS, WHICH LEAD TO CUSTOMER DISSATISFACTION



TEST OUR KNOWLEDGE

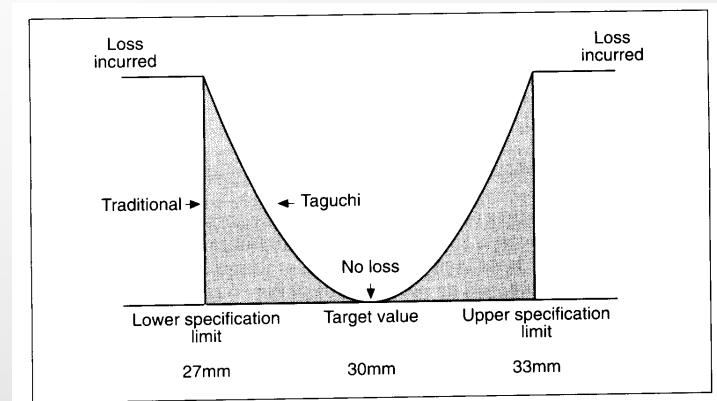
- WHICH OF THE FOLLOWING IS A METHOD FOR CALCULATING A QUALITY COST FACTOR DUE TO AN EXTERNAL FAILURE?
 - A. TOTALING THE PENALTY FEES THAT MUST BE PAID TO THE CUSTOMER DUE TO LATE DELIVERY OF A SOFTWARE PRODUCT
 - B. MEASURING THE AMOUNT OF EFFORT SPENT PERFORMING CODE REVIEWS
 - C. MEASURING THE AMOUNT OF TIME SPENT FIXING DEFECTS FOUND DURING SYSTEM TESTING
 - D. MEASURING THE CUSTOMER'S SYSTEM DOWNTIME OVER A ONE—YEAR PERIOD

OPORTUNITY, HIDDEN AND INTANGIBLE COSTS

- Difference between perceived CoQ and actual CoQ:
 - Tangible costs: P-A-F components
 - Intangible costs or opportunity costs (hidden and indirect):
 - Lost customers because of defective products
 - Under-utilization of installed capacity or resources
 - Downtime during elimination of defects

OPORTUNITY, HIDDEN AND INTANGIBLE COSTS

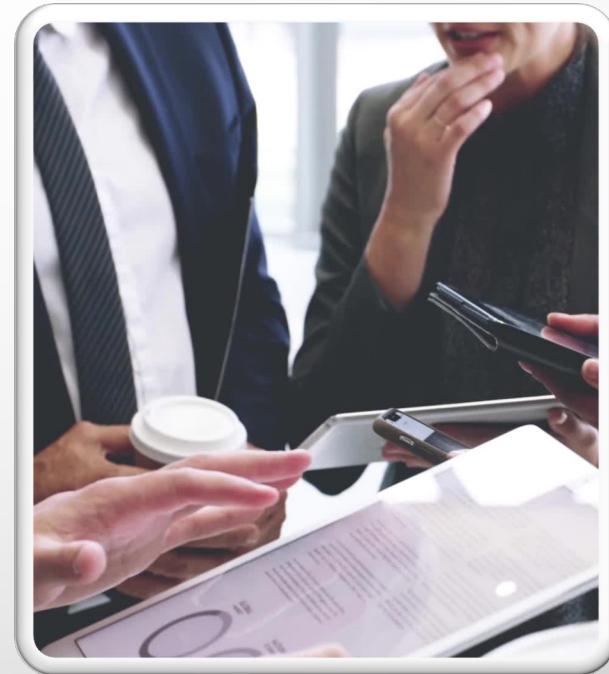
- Taguchi's loss function:
 - Any variation from the target value of a quality characteristic causes **hidden quality costs**



- Opportunity costs:
 - The **loss of potential gain** from other alternatives when one alternative is chosen

OPORTUNITY COST MODELS (ROSS, MARSH)

- INTANGIBLE COSTS
 - COSTS THAT CAN BE ONLY ESTIMATED SUCH AS PROFITS NOT EARNED BECAUSE OF
 - LOST CUSTOMERS
 - REDUCTION IN REVENUE OWING TO NON-CONFORMANCE
- OPPORTUNITY LOSSES
 - UNDER-UTILIZATION OF INSTALLED CAPACITY
 - INADEQUATE MATERIAL HANDLING
 - POOR DELIVERY OF SERVICE



PROCESS COST MODELS

- QUALITY COST SYSTEMS THAT **FOCUS ON PROCESS** RATHER THAN PRODUCTS OR SERVICES.
- PROCESS COST IS THE TOTAL COST OF CONFORMANCE AND NON-CONFORMANCE **FOR A PARTICULAR PROCESS**
 - THE COST OF CONFORMANCE:
 - THE ACTUAL PROCESS COST OF PRODUCING PRODUCTS OR SERVICES FIRST TIME TO THE REQUIRED STANDARDS BY A GIVEN SPECIFIED PROCESS
 - THE COST OF NONCONFORMANCE:
 - THE FAILURE COST ASSOCIATED WITH THE PROCESS NOT BEING EXECUTED TO THE REQUIRED STANDARD

PROCESS COST MODELS

- IDENTIFY ALL THE ACTIVITIES AND PARAMETERS WITHIN THE PROCESS TO BE MONITORED BY FLOWCHARTING THE PROCESS
- THE FLOWCHARTED ACTIVITIES ARE ALLOCATED AS COC OR CONC
- THE COST OF QUALITY AT EACH STAGE (COC +CONC) ARE CALCULATED OR ESTIMATED
- KEY AREAS FOR PROCESS IMPROVEMENT ARE IDENTIFIED
- IMPROVE BY:
 - INVESTING IN PREVENTION ACTIVITIES TO REDUCE THE CONC
 - PROCESS REDESIGN TO REDUCE COC

PROCESS COST MODELS

- PREFERRED METHOD FOR QUALITY COSTING WITHIN TQM
- IT RECOGNIZES THE IMPORTANCE OF PROCESS COST MEASUREMENT AND OWNERSHIP
- PRESENTS A MORE INTEGRATED APPROACH TO QUALITY THAN THE P-A-F MODEL
- PURSUES A CONTINUOUS IMPROVEMENT POLICY ON KEY PROCESSES WITHIN THE ORGANIZATION AND INNOVATES WHERE APPROPRIATE