

COST OF QUALITY

CATEGORIES OF QUALITY COSTS

Many companies summarize these costs into four categories. Some practitioners also call these categories the “cost of quality.” These categories and examples of typical subcategories are discussed below.

Internal Failure Costs.

These are costs of deficiencies discovered before delivery which are associated with the failure (nonconformities) to meet explicit requirements or implicit needs of external or internal customers. Also included are avoidable process losses and inefficiencies that occur even when requirements and needs are met. These are costs that would disappear if no deficiencies existed.

Failure to Meet Customer Requirements and Needs.

Examples of subcategories are costs associated with:

- *Scrap*: The labor, material, and (usually) overhead on defective product that cannot economically be repaired. The titles are numerous—scrap, spoilage, defectives, etc.
- *Rework*: Correcting defectives in physical products or errors in service products.
- *Lost or missing information*: Retrieving information that should have been supplied.
- *Failure analysis*: Analyzing nonconforming goods or services to determine causes.
- *Scrap and rework—supplier*: Scrap and rework due to nonconforming product received from suppliers. This also includes the costs to the buyer of resolving supplier quality problems.
- *One hundred percent sorting inspection*: Finding defective units in product lots which c unacceptably high levels of defectives.
- *Reinspection, retest*: Reinspection and retest of products that have undergone rework or other revision.
- *Changing processes*: Modifying manufacturing or service processes to correct deficiencies.
- *Redesign*: Changing designs to correct deficiencies.
- *Scrapping of obsolete product*: Disposing of products that have been superseded.
- *Scrap in support operations*: Defective items in indirect operations.
- *Rework in internal support operations*: Correcting defective items in indirect operations.
- *Downgrading*: The difference between the normal selling price and the reduced price due to quality reasons.

Cost of Inefficient Processes.

Examples of subcategories are

- *Variability of product characteristics:* Losses that occur even with conforming product (e.g., overfill of packages due to variability of filling and measuring equipment).
- *Unplanned downtime of equipment:* Loss of capacity of equipment due to failures.
- *Inventory shrinkage:* Loss due to the difference between actual and recorded inventory amounts.
- *Variation of process characteristics from “best practice”:* Losses due to cycle time and costs of processes as compared to best practices in providing the same output. The best-practice process may be internal or external to the organization.
- *Non-value-added activities:* Redundant operations, sorting inspections, and other non-value-added activities. A value-added activity increases the usefulness of a product to the customer; a non-value-added activity does not. (The concept is similar to the 1950s concept of value engineering and value analysis.)

External Failure Costs

These are costs associated with deficiencies that are found after product is received by the customer. Also included are lost opportunities for sales revenue. These costs also would disappear if there were no deficiencies.

Failure to Meet Customer Requirements and Needs

Examples of subcategories are

- *Warranty charges:* The costs involved in replacing or making repairs to products that are still within the warranty period.
- *Complaint adjustment:* The costs of investigation and adjustment of justified complaints attributable to defective product or installation.
- *Returned material:* The costs associated with receipt and replacement of defective product received from the field.
- *Allowances:* The costs of concessions made to customers due to substandard products accepted by the customer as is or to conforming product that does not meet customer needs.
- *Penalties due to poor quality:* This applies to goods or services delivered or to internal processes such as late payment of an invoice resulting in a lost discount for paying on time.
- *Rework on support operations:* Correcting errors on billing and other external processes.
- *Revenue losses in support operations:* An example is the failure to collect on receivables from some customers.

Lost Opportunities for Sales Revenue

Examples are

- *Customer defections:* Profit margin on current revenue lost due to customers who switch for reasons of quality. An important example of this category is current contracts that are canceled due to quality.
- *New customers lost because of quality:* Profit on potential customers lost because of poor quality.

- *New customers lost because of lack of capability to meet customer needs:* Profit on potential revenue lost because of inadequate processes to meet customer needs.

Appraisal Costs

These are the costs incurred to determine the degree of conformance to quality requirements. Examples are

- *Incoming inspection and test:* Determining the quality of purchased product, whether by inspection on receipt, by inspection at the source, or by surveillance.
- *In-process inspection and test:* In-process evaluation of conformance to requirements.
- *Final inspection and test:* Evaluation of conformance to requirements for product acceptance.
- *Document review:* Examination of paperwork to be sent to customer.
- *Balancing:* Examination of various accounts to assure internal consistency.
- *Product quality audits:* Performing quality audits on in-process or finished products.
- *Maintaining accuracy of test equipment:* Keeping measuring instruments and equipment in calibration.
- *Inspection and test materials and services:* Materials and supplies in inspection and test work (e.g., x-ray film) and services (e.g., electric power) where significant.
- *Evaluation of stocks:* Testing products in field storage or in stock to evaluate degradation.

In collecting appraisal costs, what is decisive is the kind of work done and not the department name (the work may be done by chemists in the laboratory, by sorters in Operations, by testers in Inspection, or by an external firm engaged for the purpose of testing). Also note that industries use a variety of terms for “appraisal,” e.g., checking, balancing, reconciliation, review.

Prevention Costs

These are costs incurred to keep failure and appraisal costs to a minimum.

Examples are:

- *Quality planning:* This includes the broad array of activities which collectively create the overall quality plan and the numerous specialized plans. It includes also the preparation of procedures needed to communicate these plans to all concerned.
- *New-products review:* Reliability engineering and other quality-related activities associated with the launching of new design.
- *Process planning:* Process capability studies, inspection planning, and other activities associated with the manufacturing and service processes.
- *Process control:* In-process inspection and test to determine the status of the process (rather than for product acceptance).
- *Quality audits:* Evaluating the execution of activities in the overall quality plan.
- *Supplier quality evaluation:* Evaluating supplier quality activities prior to supplier selection, auditing the activities during the contract, and associated effort with suppliers.

- *Training: Preparing and conducting quality-related training programs. As in the case of appraisal costs, some of this work may be done by personnel who are not on the payroll of the Quality department. The decisive criterion is again the type of work, not the name of the department performing the work.*

Note that prevention costs are costs of special planning, review, and analysis activities for quality.

Prevention costs do *not* include basic activities such as product design, process design, process maintenance, and customer service.

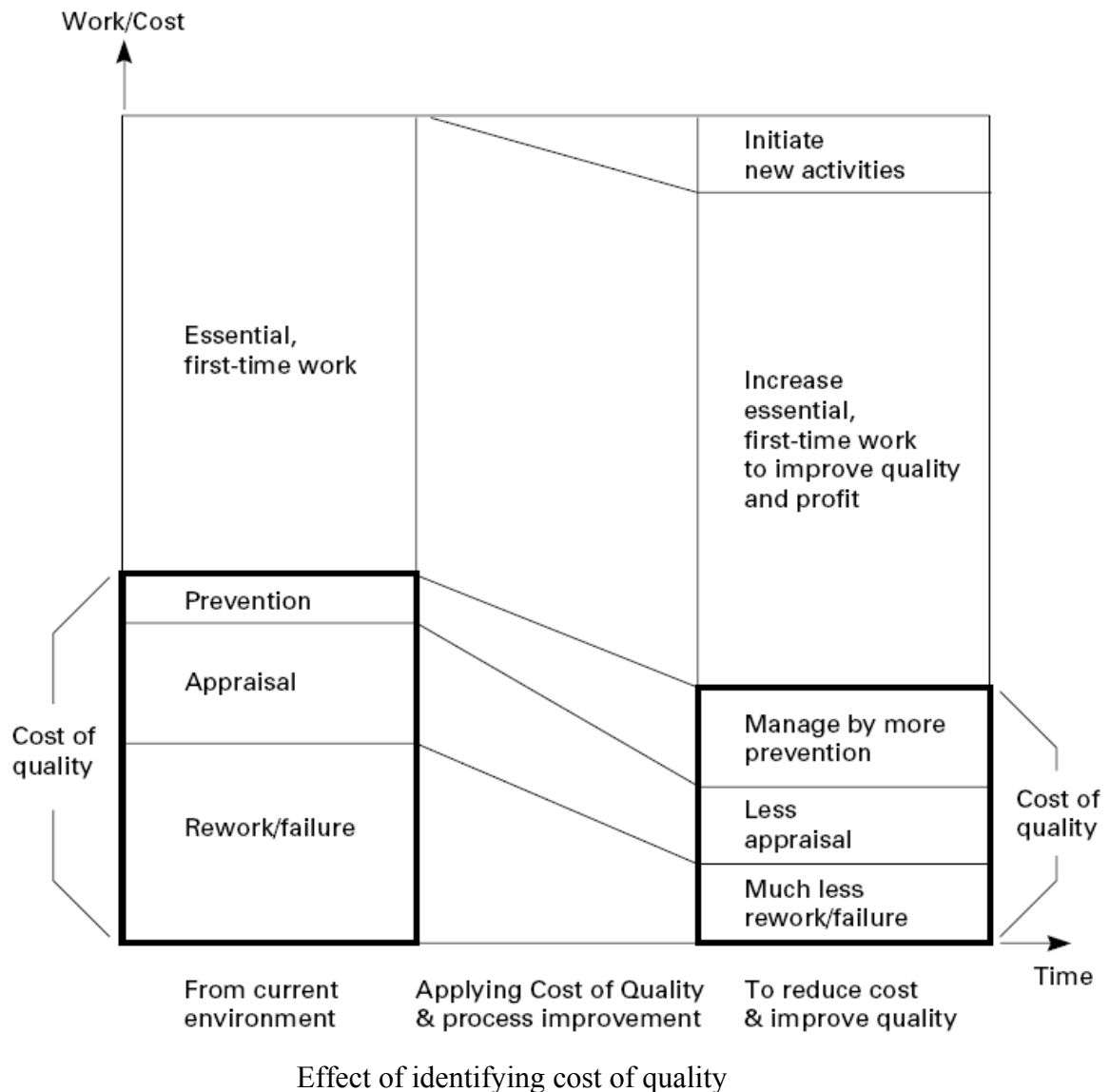
Hidden Costs.

The cost of poor quality may be understated because of costs which are difficult to estimate. The “hidden” costs occur in both manufacturing and service industries and include:

1. Potential lost sales (see above under External Failure Costs).
2. Costs of redesign of products due to poor quality.
3. Costs of changing processes due to inability to meet quality requirements for products.
4. Costs of software changes due to quality reasons.
5. Costs of downtime of equipment and systems including computer information systems.
6. Costs included in standards because history shows that a certain level of defects is inevitable and allowances should be included in standards:
 - a. *Extra material purchased:* The purchasing buyer orders 6 percent more than the production quantity needed.
 - b. *Allowances for scrap and rework during production:* History shows that 3 percent is “normal” and accountants have built this into the cost standards. One accountant said, “Our scrap cost is zero. The production departments are able to stay within the 3 percent that we have added in the standard cost and therefore the scrap cost is zero.” Ah, for the make-believe “numbers game.”
 - c. *Allowances in time standards for scrap and rework:* One manufacturer allows 9.6 percent in the time standard for certain operations to cover scrap and rework.
 - d. *Extra process equipment capacity:* One manufacturer plans for 5 percent unscheduled downtime of equipment and provides extra equipment to cover the downtime. In such cases, the alarm signals ring only when the standard value is exceeded. Even when operating within those standards, however, the costs should be a part of the cost of poor quality. They represent opportunities for improvement.
7. Extra indirect costs due to defects and errors. Examples are space charges and inventory charges.
8. Scrap and errors not reported. One example is scrap that is never reported because of fear of reprisals, or scrap that is charged to a general ledger account without an identification as scrap.
9. Extra process costs due to excessive product variability (even though within specification limits):

For example, a process for filling packages with a dry soap mix meets requirements for label weight on the contents. The process aim, however, is set above label weight to account for variability in the filling process. See Cost of Inefficient Processes above under Internal Failure Costs.

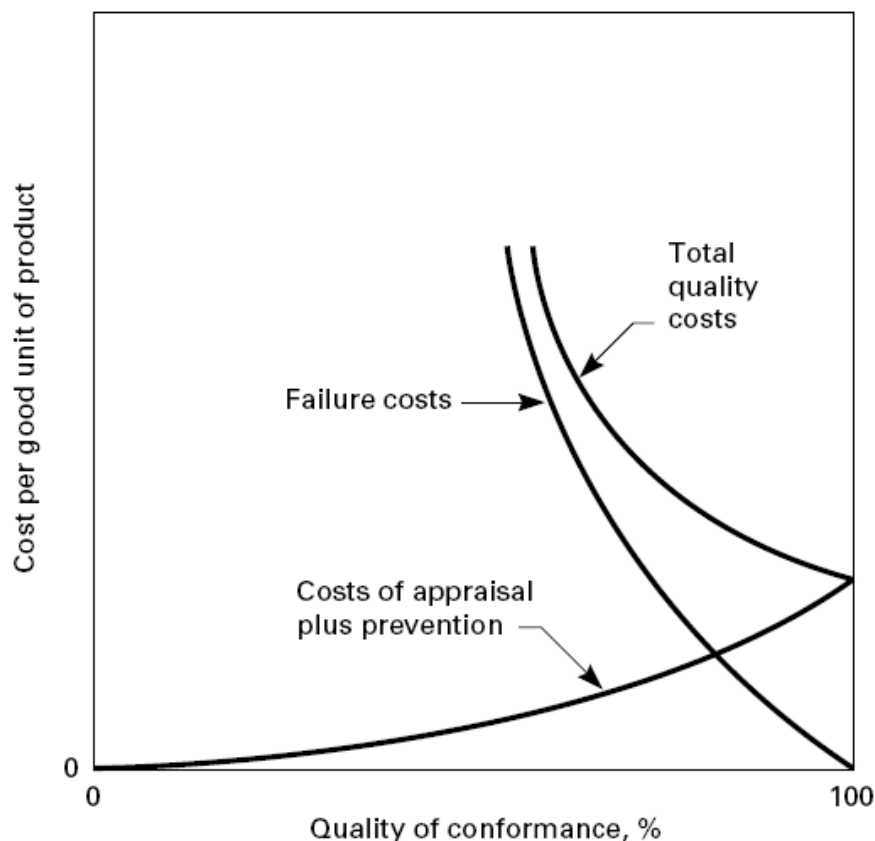
10. Cost of errors made in support operations, e.g., order filling, shipping, customer service, billing.
11. Cost of poor quality within a supplier's company. Such costs are included in the purchase price.



Optimum Quality Cost Model

The model shows three curves:

1. *The failure costs:* These equal zero when the product is 100 percent good, and rise to infinity when the product is 100 percent defective. (Note that the vertical scale is cost per good unit of product. At 100 percent defective, the number of good units is zero, and hence the cost per good unit is infinity.)
2. *The costs of appraisal plus prevention:* These costs are zero at 100 percent defective, and rise as perfection is approached.
3. *The sum of curves 1 and 2:* This third curve is marked “total quality costs” and represents the total cost of quality per good unit of product.



The previous figure suggests that the minimum level of total quality costs occurs when the quality of conformance is 100 percent, i.e., perfection. This has not always been the case. During most of the twentieth century the predominant role of (fallible) human beings limited the efforts to attain perfection at finite costs. Also, the inability to quantify the impact of quality failures on sales revenue resulted in underestimating the failure costs. The result was to view the optimum value of quality of conformance as less than 100 percent.

REPORTING ON THE COST OF POOR QUALITY

When managers use a scoreboard on the cost of poor quality, they are not content to look at the gross dollar figures. They want, in addition, to compare the costs with some base which is an index of the opportunity for creating these costs. A summary of some widely used bases, along with the advantages and disadvantages of each, is presented in the following table. The base used can greatly influence the interpretation of the cost data.

Measurement Bases for Quality Costs

Base	Advantages	Disadvantages
Direct labor hour	Readily available and understood	Can be drastically influenced by automation
Direct labor dollars	Available and understood; tends to balance any inflation effect	Can be drastically influenced by automation
Standard manufacturing cost dollars	More stability than above	Includes overhead costs both fixed and variable
Value-added dollars	Useful when processing costs are important	Not useful for comparing different types of manufacturing departments
Sales dollars	Appeals to higher management	Sales dollars can be influenced by changes in prices, marketing costs, demand, etc.
Product units	Simplicity	Not appropriate when different products are made unless “equivalent” item can be defined