Cost of Poor Quality

H. James Harrington

EXECUTIVE SUMMARY

- Quality cost systems have evolved radically. The early systems reflected the limited "quality" thinking of the 1940s by reporting only the costs of manufacturing defects. Now their scope has expanded: They are "poor-quality" cost systems that reflect the "total process" quality orientation of the 1990s.
- Poor-quality cost systems are designed to understand and reduce both the direct and indirect costs associated with poor quality: the costs of evaluating acceptability, preventing and measuring errors, and falling short of internal and consumer expectations.
- The cost of poor quality is usually much higher than managers imagine. It often runs as high as 60% of the area's budget.
- Poor-quality cost systems can help managers and employees change the way they think about errors.

For years managers believed that providing high-quality products and services to customers was more expensive. They used this excuse to keep the organization's output from reaching its full potential. But in the 1970s and 1980s, managers' attitudes began to change as they were confronted with the fact that, in international markets, high-quality products provided greater returns on investment and also increased the company's market share. Therefore, managers began to focus on improving the quality of output from all employees.

This new focus revealed three truths:

1. *It is not more expensive to provide high-quality products and services.* In fact, in many cases, it is less expensive.
2. *When quality problems are solved, cost and scheduling problems are greatly reduced.* Managers must therefore put quality first in every decision they make. As the old saying goes, "The bitterness of poor quality lingers long after the sweetness of meeting a schedule."
3. *The terms that most quality professionals use are completely foreign to other managers and difficult, if not impossible, to summarize in an organizationwide measure.* But terms such as "percent defective," "throughput yields," "defects per unit," and "mean time to failure" can all be translated into a common

***H. James Harrington** is a Principal and International Quality Advisor at Ernst & Young LLP in San Jose, California.*

CCC 1098-9382/99/01017-11

denominator in order to manage the business—namely, dollars (or any other unit of currency).

"Our objective in developing the concept and quantification of quality costs was to give managers the practical tools and economic know-how to identify and manage their own costs of quality."

To devise an organizationwide measure, Armand V. Feigenbaum (while working with General Electric Company's Schenectady Works in 1943) developed a dollar-based reporting system called "cost of quality." This system pulled together all the costs related to developing a quality system and inspecting products, including the cost incurred when a product failed to meet requirements. He then gave management a report that got their attention because it was based on dollars—the "language" of top management and the stockholder. Feigenbaum's cost-of-quality system was soon adopted by GE's Jet Engine Group in Massachusetts. By 1948, it was in use throughout GE's operations in the United States.

A COST-OF-QUALITY CLASSIFICATION

Feigenbaum's 1943 cost-of-quality system divided cost of quality into the following four categories:

- Prevention cost
- Appraisal cost
- Internal defect cost
- External defect cost

In discussing quality cost, Feigenbaum (now chief executive officer of General Systems Co.) states: "Our objective in developing the concept and quantification of quality costs was to give managers the practical tools and economic know-how to identify and manage their own costs of quality." He now calls quality costs the "cost of delivering customer satisfaction."

Unfortunately, the term "quality cost" leaves a negative impression that reflects the thinking of the 1950s, when it was widely believed that better-quality products cost more to produce.

Quality cost systems of one kind or another have been implemented by many organizations to help managers direct their improvement activities and measure the effectiveness of their quality system. Among these organizations are IBM, Bendix, Komatsu Ltd., Abbott Laboratories, Westinghouse, Honeywell, General Electric, International Telephone & Telegraph, Irving Trust, Eaton, Digital Equipment, Allis-Chalmers Canada, General Motors, and many more.

QUALITY DOESN'T COST MORE

Unfortunately, the term "quality cost" leaves a negative impression that reflects the thinking of the 1950s, when it was widely believed that better-quality products cost more to produce. Given the change in managers' attitudes toward quality and the new dimensions that have been added to the original concept, the term "poor-quality cost" (PQC) now seems more appropriate and is used for the remainder of this article. The system—whether a "quality cost" or a "poor-quality cost" system—is designed to help reduce the cost associated with poor quality.

Quality costs vary from one company to the next. The variations depend on such factors as the following:

Government Support of PQC Systems

In 1998, the government of Singapore set aside $40 million to help companies in Singapore establish PQC systems: "The $40 million investment will help 1,000 organizations here [Singapore] to keep their operations lean," said Minister Without Portfolio Lim Hoon Heng.

Local Enterprise Technical Assistance Scheme" (LETAS) will pay up to 90 percent of consulting costs for one year and 70 percent for the next four years.

Poor quality cost pilot projects started in 1998 to examine the quality costs in six industries—plastic products, printing, hotel, garment, electrical, and packaging—and are expected to produce savings estimated at more than $12 billion a year.

- Product complexity
- Technology used
- How customers use the product
- The elements of quality costs included
- The level of refinement of the quality system

In many cases, PQC accounts for more than 40 percent of sales price. IBM, for example, has reported that its PQC ranged between 20 and 40 percent of revenue before IBM began its quality improvement process. (This range is not out of line when a high-technology organization considers both blue-collar and white-collar PQC.)

THE SHOCKING COST OF POOR QUALITY

Most company presidents know that poor quality costs them a great deal of money, but they are often shocked when they find out what the cost really is. As John Akers, the former chairman of IBM, says, "When we analyzed what we were spending on quality—the cost to make things right, as well as the cost to fix and rework things that weren't right—we were surprised and disturbed. We found that our total quality costs were higher than we had thought. Roughly one-quarter was what we call prevention and appraisal cost, and roughly three-quarters were failure costs." (Harrington, 1988)

Other organizations have reported costs in the same range. According to James E. Preston, former president of Avon, "The cost of building quality into the product is 5 percent of sales, while the cost of nonconformance is 20 percent."

DIFFERENCES FROM PRIOR QUALITY COST SYSTEMS

The PQC concepts presented here differ from the original quality cost concepts in the following ways:

1. The term "errors" is used instead of the term "defects" to help win acceptance of the concept in white-collar areas.
2. The concept of an "optimum quality cost" operating point has been changed to reflect the cost advantages of error-free performance, in keeping with the current needs for continuous improvement.
3. Test equipment costs are taken out of the appraisal category and placed in a separate category so that these costs can be spread equally across the total output they support.
4. The cost that a customer incurs as a result of poor quality is taken into consideration.
5. Non-value-added costs are included in the PQC system.

The purpose of a PQC system, then, is to provide managers and employees with information they can use to identify needed improvement, maximize the effectiveness of improvement efforts, and measure ongoing improvement.

Exhibit 1. The Elements of Poor-Quality Costs

I. Direct poor-quality cost
A. Controllable poor-quality cost
1. Prevention cost
2. Appraisal cost
3. Non-value-added cost
B. Resultant poor-quality cost
1. Internal error cost
2. External error cost
C. Equipment poor-quality cost
II. Indirect poor-quality cost
A. Customer-incurred cost
B. Customer-dissatisfaction cost
C. Loss of reputation cost
D. Lost-opportunity cost

"A lot of people say quality costs you too much. It does not. It will cost you less."

Quality is not the cost of providing an output. Quality is the value the customer receives from the output.

WHAT IS THE COST OF POOR QUALITY?

Poor quality costs an organization money; good quality saves an organization money. As James E. Olson, past president of AT&T, says, "A lot of people say quality costs you too much. It does not. It will cost you less." (Harrington, 1987) But many organizations today do not measure the cost of poor quality.

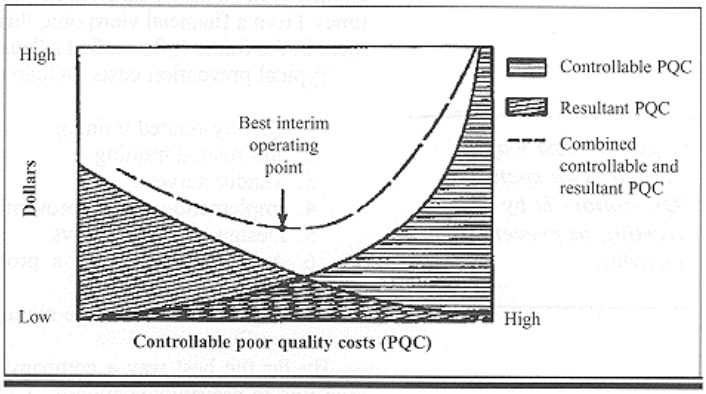
Costs that cannot be measured cannot be controlled. Why is it, then, that people in corporate management do not insist on the same good financial control over poor-quality costs that they exercise over the purchase of materials, especially when (as is often the case) PQC exceeds the total materials budget? It is often cheaper to provide high-quality products and services than to provide shabby ones. Quality is not the cost of providing an output. Quality is the value the customer receives from the output.

Poor-quality cost is defined as the sum of all costs incurred in the following ways:

- Helping employees do the job right every time (including process designs that have non-value-added activities included in them)
- Determining whether the output is acceptable
- Not meeting specifications and/or customer expectations

Exhibit 1 lists the elements of poor-quality cost. Each element is discussed in detail later.

Exhibit 2. Effect of Varying Controllable Poor-Quality Costs



Direct PQC can be found in a company's ledger and verified by the company's accountants.

UNDERSTANDING DIRECT POOR-QUALITY COST

A poor-quality cost system has two major divisions: direct and indirect poor-quality costs. Of the two categories, direct poor-quality costs are better understood and traditionally used by management, because the results are less subjective. Direct PQC can be found in a company's ledger and verified by the company's accountants. These costs include the following:

- Costs a company incurs because management is afraid that people will make errors.
- Costs incurred because people do make errors.
- Costs related to training people so that they can do their jobs effectively.

Direct PQC encompasses three major expenditures:

- Controllable PQC
- Resultant PQC
- Equipment PQC (see Exhibit 2)

Controllable PQC includes costs that management has direct control over to ensure that only products and services acceptable to customers are delivered.

CONTROLLABLE POOR-QUALITY COST

Controllable PQC includes costs that management has direct control over to ensure that only products and services acceptable to customers are delivered. Controllable PQC is further subdivided into two categories:

- Prevention costs
- Appraisal costs
- Non-value-added costs

Prevention Costs

Prevention costs are all costs expended to prevent errors (or, to say it another way, all costs related to helping an employee do a job right every time). From a financial viewpoint, this is not really a cost: It is an investment in the future (often called a "cost avoidance investment").

Typical prevention costs include the following:

1. Quality-related training
2. Job-related training
3. Vendor surveys
4. Implementing the improvement process
5. Design concept reviews
6. Action that prevents a problem from recurring (preventive action)
7. Organizational change-management activities

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By far the best way a company can spend its PQC dollars is by investing in preventive activities. Unfortunately, most companies have neglected this valuable investment because it is difficult to tie it to a tangible return on the investment.

Appraisal Costs

Appraisal costs arise from evaluating already-completed output and auditing a process to measure conformance to established criteria and procedures. In other words, appraisal costs are all costs expended to determine whether an activity was done right every time. Typical appraisal costs include the following:

1. Quality assurance audits of the manufacturing process
2. Outside financial audits
3. Inspection and testing to determine conformance of products or services to specifications
4. Approval signatures on a document
5. Outside endorsements (e.g., from Underwriter Laboratories Review) of completed designs
6. Second-level managers' review of first-level management decisions
7. Proofreading of letters or other documents
8. Payroll audits
9. Field performance testing
10. Certification evaluation (e.g., lawyers taking the bar exam)

Appraisal costs are all costs expended to determine whether an activity was done right every time.

Appraisal costs (which are unfortunately too little and too late) are incurred when management is not confident that the money and time the company has expended on prevention will entirely eliminate the possibility of error.

Non-Value-Added Costs

Direct poor-quality costs also include non-value-added costs. These

are the costs of efforts that are not directly related to the product that the external customer wants.

Internal error cost is defined as the cost a company incurs because of errors detected before the output is accepted by the company's customer.

RESULTANT POOR-QUALITY COST

Resultant PQC includes all costs a company incurs because of errors. In other words, it is all the money a company has to spend simply because some activities were not done right every time. These are "resultant costs" because they are the direct result of management decisions made in the controllable PQC category. Resultant costs are also divided into two subcategories:

- Internal error costs
- External error costs

Internal Error Cost

Internal error cost is defined as the cost a company incurs because of errors detected before the output is accepted by the company's customer. To put it another way, it is the cost a company incurs (before a product or service is accepted by the customer) because not everyone did the job right every time. Included are the costs incurred from the time an item is shipped from a supplier until it has been accepted by the final customer.

Following are examples of internal error costs:

1. In-process scrap and rework
2. Engineering changes
3. Activities of the material review board
4. Costs resulting when additional inventory is required to support poor process yields, parts that may have to be scrapped, and rejected lots
5. Downgrading (i.e., when some lower-quality products are classified as seconds and sold at a reduced price)

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External Error Cost

A producer incurs external error cost when an external customer receives an unacceptable product or service. It is the cost the producer incurs when an appraisal system fails to detect all errors before the product or service is delivered to the customer.

Typical external error costs relate to items such as the following:

1. Cost of customer-rejected services or products
2. Product liability suits
3. Complaint-handling
4. Warranty administration
5. Overhead costs required to maintain field service centers

EQUIPMENT PQC

Investment in equipment used to measure, accept, or control a product or service (plus the cost of the space that equipment occupies)

makes up equipment PQC. An example of equipment PQC is the purchase of a chip tester and all the supporting programming necessary to customize it to perform its desired function.

Typically, equipment PQC is paid for at one point in time, thus causing a spike in the related cost data. A better way of handling it is to amortize the cost of the test equipment over the life of the project. This allows comparisons between projects that have adopted different philosophies related to their testing approaches (e.g., manual vs. automatic).

As controllable PQC increases, resultant costs decrease because fewer errors are made and more errors are detected before output is delivered to customers.

INTERACTION BETWEEN CONTROLLABLE AND RESULTANT PQC

To better understand PQC, consider the theoretical interaction between controllable and resultant PQC, as illustrated in Exhibit 2. On the left side of the curve, controllable PQC is very low. This causes the resultant PQC to be very high, because little money is being spent to prevent errors or to detect them before they are delivered to the customer.

As controllable PQC increases, resultant costs decrease because fewer errors are made and more errors are detected before output is delivered to customers. At the right-hand side of the curve, although controllable PQC is high, only a negligible decrease in resultant costs occurs because increasing expenditures on controllable PQC become less and less effective.

BEST INTERIM OPERATING POINT

When controllable and resultant costs are added together, a new curve develops. This curve shows a picture of all costs that result from the interaction between controllable and resultant PQC.

An effective quality system should operate at the point on the curve labeled "best interim operating point." At this point, the total controllable and resultant PQCs are minimized, so the return on investment is maximized for that point in time. The term "best interim operating point" was chosen carefully: It is the best point for one set of conditions only and will change as the improvement process drives the error level lower. This operating point also changes as indirect PQC is considered.

INDIRECT PQC

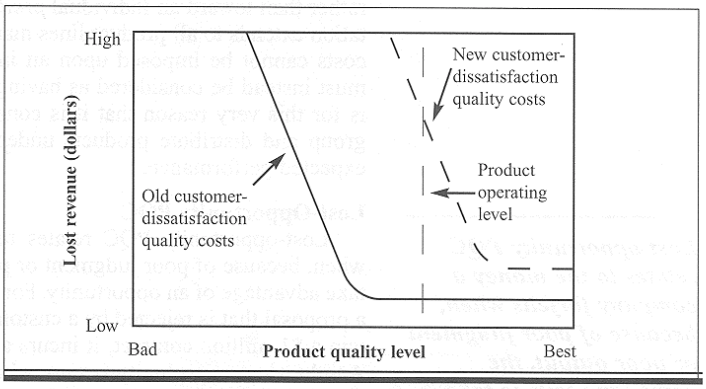
The other major part of the PQC system is indirect PQC, which is defined as those costs not directly measurable in the organization's ledger but part of the product life cycle PQC. These quality costs include the following four major categories:

- Customer-incurred PQC
- Customer-dissatisfaction PQC
- Loss-of-reputation PQC
- Lost-opportunity PQC

Customer-Incurred PQC

Customer-incurred PQC occurs when an output fails to meet the customer's expectations. Typical customer-incurred PQCs include the following:

Exhibit 3. Changes in Customer-Dissatisfaction Costs



Frequently, the cost incurred by a customer when an error occurs can far exceed the cost of repairing the defective item.

- Loss of productivity while equipment is down
- Travel costs and time spent to return defective merchandise
- Overtime to make up production because equipment is down
- Repair costs after the warranty period is over
- Backup equipment needed when regular equipment fails

It is also necessary to apply PQC systems to the impact that errors have on the customer. Frequently, the cost incurred by a customer when an error occurs can far exceed the cost of repairing the defective item. Consider a 10-year-old boy who is delighted to find a new red and white bicycle beneath the Christmas tree. When he and his father try to assemble the bicycle, everything goes well until they attempt to put on the front wheel and find that a nut is missing. As a result, before the bicycle can be used, the father must make a trip to the bicycle store, wait in line to get a new nut, and return home—a waste of probably at least an hour of valuable time and 24 miles of travel. The cost to the organization is a 5¢ nut; the cost to the customer is 300 times more.

Customers are either satisfied or dissatisfied: It is rare to find one who is in between.

Customer-Dissatisfaction PQC

Customers are either satisfied or dissatisfied: It is rare to find one who who is in between. Exhibit 3 portrays customer-dissatisfaction PQC in terms of lost revenue versus product quality level. On the left side of the curve, there is a sharp decrease in lost revenue for only small improvements in product quality. This curve reflects the binary classification of satisfaction in the customer's mind. Once a customer's acceptance level has been reached, the curve becomes almost flat, even though the product quality level continues to improve.

Loss-of-Reputation PQC

Loss-of-reputation PQC is even more difficult to measure and predict than customer-dissatisfaction and customer-incurred PQC. Costs

incurred for loss of reputation differ from customer-dissatisfaction costs in that they reflect the customer's attitude toward an *organization* rather than toward an individual *product line*. The loss of a good reputation extends to all product lines manufactured by an organization. Its costs cannot be imposed upon an individual product PQC curve but must instead be considered as having an effect on *all* product lines. It is for this very reason that it is considered good business practice to group and distribute products under different trade names based on expected performance.

Lost-opportunity PQC relates to the money a company forfeits when, because of poor judgment or poor output, the comapany fails to take advantage of an opportunity.

Lost-Opportunity PQC

Lost-opportunity PQC relates to the money a company forfeits when, because of poor judgment or poor output, the comapany fails to take advantage of an opportunity. For example, consider the example of a proposal that is rejected by a customer. When an organization fails to win a $1 million contract, it incurs a $1 million lost-opportunity cost. Another lost opportunity occurs when a customer changes from one organization's product to that of a competitor.

Every customer who changes products represents a lost-opportunity cost. It is important to understand and consider the losses involved when customers are lost. For example, every lost customer for a grocery store represents about $12,000 per year in lost revenue and about $400 in lost profits. Just think about the lost revenue when IBM turned down Bill Gates's offer to sell the patents to IBM for the products that now make up Microsoft. In many organizations, lost-opportunity PQC represents more than 100 percent of the organization's total revenue.

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USING INDIRECT PQC

How do you use indirect PQC? Some organizations ignore it, others consider it only when they are making a change in appraisal activities, and still others integrate it into their basic PQC system. The degree to which indirect PQC is implemented depends on the importance that the organization places on its customers. At the very least, some portion of customer-incurred PQC should be added to the cost of each external error to show that the organization realizes that the error has an impact on customers. Management must decide on the percentage of the actual customer-incurred PQC that is added.

There must be a continuous effort to evaluate customer expectations so that the organization's output remains on the right-hand side of the customer-dissatisfaction PQC curve. This analysis must also be kept up to date, because the knee of the curve continuously moves toward the right.

How does Armand V. Feigenbaum, the originator of the quality cost concept, feel about expanding his original conception of quality costs to the concepts defined in PQC? He answers this way: "[T]he concepts in 'poor-quality cost' add significant value to the development of the economics of quality and its utilization and management." (Harrington, 1989)

WHY USE PQC?

PQC provides a useful tool to change the way managers and employees think about errors. Specifically, PQC helps to do the following:

Talking to managers in terms of dollars and cents makes quality relevant to the bottom line.

1. *Get managers' attention.* Talking to managers in terms of dollars and cents makes quality relevant to the bottom line. It takes quality out of the abstract and makes it a practical concern that can compete with cost and scheduling.
2. *Change the way employees think about errors.* When a defective gear is scrapped because of an employee's actions, there will be greater impact on future performance if the employee knows that the gear costs $100. Before, it is only a piece of metal that is being tossed; after, it is a $100 bill. Employees need to understand the cost of errors they make.
3. *Achieve a better return on problem-solving efforts.* PQC puts problems in a financial context so that solutions can be evaluated based on maximum return. According to James R. Houghton, chairman of Corning Glass, "At Corning, cost of quality is being used to identify opportunities, to help prioritize those opportunities, and to set targets and measure progress. It's a tremendous tool, but we are taking great care to ensure that it is not used as a club." (Harrington, 1989)
4. *Measure the true impact of corrective action and changes made to improve the process.* By focusing on the poor-quality cost of the total process, inefficiencies can be eliminated.
5. *Measure, in a simple and understandable way, the effect of poor-quality on the organization.* It also helps to assess the impact of a quality-improvement process.

Cost of quality is being used to identify opportunities, to help prioritize those opportunities, and to set targets and measure progress.

SUMMARY

Poor-quality cost systems have become invaluable to many successful businesses. With today's focus on the external customer and on business process, every organization should report and consider the impact of poor quality (on its customers and on the amount of money it spends on internal customer-related activities). This requires organizations to rethink the way they measure and quantify poor-quality cost. They will likely find that the cost of quality is much higher than they imagined. In most organizations, it represents at least 20 percent of sales. Too often, it exceeds 100 percent. ♦

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