# Chapter 8:
# Project Quality Management

**Information Technology Project Management, Fourth Edition**

## Learning Objectives

- Understand the importance of project quality management for information technology products and services.
- Define project quality management and understand how quality relates to various aspects of information technology projects.
- Describe quality planning and its relationship to project scope management.
- Discuss the importance of quality assurance.
- List the three outputs of the quality control process.



## Learning Objectives

- Understand the tools and techniques for quality control, such as Pareto analysis, statistical sampling, Six Sigma, quality control charts, and testing.
- Summarize the contributions of noteworthy quality experts to modern quality management.
- Describe how leadership, cost, organizational influences, expectations, cultural differences, standards, and maturity models relate to improving quality in information technology projects.
- Discuss how software can assist in project quality management.



## The Importance of Project Quality Management

- Many people joke about the poor quality of IT products (see cars and computers joke on pages 290-291).
- People seem to accept systems being down occasionally or needing to reboot their PCs.
- But quality is very important in many IT projects.



## What Went Wrong?

- In 1981, a small timing difference caused by a computer program caused a launch abort.*
- In 1986, two hospital patients died after receiving fatal doses of radiation from a Therac 25 machine after a software problem caused the machine to ignore calibration data.**
- Britain's Coast Guard was unable to use its computers for several hours in May 2004 after being hit by the Sasser virus, which knocked out the electronic mapping systems, e-mail, and other computer functions, forcing workers to revert to pen, paper, and radios.***

*_Design News_ (February 1988).
**_Datamation_ (May 1987).
***Fleming, Nic, "Virus sends coastguard computers off course" (_http://news.telegraph.co.uk/news/main.jhtml?xml=/news/2004/05/05/ncoast05.xml_) (May 15, 2004).



## What Is Quality?

- The International Organization for Standardization (ISO) defines **quality** as "the degree to which a set of inherent characteristics fulfils requirements" (ISO9000:2000).
- Other experts define quality based on:
  - **Conformance to requirements**: The project's processes and products meet written specifications.
  - **Fitness for use**: A product can be used as it was intended.

## What Is Project Quality Management?

- Project quality management ensures that the project will satisfy the needs for which it was undertaken.
- Processes include:
  - **Quality planning**: Identifying which quality standards are relevant to the project and how to satisfy them.
  - **Quality assurance**: Periodically evaluating overall project performance to ensure the project will satisfy the relevant quality standards.
  - **Quality control**: Monitoring specific project results to ensure that they comply with the relevant quality standards.



## Quality Planning

- Implies the ability to anticipate situations and prepare actions to bring about the desired outcome.
- Important to prevent defects by:
  - Selecting proper materials.
  - Training and indoctrinating people in quality.
  - Planning a process that ensures the appropriate outcome.



## Design of Experiments

- **Design of experiments** is a quality planning technique that helps identify which variables have the most influence on the overall outcome of a process.
- Also applies to project management issues, such as cost and schedule trade-offs.
- Involves documenting important factors that directly contribute to meeting customer requirements.



## Scope Aspects of IT Projects

- **Functionality** is the degree to which a system performs its intended function.
- **Features** are the system's special characteristics that appeal to users.
- **System outputs** are the screens and reports the system generates.
- **Performance** addresses how well a product or service performs the customer's intended use.
- **Reliability** is the ability of a product or service to perform as expected under normal conditions.
- **Maintainability** addresses the ease of performing maintenance on a product.



## Who's Responsible for the Quality of Projects?

- Project managers are ultimately responsible for quality management on their projects.
- Several organizations and references can help project managers and their teams understand quality.
  - International Organization for Standardization (www.iso.org)
  - IEEE (www.ieee.org)



## Quality Assurance

- Quality assurance includes all the activities related to satisfying the relevant quality standards for a project.
- Another goal of quality assurance is continuous quality improvement.
- **Benchmarking** generates ideas for quality improvements by comparing specific project practices or product characteristics to those of other projects or products within or outside the performing organization.
- A **quality audit** is a structured review of specific quality management activities that help identify lessons learned that could improve performance on current or future projects.

## Table 8-1. Table of Contents for a Quality Assurance Plan*

1.0 Draft Quality Assurance Plan
1.1 Introduction
1.2 Purpose
1.3 Policy Statement
1.4 Scope
2.0 Management
2.1 Organizational Structure
2.2 Roles and Responsibilities
2.2.1 Technical Monitor/Senior Management
2.2.2 Task Leader
2.2.3 Quality Assurance Team
2.2.4 Technical Staff
3.0 Required Documentation
4.0 Quality Assurance Procedures
4.1 Walkthrough Procedure
4.2 Review Process
4.2.1 Review Procedures
4.3 Audit Process
4.3.1 Audit Procedures
4.4 Evaluation Process
4.5 Process Improvement
5.0 Problem Reporting Procedures
5.1 Noncompliance Reporting Procedures
6.0 Quality Assurance Metrics
Appendix
Quality Assurance Checklist Forms

*U.S. Department of Energy



## Quality Control

- The main outputs of quality control are:
  - Acceptance decisions
  - Rework
  - Process adjustments
- Some tools and techniques include:
  - Pareto analysis
  - Statistical sampling
  - Six Sigma
  - Quality control charts

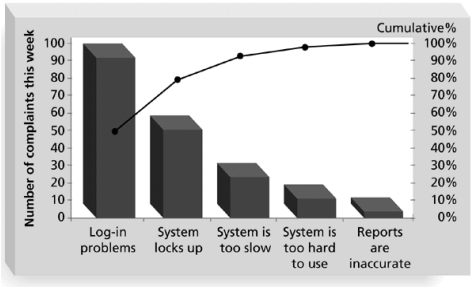


## Pareto Analysis

- **Pareto analysis** involves identifying the vital few contributors that account for the most quality problems in a system.
- Also called the 80-20 rule, meaning that 80 percent of problems are often due to 20 percent of the causes.
- **Pareto diagrams** are histograms, or column charts representing a frequency distribution, that help identify and prioritize problem areas.



## Figure 8-1. Sample Pareto Diagram






## Statistical Sampling and Standard Deviation

- **Statistical sampling** involves choosing part of a population of interest for inspection.
- The size of a sample depends on how representative you want the sample to be.
- Sample size formula:

  Sample size = .25 X (certainty factor/acceptable error)$^2$
- Be sure to consult with an expert when using statistical analysis.



## Six Sigma

- **Six Sigma** is "a comprehensive and flexible system for achieving, sustaining, and maximizing business success. Six Sigma is uniquely driven by close understanding of customer needs, disciplined use of facts, data, and statistical analysis, and diligent attention to managing, improving, and reinventing business processes."*

*Pande, Peter S., Robert P. Neuman, and Roland R. Cavanagh, *The Six Sigma Way*, New York: McGraw-Hill, 2000, p. xi.

## Basic Information on Six Sigma

- The target for perfection is the achievement of no more than **3.4 defects per million opportunities**.
- The principles can apply to a wide variety of processes.
- Six Sigma projects normally follow a five-phase improvement process called DMAIC.



## DMAIC

- **DMAIC** is a systematic, closed-loop process for continued improvement that is scientific and fact based.
- DMAIC stands for:
  - **D**efine: Define the problem/opportunity, process, and customer requirements.
  - **M**easure: Define measures, then collect, compile, and display data.
  - **A**nalyze: Scrutinize process details to find improvement opportunities.
  - **I**mprove: Generate solutions and ideas for improving the problem.
  - **C**ontrol: Track and verify the stability of the improvements and the predictability of the solution.



## How is Six Sigma Quality Control Unique?

- It requires an organization-wide commitment.
- Training follows the "Belt" system.
- Six Sigma organizations have the ability and willingness to adopt contrary objectives, such as reducing errors and getting things done faster.
- It is an operating philosophy that is customer focused and strives to drive out waste, raise levels of quality, and improve financial performance at *breakthrough* levels.



## Examples of Six Sigma Organizations

- Motorola, Inc. pioneered the adoption of Six Sigma in the 1980s and saved about $14 billion.*
- Allied Signal/Honeywell saved more than $600 million a year by reducing the costs of reworking defects and improving aircraft engine design processes.**
- General Electric uses Six Sigma to focus on achieving customer satisfaction.

*Pande, Peter S., Robert P. Neuman, and Roland R. Cavanagh, *The Six Sigma Way*. New York: McGraw-Hill, 2000, p. 7.
**Ibid. p. 9.



## Six Sigma and Project Management

- Joseph M. Juran stated, "All improvement takes place project by project, and in no other way."*
- It's important to select projects carefully and apply higher quality where it makes sense; companies that use Six Sigma do not always boost their stock values.
- As Mikel Harry puts it, "I could genetically engineer a Six Sigma goat, but if a rodeo is the marketplace, people are still going to buy a Four Sigma horse."**
- Six Sigma projects must focus on a quality problem or gap between the current and desired performance and not have a clearly understood problem or a predetermined solution.

*"What You Need to Know About Six Sigma," *Productivity Digest* (December 2001), p. 38.
**Clifford, Lee, "Why You Can Safely Ignore Six Sigma," *Fortune* (January 22, 2001), p. 140.



## Six Sigma Projects Use Project Management

- The training for Six Sigma includes many project management concepts, tools, and techniques.
- For example, Six Sigma projects often use business cases, project charters, schedules, budgets, and so on.
- Six Sigma projects are done in teams; the project manager is often called the team leader, and the sponsor is called the champion.

## Six Sigma and Statistics

- The term *sigma* means standard deviation.
- **Standard deviation** measures how much variation exists in a distribution of data.
- Standard deviation is a key factor in determining the acceptable number of defective units found in a population.
- Six Sigma projects strive for no more than 3.4 defects per million opportunities, yet this number is confusing to many statisticians.

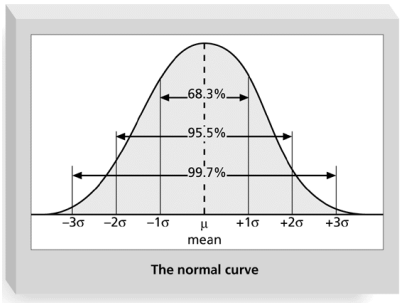


## Six Sigma Uses a Conversion Table

- Using a normal curve, if a process is at six sigma, there would be no more than two defective units per billion produced.
- Six Sigma uses a scoring system that accounts for time, an important factor in determining process variations.
- **Yield** represents the number of units handled correctly through the process steps.
- A **defect** is any instance where the product or service fails to meet customer requirements.
- There can be several opportunities to have a defect.



## Figure 8-2. Normal Distribution and Standard Deviation






## Table 8-3. Sigma and Defective Units

| Specification Range (in +/- Sigmas) | Percent of Population Within Range | Defective Units Per Billion |
|---|---|---|
| 1 | 68.27 | 317,300,000 |
| 2 | 95.45 | 45,400,000 |
| 3 | 99.73 | 2,700,000 |
| 4 | 99.9937 | 63,000 |
| 5 | 99.999943 | 57 |
| 6 | 99.9999998 | 2 |



## Table 8-4: Six Sigma Conversion Table

| Sigma | Yield | Defects per Million Opportunities (DPMO) |
|---|---|---|
| 1 | 31.0% | 690,000 |
| 2 | 69.2% | 308,000 |
| 3 | 93.3% | 66,800 |
| 4 | 99.4% | 6,210 |
| 5 | 99.97% | 230 |
| 6 | 99.99966% | 3.4 |

The Six Sigma convention for determining defects is based on the above conversion table. It accounts for a 1.5 sigma shift to measure the number of defects per million opportunities instead of the number of defects per unit.



## Quality Control Charts and the Seven Run Rule

- A control chart is a graphic display of data that illustrates the results of a process over time. It helps prevent defects and allows you to determine whether a process is in control or out of control.
- The seven run rule states that if seven data points in a row are all below the mean, above the mean, or are all increasing or decreasing, then the process needs to be examined for non-random problems.

## Six 9s of Quality

- **Six 9s of quality** is a measure of quality control equal to 1 fault in 1 million opportunities.
- In the telecommunications industry, it means 99.9999 percent service availability or *30 seconds of down time a year*.
- This level of quality has also been stated as the target goal for the number of errors in a communications circuit, system failures, or errors in lines of code.



## Quality Control Charts

- A **control chart** is a graphic display of data that illustrates the results of a process over time.
- The main use of control charts is to prevent defects, rather than to detect or reject them.
- Quality control charts allow you to determine whether a process is in control or out of control.
  - When a process is in control, any variations in the results of the process are created by random events; processes that are in control do not need to be adjusted.
  - When a process is out of control, variations in the results of the process are caused by non-random events; you need to identify the causes of those non-random events and adjust the process to correct or eliminate them.

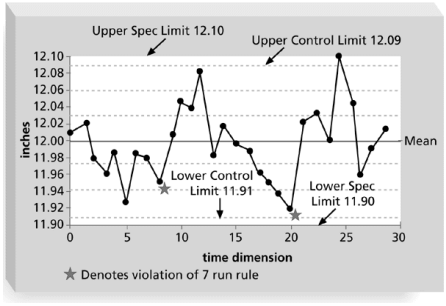


## The Seven Run Rule

- You can use quality control charts and the seven run rule to look for patterns in data.
- The **seven run rule** states that if seven data points in a row are all below the mean, above the mean, or are all increasing or decreasing, then the process needs to be examined for non-random problems.



## Figure 8-3. Sample Quality Control Chart



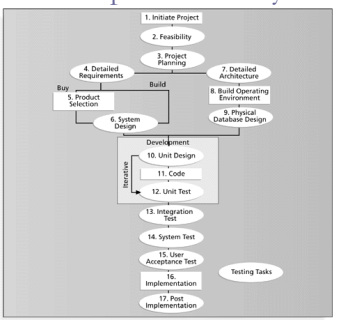



## Testing

- Many IT professionals think of testing as a stage that comes near the end of IT product development.
- Testing should be done during almost every phase of the IT product development life cycle.



## Figure 8-4. Testing Tasks in the Software Development Life Cycle

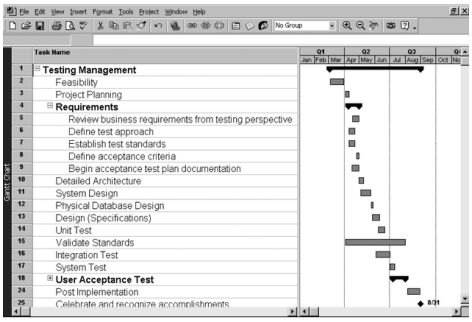


## Types of Tests

- **Unit testing** tests each individual component (often a program) to ensure it is as defect-free as possible.
- **Integration testing** occurs between unit and system testing to test functionally grouped components.
- **System testing** tests the entire system as one entity.
- **User acceptance testing** is an independent test performed by end users prior to accepting the delivered system.



## Figure 8-5. Gantt Chart for Building Testing into a Systems Development Project Plan






## Testing Alone Is Not Enough

- Watts S. Humphrey, a renowned expert on software quality, defines a **software defect** as anything that must be changed before delivery of the program.
- Testing does not sufficiently prevent software defects because:
  - The number of ways to test a complex system is huge.
  - Users will continue to invent new ways to use a system that its developers never considered.
- Humphrey suggests that people rethink the software development process to provide *no* potential defects when you enter system testing; developers must be responsible for providing error-free code at each stage of testing.



## Modern Quality Management

- Modern quality management:
  - Requires customer satisfaction.
  - Prefers prevention to inspection.
  - Recognizes management responsibility for quality.
- Noteworthy quality experts include Deming, Juran, Crosby, Ishikawa, Taguchi, and Feigenbaum.

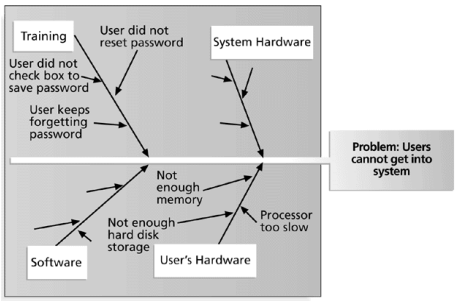


## Quality Experts

- Deming was famous for his work in rebuilding Japan and his 14 Points for Management.
- Juran wrote the *Quality Control Handbook* and ten steps to quality improvement.
- Crosby wrote *Quality is Free* and suggested that organizations strive for zero defects.
- Ishikawa developed the concepts of quality circles and fishbone diagrams.
- Taguchi developed methods for optimizing the process of engineering experimentation.
- Feigenbaum developed the concept of total quality control.



## Figure 8-6. Sample Fishbone or Ishikawa Diagram



## Malcolm Baldrige Award

- The **Malcolm Baldrige National Quality Award** originated in 1987 to recognize companies that have achieved a level of world-class competition through quality management.
- Given by the President of the United States to U.S. businesses.
- Three awards each year in different categories:
  - Manufacturing
  - Service
  - Small business
  - Education and health care



## ISO Standards

- **ISO 9000** is a quality system standard that:
  - Is a three-part, continuous cycle of planning, controlling, and documenting quality in an organization.
  - Provides minimum requirements needed for an organization to meet its quality certification standards.
  - Helps organizations around the world reduce costs and improve customer satisfaction.
- **ISO 15504**, sometimes known as SPICE (Software Process Improvement and Capability dEtermination), is a framework for the assessment of software processes.



## Improving Information Technology Project Quality

- Several suggestions for improving quality for IT projects include:
  - Establish leadership that promotes quality.
  - Understand the cost of quality.
  - Focus on organizational influences and workplace factors that affect quality.
  - Follow maturity models.



## Leadership

- As Joseph M. Juran said in 1945, "It is most important that top management be quality-minded. In the absence of sincere manifestation of interest at the top, little will happen below."*
- A large percentage of quality problems are associated with management, not technical issues.

*American Society for Quality (ASQ), *(www.asqc.org/about/history/juran.html)*.



## The Cost of Quality

- The **cost of quality** is the cost of conformance plus the cost of nonconformance.
  - **Conformance** means delivering products that meet requirements and fitness for use.
  - **Cost of nonconformance** means taking responsibility for failures or not meeting quality expectations.
- A 2002 study reported that software bugs cost the U.S. economy $59.6 billion each year and that one third of the bugs could be eliminated by an improved testing infrastructure.*

*RTI International, "Software Bugs Cost U.S. Economy $59.6 Billion Annually, RTI Study Finds," July 1, 2002.



## Table 8-5. Costs Per Hour of Downtime Caused by Software Defects

| Business | Cost per Hour Downtime |
|---|---|
| Automated teller machines (medium-sized bank) | $14,500 |
| Package shipping service | $28,250 |
| Telephone ticket sales | $69,000 |
| Catalog sales center | $90,000 |
| Airline reservation center (small airline) | $89,500 |

## Five Cost Categories Related to Quality

- **Prevention cost**: Cost of planning and executing a project so it is error-free or within an acceptable error range.
- **Appraisal cost**: Cost of evaluating processes and their outputs to ensure quality.
- **Internal failure cost**: Cost incurred to correct an identified defect before the customer receives the product.
- **External failure cost**: Cost that relates to all errors not detected and corrected before delivery to the customer.
- **Measurement and test equipment costs**: Capital cost of equipment used to perform prevention and appraisal activities.



## Media Snapshot*

- A 2004 study by Nucleus Research Inc. estimates that spam will cost large companies nearly $2,000 per employee in lost productivity in 2004 alone, despite investments in software to block spam. Spam currently accounts for more than *70 percent* of total e-mail volume worldwide.
- In just one month (August 2003), at least 50 new Internet viruses surfaced, and losses related to computer viruses cost North American companies about $3.5 billion. Businesses have suffered at least *$65 billion in lost productivity* because of computer viruses since 1997.

*McGuire, David, "Report: Spam Costs Are Rising at Work," *Washington Post* (June 7, 2004).



## Organizational Influences, Workplace Factors, and Quality

- Study by DeMarco and Lister showed that organizational issues had a much greater influence on programmer productivity than the technical environment or programming languages.
- Programmer productivity varied by a factor of one to ten across organizations, but only by 21 percent within the same organization.
- Study found no correlation between productivity and programming language, years of experience, or salary.
- A dedicated workspace and a quiet work environment were key factors to improving programmer productivity.



## Expectations and Cultural Differences in Quality

- Project managers must understand and manage stakeholder expectations.
- Expectations also vary by:
  - Organization's culture
  - Geographic regions



## Maturity Models

- **Maturity models** are frameworks for helping organizations improve their processes and systems.
  - The **Software Quality Function Deployment Model** focuses on defining user requirements and planning software projects.
  - The Software Engineering Institute's **Capability Maturity Model** is a five-level model laying out a generic path to process improvement for software development in organizations.



## CMM Levels and CMMI

- CMM levels, from lowest to highest, are:
  - Initial
  - Repeatable
  - Defined
  - Managed
  - Optimizing
- The **Capability Maturity Model Integration (CMMI)** is replacing the older CMM ratings and addresses software engineering, system engineering, and program management.
- Companies may not get to bid on government projects unless they have a CMMI Level 3.

## PMI's Maturity Model

- PMI released the Organizational Project Management Maturity Model (OPM3) in December 2003.
- Model is based on market research surveys sent to more than 30,000 project management professionals and incorporates 180 best practices and more than 2,400 capabilities, outcomes, and key performance indicators.
- Addresses standards for excellence in project, program, and portfolio management best practices and explains the capabilities necessary to achieve those best practices.



## Using Software to Assist in Project Quality Management

- Spreadsheet and charting software helps create Pareto diagrams, fishbone diagrams, and so on.
- Statistical software packages help perform statistical analysis.
- Specialized software products help manage Six Sigma projects or create quality control charts.
- Project management software helps create Gantt charts and other tools to help plan and track work related to quality management.



## Chapter Summary

- Project quality management ensures that the project will satisfy the needs for which it was undertaken.
- Main processes include:
  - Quality planning
  - Quality assurance
  - Quality control