8

Project Quality Management

OPENING CASE

A large medical instruments company just hired Scott Daniels, a senior consultant from a large consulting firm, to lead a project to resolve the quality problems with the company's new Executive Information System (EIS). A team of internal programmers and analysts worked with several company executives to develop this new system. Many executives were hooked on the new, user-friendly EIS. They loved the way the system allowed them to track sales of various medical instruments quickly and easily by product, country, hospital, and sales representative. After successfully testing the new EIS with several executives, the company decided to make the system available to all levels of management.

Unfortunately, several quality problems developed with the new EIS after a few months of operation. People were complaining that they could not get into the Web-based system. The system started going down a couple of times a month, and the response time was reportedly getting slower. Users complained when they could not access information within a few seconds. Several people kept forgetting how to log in to the system, thus increasing the number of calls to the company's Help Desk. There were complaints that some of the reports in the system gave inconsistent information. How could a summary report show totals that were not consistent with a detailed report on the same information? The executive sponsor of the EIS wanted the problems fixed quickly and accurately, so he decided to hire an expert in quality from outside the company whom he knew from past projects. Scott Daniels' job was to lead a team of people from both the medical instruments company and his own firm to identify and resolve quality-related issues with the EIS and to develop a plan to help prevent quality problems from happening on future projects.

THE IMPORTANCE OF PROJECT QUALITY MANAGEMENT

Most people have heard jokes about what cars would be like if they followed a development history similar to that of computers. A well-known joke that has been traveling around the Internet goes as follows:

> "At a recent computer exposition (COMDEX), Bill Gates, the founder and CEO of Microsoft Corporation, stated: "If General Motors had kept up with technology like the computer industry has, we would all be driving $25 cars that got 1,000 miles to the gallon." In response to Gates' comments, General Motors issued a press release stating: "If GM had developed technology like Microsoft, we would all be driving cars with the following characteristics:
>
> 1. For no reason whatsoever your car would crash twice a day.
> 2. Every time they repainted the lines on the road, you would have to buy a new car.
> 3. Occasionally, your car would die on the freeway for no reason, and you would just accept this, restart, and drive on.
> 4. Occasionally, executing a maneuver such as a left turn would cause your car to shut down and refuse to restart, in which case you would have to reinstall the engine.
> 5. Only one person at a time could use the car, unless you bought 'Car95' or 'CarNT.' But then you would have to buy more seats.
> 6. Macintosh would make a car that was powered by the sun, reliable, five times as fast, and twice as easy to drive, but would run on only five percent of the roads.
> 7. The oil, water temperature, and alternator warning lights would be replaced by a single 'general car default' warning light.
> 8. New seats would force everyone to have the same size hips.
> 9. The airbag system would say 'Are you sure?' before going off.
> 10. Occasionally, for no reason whatsoever, your car would lock you out and refuse to let you in until you simultaneously lifted the door handle, turned the key, and grabbed hold of the radio antenna.
> 11. GM would require all car buyers to also purchase a deluxe set of Rand McNally road maps (now a GM subsidiary), even though they neither need them nor want them. Attempting to delete this option would immediately cause the car's performance to diminish by 50 percent or more. Moreover, GM would become a target for investigation by the Justice Department.
> 12. Every time GM introduced a new model car, buyers would have to learn how to drive all over again because none of the controls would operate in the same manner as the old car.
> 13. You would press the Start button to shut off the engine."[1]

Most people simply accept poor quality from many information technology products. So what if your computer crashes a couple of times a month? Just make sure you back up your data. So what if you cannot log in to the corporate intranet or the Internet right now? Just try a little later when it is less busy. So what if the latest version of your word-processing software was shipped with several known bugs? You like the software's new features, and all new software has bugs. Is quality a real problem with information technology projects?

Yes, it is! Information technology is not just a luxury available in some homes, schools, or offices. Many companies throughout the world provide all employees with access to computers. The majority of people in the United States use the Internet, and usage in other countries continues to grow rapidly. It took only five years for 50 million people to use the Internet compared to 25 years for 50 million people to use telephones. Many aspects of our daily lives depend on high-quality information technology products. Food is produced and distributed with the aid of computers; cars have computer chips to track performance; children use computers to help them learn in school; corporations depend on technology for many business functions; and millions of people rely on technology for entertainment and personal communications. Many information technology projects develop mission-critical systems that are used in life-and-death situations, such as navigation systems on board aircraft and computer components built into medical equipment. Financial institutions and their customers also rely on high quality information systems. Customers get very upset when systems provide inaccurate financial data or reveal information to unauthorized users that could lead to identity theft problems. When one of these systems does not function correctly, it is much more than a slight inconvenience.

Before you can improve the quality of information technology projects, it is important to understand the basic concepts of project quality management.

WHAT IS PROJECT QUALITY MANAGEMENT?

Project quality management is a difficult knowledge area to define. The International Organization for Standardization (ISO) defines quality as "the totality of characteristics of an entity that bear on its ability to satisfy stated or implied needs" (ISO8042:1994) or "the degree to which a set of inherent characteristics fulfils requirements." (ISO9000:2000). Many people spent many hours coming up with these definitions, yet they are still very vague. Other experts define quality based on conformance to requirements and fitness for use. Conformance to requirements means the project's processes and products meet written specifications. For example, if the project scope statement requires delivery of 100 computers with specific processors, memory, and so on, you could easily check whether suitable computers had been delivered. Fitness for use means a product can be used as it was intended. If these computers were delivered without monitors or keyboards and were left in boxes on the customer's shipping dock, the customer might not be satisfied because the computers would not be fit for use. The customer may have assumed that the delivery included monitors and keyboards, unpacking the computers, and installation so they would be ready to use.

ISO

Purpose

The purpose of project quality management is to ensure that the project will satisfy the needs for which it was undertaken. Recall that project management involves meeting or exceeding stakeholder needs and expectations. The project team must develop good relationships with key stakeholders, especially the main customer for the project, to understand what quality means to them. *After all, the customer ultimately decides if quality is acceptable.* Many technical projects fail because the project team focuses only on meeting the written requirements for the main products being produced and ignores other stakeholder needs and expectations for the project. For example, the project team should know what successfully delivering 100 computers means to the customer.

Quality, therefore, must be on an equal level with project scope, time, and cost. If a project's stakeholders are not satisfied with the quality of the project management or the resulting products of the project, the project team will need to adjust scope, time, and cost to satisfy the stakeholder. Meeting only written requirements for scope, time, and cost is not sufficient. To achieve stakeholder satisfaction, the project team must develop a good working relationship with all stakeholders and understand their stated or implied needs.

Project quality management involves three main processes:

1. Quality planning includes identifying which quality standards are relevant to the project and how to satisfy those standards. Incorporating quality standards into project design is a key part of quality planning. For an information technology project, quality standards might include allowing for system growth, planning a reasonable response time for a system, or ensuring that the system produces consistent and accurate information. Quality standards can also apply to information technology services. For example, you can set standards for how long it should take to get a reply from a Help Desk or how long it should take to ship a replacement part for a hardware item under warranty. The main outputs of quality planning are a quality management plan, quality metrics, quality checklists, a process

improvement plan, a quality baseline, and updates to the project management plan. A metric is a standard of measurement. Examples of common metrics include failure rates of products produced, availability of goods and services, and customer satisfaction ratings. See the sample documents on the companion Web site for examples of a quality management plan, metrics, a quality checklist, and other documents related to quality management.

2. Quality assurance involves periodically evaluating overall project performance to ensure that the project will satisfy the relevant quality standards. The quality assurance process involves taking responsibility for quality throughout the project's life cycle. Top management must take the lead in emphasizing the roles all employees play in quality assurance, especially senior managers' roles. The main outputs of this process are requested changes, recommended corrective actions, and updates to organization process assets and the project management plan.
3. Quality control involves monitoring specific project results to ensure that they comply with the relevant quality standards while identifying ways to improve overall quality. This process is often associated with the technical tools and techniques of quality management, such as Pareto charts, quality control charts, and statistical sampling. You will learn more about these tools and techniques later in this chapter. The main outputs of quality control include quality control measurements, validated and recommended defect repair, recommended corrective and preventive actions, requested changes, validated deliverables, and updates to the quality baseline, organization process assets, and the project management plan.

Figure 8-1 summarizes these processes and outputs, showing when they occur in a typical project.

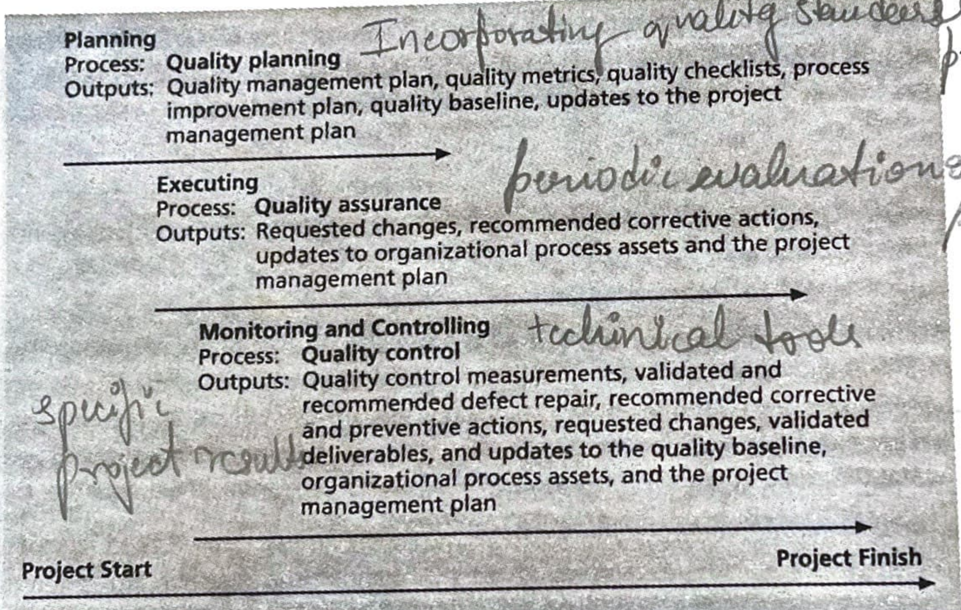


Figure 8-1. Project Quality Management Summary

QUALITY PLANNING

Project managers today have a vast knowledge base of information related to quality, and the first step to ensuring project quality management is planning. Quality planning implies the ability to anticipate situations and prepare actions that bring about the desired outcome. The current thrust in modern quality management is the prevention of defects through a program of selecting the proper materials, training and indoctrinating people in quality, and planning a process that ensures the appropriate outcome. In project quality planning, it is important to identify relevant quality standards, such as ISO standards described later in this chapter, for each unique project and to design quality into the products of the project and the processes involved in managing the project.

identify variables

Design of experiments is a quality planning technique that helps identify which variables have the most influence on the overall outcome of a process. Understanding which variables affect outcome is a very important part of quality planning. For example, computer chip designers might want to determine which combination of materials and equipment will produce the most reliable chips at a reasonable cost. You can also apply design of experiments to project management issues such as cost and schedule trade-offs. For example, junior programmers or consultants cost less than senior programmers or consultants, but you cannot expect them to complete the same level of work in the same amount of time. An appropriately designed experiment to compute project costs and durations for various combinations of junior and senior programmers or consultants can allow you to determine an optimal mix of personnel, given limited resources. Refer to the section on the Taguchi method later in this chapter for more information. Ex

communicati

Quality planning also involves communicating the correct actions for ensuring quality in a format that is understandable and complete. In quality planning for projects, it is important to describe important factors that directly contribute to meeting the customer's requirements. Organizational policies related to quality, the particular project's scope statement and product descriptions, and related standards and regulations are all important input to the quality planning process.

As mentioned in the discussion of project scope management (see Chapter 5), it is often difficult to completely understand the performance dimension of information technology projects. Even if the development of hardware, software, and networking technology would stand still for a while, it is often difficult for customers to explain exactly what they want in an information technology project. Important scope aspects of information technology projects that affect quality include functionality and features, system outputs, performance, and reliability and maintainability.

intended fuction · sys char fun

- Functionality is the degree to which a system performs its intended function. Features are the system's special characteristics that appeal to users. It is important to clarify what functions and features the system *must* perform, and what functions and features are *optional*. In the EIS example in the opening case, the mandatory functionality of the system might be that it allows users to track sales of specific medical instruments by predetermined categories such as the product group, country, hospital, and sales representative. Mandatory features might be a graphical user interface with icons, menus, online Help, and so on. feature Ex GUI outputs reports
- System outputs are the screens and reports the system generates. It is important to define clearly what the screens and reports look like for a system. Can the users easily interpret these outputs? Can users get all of the reports they need in a suitable format?
- Performance addresses how well a product or service performs the customer's intended use. To design a system with high quality performance, project stakeholders must address many issues. What volumes of data and transactions should the system be capable of handling? How many simultaneous users should the system be designed to handle? What is the projected growth rate in the number of users? What type of equipment must the system run on? How fast must the response time be for different aspects of the system under different circumstances? For the EIS in the opening case, several of the quality problems appear to relate to performance issues. The system is failing a couple of times a month, and users are unsatisfied with the response time. The project team may not have had specific performance requirements or tested the system under the right conditions to deliver the expected performance. Buying faster hardware might address these performance issues. Another performance problem that might be more difficult to fix is the fact that some of the reports are generating inconsistent results. This could be a software quality problem that may be difficult and costly to correct since the system is already in operation.

pmcc apr cc

perform as expected under normal

- Reliability is the ability of a product or service to perform as expected under normal conditions. In discussing reliability for information technology projects, many people use the term IT service management. (See the Suggested Readings on the companion Web site, such as ISO/IEC 20000, which is based on ITIL.) Maintainability addresses the ease of performing maintenance on a product. Most information technology products cannot reach 100 percent reliability, but stakeholders must define what their expectations are. For the EIS, what are the normal conditions for operating the system? Should reliability tests be based on 100 people accessing the system at once and running simple queries? Maintenance for the EIS might include uploading new data into the system or performing maintenance procedures on the system hardware and software. Are the users willing to have the system be unavailable several hours a week for system maintenance? Providing Help Desk support could also be a maintenance function. How fast a response do users expect for Help Desk support? How often can users tolerate system failure? Are the stakeholders willing to pay more for higher reliability and fewer failures?

These aspects of project scope are just a few of the requirement issues related to quality planning. Project managers and their teams need to consider all of these project scope issues in determining quality goals for the project. The main customers for the project must also realize their role in defining the most critical quality needs for the project and constantly communicate these needs and expectations to the project team. Since most information technology projects involve requirements that are not set in stone, it is important for all project stakeholders to work together to balance the quality, scope, time, and cost dimensions of the project. *Project managers, however, are ultimately responsible for quality management on their projects.*

Project managers should be familiar with basic quality terms, standards, and resources. For example, the International Organization for Standardization (ISO) provides information based on inputs from 157 different countries. They have an extensive Web site (*www.iso.org*), which is the source of ISO 9000 and more than 14,000 international standards for business, government and society. If you're curious where the acronym came from, the word "iso" comes from the Greek, meaning "equal." IEEE also provides many standards related to quality and has detailed information on their Web site (*www.ieee.org*).

QUALITY ASSURANCE

evaluate actions

It is one thing to develop a plan for ensuring quality on a project; it is another to ensure delivery of quality products and services. Quality assurance includes all of the activities related to satisfying the relevant quality standards for a project. Another goal of quality assurance is continuous quality improvement.

Many companies understand the importance of quality assurance and have entire departments dedicated to this area. They have detailed processes in place to make sure their products and services conform to various quality requirements. They also know they must produce those products and services at competitive prices. To be successful in today's competitive business environment, successful companies develop their own best practices and evaluate other organizations' best practices to continuously improve the way they do business.

Top management and project managers can have the greatest impact on the quality of projects by doing a good job of quality assurance. The importance of leadership in improving information technology project quality is discussed in more detail later in this chapter.

Several tools used in quality planning can also be used in quality assurance. Design of experiments, as described under quality planning, can also help ensure and improve product quality. 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. For example, if a competitor has an EIS with an average down time of only one hour a week, that might be a benchmark for which to strive.

Fishbone or Ishikawa diagrams, as described later in this chapter, can assist in ensuring and improving quality by finding the root causes of quality problems.

An important tool for quality assurance is a quality audit. 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. In-house auditors or third parties with expertise in specific areas can perform quality audits, and quality audits can be scheduled or random. Industrial engineers often perform quality audits by helping to design specific quality metrics for a project and then applying and analyzing the metrics throughout the project. For example, the Northwest Airlines ResNet project (available on the companion Web site for this text) provides an excellent example of using quality audits to emphasize the main goals of a project and then track progress in reaching those goals. The main objective of the ResNet project was to develop a new reservation system to increase direct airline ticket sales and reduce the time it took for sales agents to handle customer calls. The measurement techniques for monitoring these goals helped ResNet's project manager and project team supervise various aspects of the project by focusing on meeting those goals. Measuring progress toward increasing direct sales and reducing call times also helped the project manager justify continued investments in ResNet.

audits

QUALITY CONTROL

Many people only think of quality control when they think of quality management. Perhaps it is because there are many popular tools and techniques in this area. Before describing some of these tools and techniques, it is important to distinguish quality control from quality planning and quality assurance.

Although one of the main goals of quality control is to improve quality, the main outcomes of this process are acceptance decisions, rework, and process adjustments.

acceptance or rework

- Acceptance decisions determine if the products or services produced as part of the project will be accepted or rejected. If they are accepted, they are considered to be validated deliverables. If project stakeholders reject some of the products or services produced as part of the project, there must be rework. For example, the executive who sponsored development of the EIS in the opening case was obviously not satisfied with the system and hired an outside consultant, Scott Daniels, to lead a team to address and correct the quality problems.
- Rework is action taken to bring rejected items into compliance with product requirements or specifications or other stakeholder expectations. Rework often results in requested changes and validated defect repair, resulting from recommended defect repair or corrective or preventive actions. Rework can be very expensive, so the project manager must strive to do a good job of quality planning and quality assurance to avoid this need. Since the EIS did not meet all of the stakeholders' expectations for quality, the medical instruments company was spending additional money for rework.
- Process adjustments correct or prevent further quality problems based on quality control measurements. Process adjustments are often found by using quality control measurements, and they often result in updates to the quality baseline, organization process assets, and the project management plan. For example, Scott Daniels, the consultant in the opening case, might recommend that the medical instruments company purchase a faster server for the EIS to correct the response-time problems. This change would require changes to the project management plan since it would require more work to be done related to the project. The company also hired Scott to develop a plan to help prevent future information technology project quality problems.

expensive

TOOLS AND TECHNIQUES FOR QUALITY CONTROL

Quality control includes many general tools and techniques. This section describes the Seven Basic Tools of Quality, statistical sampling, and Six Sigma—and discusses how they can be applied to information technology projects. The section concludes with a discussion on testing, since information technology projects use testing extensively to ensure quality.

The following seven tools are known as the Seven Basic Tools of Quality:

trace complaint
root cause
5 why

1. *Cause-and-effect diagrams:* Cause-and-effect diagrams trace complaints about quality problems back to the responsible production operations. In other words, they help you find the root cause of a problem. They are also known as fishbone or Ishikawa diagrams, named after their creator, Kaoru Ishikawa. You can also use the technique known as the 5 whys, where you repeatedly ask the question "Why" (five is a good rule of thumb) to help peel away the layers of symptoms that can lead to the root cause of a problem. These symptoms can be branches on the cause-and-effect diagram. Figure 8-2 provides an example of a cause-and-effect diagram that Scott Daniels, the consultant in the opening case, might create to uncover the root cause of the problem of users not being able to log in to the EIS. Notice that it resembles the skeleton of a fish, hence the name fishbone diagram. This fishbone diagram lists the main areas that could be the cause of the problem: the EIS system's hardware, the user's hardware or software, or the user's training. This figure describes two of these areas, the individual user's hardware and training, in more detail. For example, using the 5 whys, you could first ask why the users cannot get into the system, then why they keep forgetting their passwords, why they did not reset their passwords, why they did not check a box to save a password, and so on. The root cause of the problem would have a significant impact on the actions taken to solve the problem. If many users could not get into the system because their computers did not have enough memory, the solution might be to upgrade memory for those computers. If many users could not get into the system because they forgot their passwords, there might be a much quicker, less expensive solution.

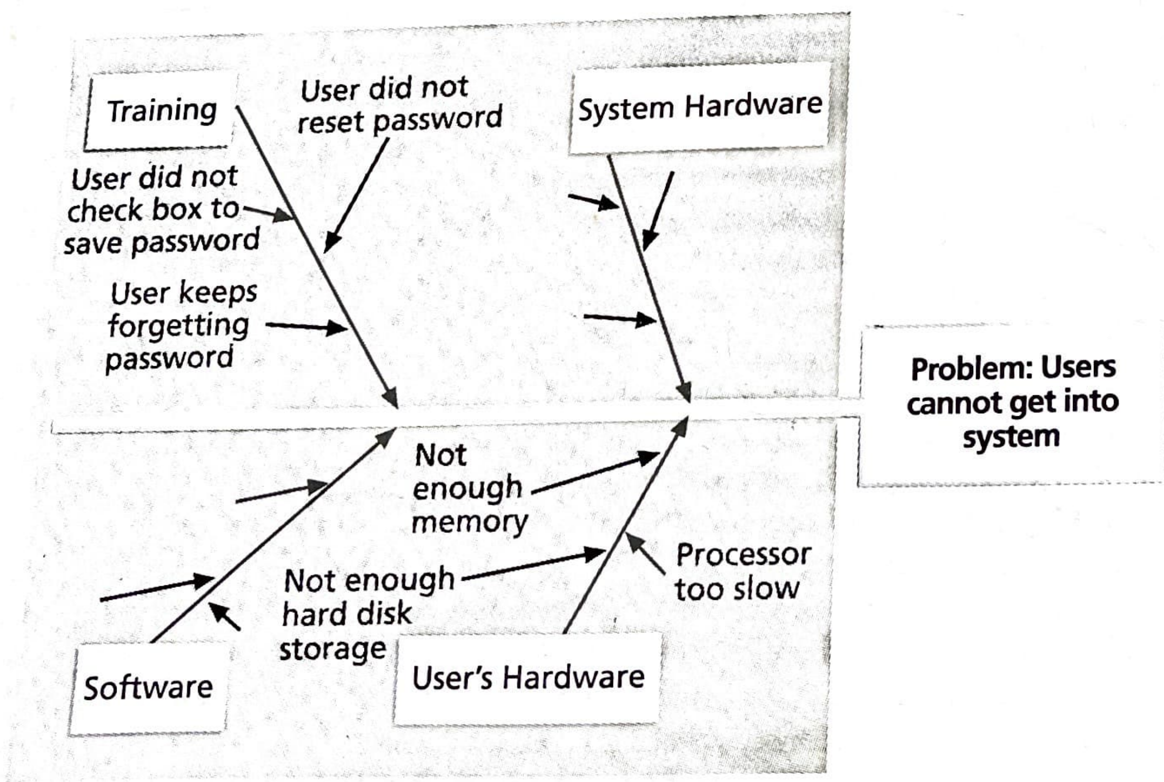


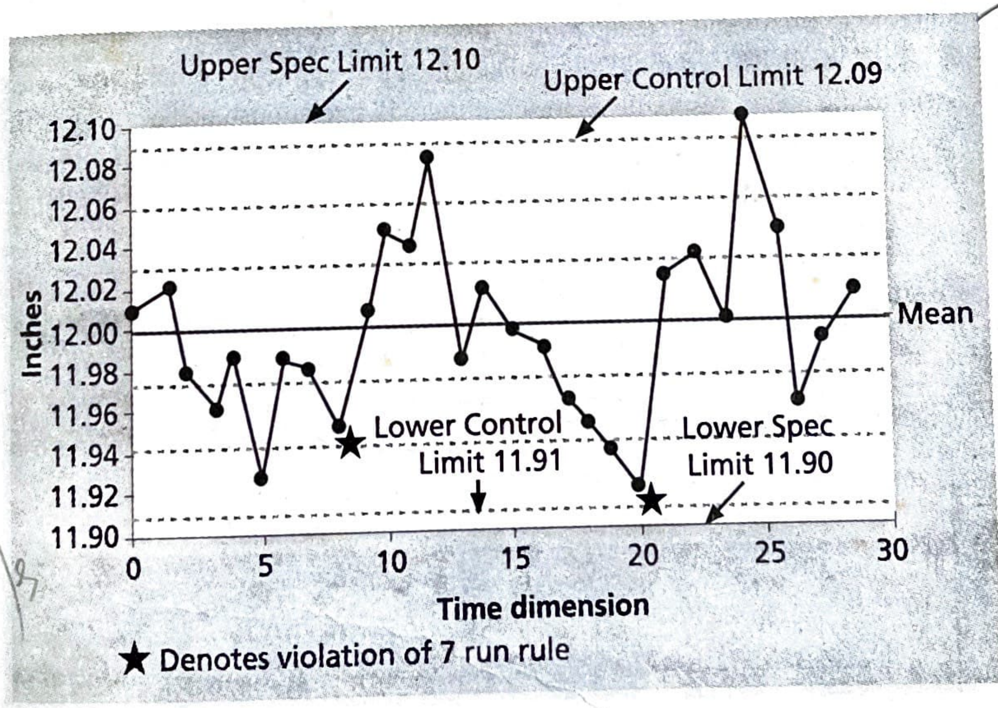
Figure 8-2. *Sample Cause-and-Effect Diagram*

result over time

2. *Control Charts:* A control chart is a graphic display of data that illustrates the results of a process over time. 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 nonrandom events. When a process is out of control, you need to identify the causes of those nonrandom events and adjust the process to correct or eliminate them. For example, Figure 8-3 provides an example of a control chart for a process that manufactures 12-inch rulers. Assume that these are wooden rulers created by machines on an assembly line. Each point on the chart represents a length measurement for a ruler that comes off the assembly line. The scale on the vertical axis goes from 11.90 to 12.10. These numbers represent the lower and upper specification limits for the ruler. In this case, this would mean that the customer for the rulers has specified that all rulers purchased must be between 11.90 and 12.10 inches long, or 12 inches plus or minus 0.10 inches. The lower and upper control limits on the quality control chart are 11.91 and 12.09 inches, respectively. This means the manufacturing process is designed to produce rulers between 11.91 and 12.09 inches long. Looking for and analyzing patterns in process data is an important part of quality control. 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. In Figure 8-3, data points that violate the seven run rule are starred. Note that you include the first point in a series of points that are all increasing or decreasing. In the ruler manufacturing process, these data points may indicate that a calibration device may need adjustment. For example, the machine that cuts the wood for the rulers might need to be adjusted or the blade on the machine might need to be replaced.

rule

result of process



→ process in control or out of control → non-random events

Figure 8-3. Sample Control Chart

history line chart

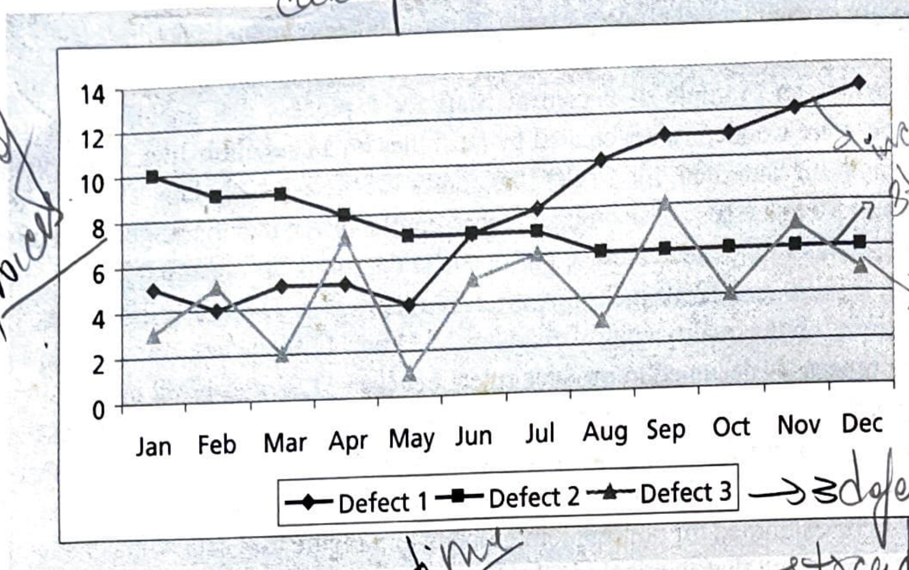
3. *Run chart:* A run chart displays the history and pattern of variation of a process over time. It is a line chart that shows data points plotted in the order in which they occur. You can use run charts to perform trend analysis to forecast future outcomes based on historical results. For example, trend analysis can help you analyze how many defects have been identified over time and see if there are trends. Figure 8-4 shows a sample run chart, charting the number of defects each month for three different types of

trend analysis

defects. Notice that you can easily see the patterns of Defect 1 continuing to increase over time, Defect 2 decreasing the first several months and then holding steady, and Defect 3 fluctuating each month.

data points scattered in order in which they occur

history & pattern variation of process



stored analysis to detect defects

Figure 8-4. Sample Run Chart

4. *Scatter diagram:* A scatter diagram helps to show if there is a relationship between two variables. The closer data points are to a diagonal line, the more closely the two variables are related. For example, Figure 8-5 provides a sample scatter diagram that Scott Daniels might create to compare user satisfaction ratings of the EIS system to the age of respondents to see if there is a relationship. They might find that younger users are less satisfied with the system, for example, and make decisions based on that finding.

shows relationship b/w 2 variables

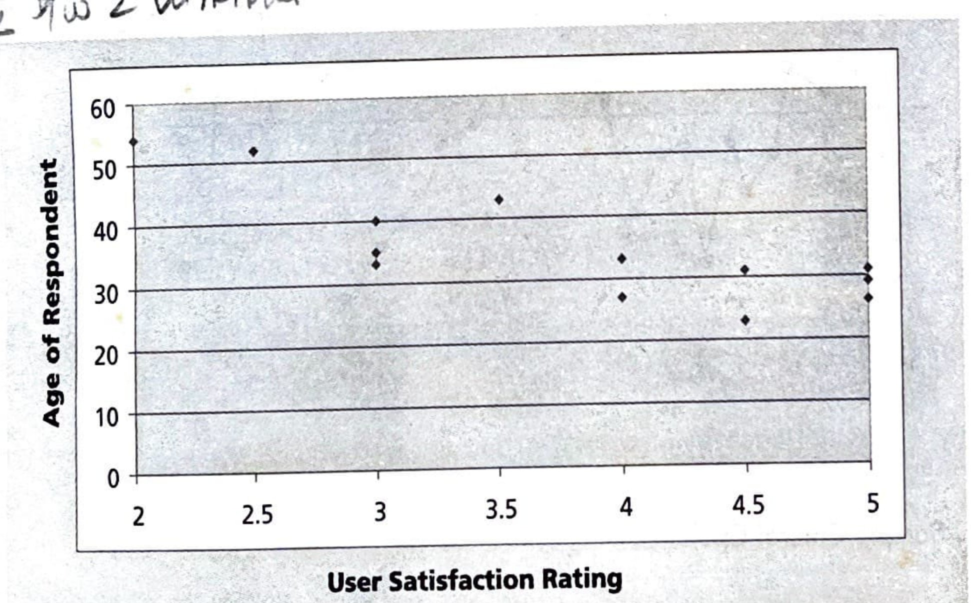


Figure 8-5. Sample Scatter Diagram

distribution

5. *Histograms:* A histogram is a bar graph of a distribution of variables. Each bar represents an attribute or characteristic of a problem or situation, and the height of the bar represents its frequency. For example,

Scott Daniels might ask the Help Desk to create a histogram to show how many total complaints they received each week related to the EIS system. Figure 8-6 shows a sample histogram.

freq — bar graph of a distribution of variables

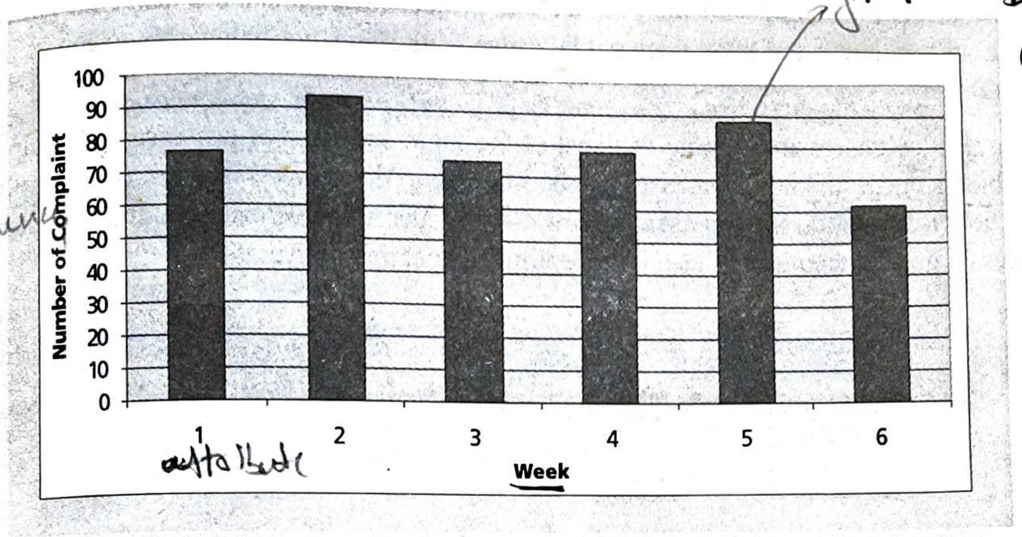


Figure 8-6. Sample Histogram

Priority

6. *Pareto charts*: A Pareto chart is a histogram that can help you identify and prioritize problem areas. The variables described by the histogram are ordered by frequency of occurrence. Pareto charts help you identify the vital few contributors that account for most quality problems in a system. Pareto analysis is sometimes referred to as the 80-20 rule, meaning that 80 percent of problems are often due to 20 percent of the causes. For example, suppose there was a detailed history of user complaints about the EIS. The project team could create a Pareto chart based on that data, as shown in Figure 8-7. Notice that log-in problems are the most frequent user complaint, followed by the system locking up, the system being too slow, the system being hard to use, and the reports being inaccurate. The first complaint accounts for

80-20

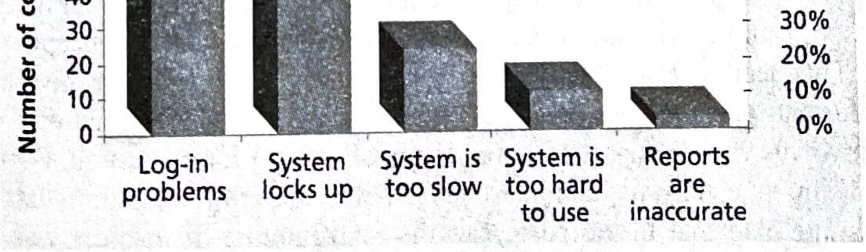


Figure 8-7. Sample Pareto Chart

55 percent of the total complaints. The first and second complaints have a cumulative percentage of almost 80 percent, meaning these two areas account for 80 percent of the complaints. Therefore, the company should focus on making it easier to log in to the system to improve quality, since the majority

of complaints fall under that category. The company should also address why the system locks up. Because Figure 8-7 shows that inaccurate reports are a problem that is rarely mentioned, the project manager should investigate who made this complaint before spending a lot of effort on addressing that potentially critical problem with the system. The project manager should also find out if complaints about the system being too slow were actually due to the user not being able to log in or the system locking up.

7. *Flowcharts:* Flowcharts are graphic displays of the logic and flow of processes that help you analyze how problems occur and how processes can be improved. They show activities, decision points, and the order of how information is processed. Figure 8-8 provides a simple example of a flowchart that shows the process a project team might use for accepting or rejecting deliverables.

graphical displays of the logic & flow of the process

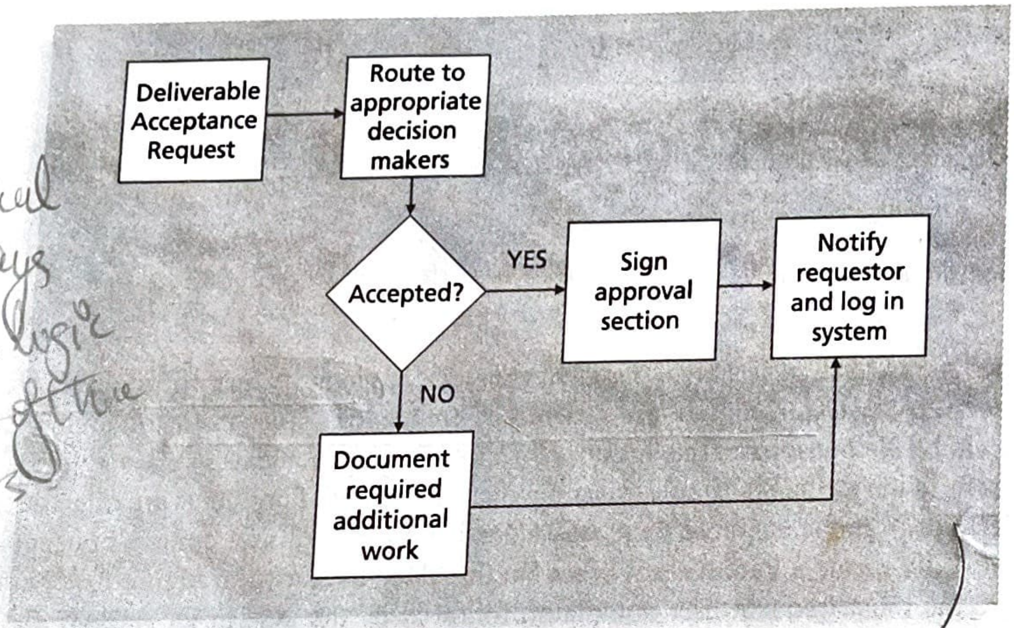


Figure 8-8. Sample Flowchart

Statistical Sampling

know statistics Statistical sampling is a key concept in project quality management. Members of a project team who focus on quality control must have a strong understanding of statistics, but other project team members need to understand only the basic concepts. These concepts include statistical sampling, certainty factor, standard deviation, and variability. Standard deviation and variability are fundamental concepts for understanding quality control charts. This section briefly describes these concepts and describes how a project manager might apply them to information technology projects. Refer to statistics texts for additional details.

choosing part Statistical sampling involves choosing part of a population of interest for inspection. For example, suppose a company wants to develop an electronic data interchange (EDI) system for handling data on invoices from all of its suppliers. Assume also that in the past year, the total number of invoices was 50,000 from 200 different suppliers. It would be very time consuming and expensive to review every single invoice to determine data requirements for the new system. Even if the system developers did review all 200 invoice forms from the different suppliers, the data might be entered differently on every form. It is impractical to study every member of a population, such as all 50,000 invoices, so statisticians have developed techniques to help determine an appropriate sample size. If the system developers used statistical techniques, they might find that by studying only 100 invoices, they would have a good sample of the type of data they would need in designing the system.