

The impact of costs of quality on monitoring, analysis, and improvement of integrated management systems

Arash Asghari Nejad

Master of Mechanics - Energy Conversion- Islamic Azad University, South Tehran Branch.

ABSTRACT

Cost of quality (COQ) means the quality cost is an important and well-known methodology in various industries for measuring the resources used to carry out preventive activities and maintain product quality compared to the costs of internal and external failures. In addition, the implementation of COQ provides the financial feasibility of all quality activities in different organizations. The cost of quality is critical to companies operating in the automotive industry that have implemented IATF 16949, especially when analyzing the management review described in Section 9-3. This question is always asked among experts and industry experts whether the cost of quality is good or not. Moreover, what is the optimal limit for estimating the cost of quality? In this study, we discuss the calculation of costs of quality and the best possible case and ultimately evaluate its role in monitoring, analyzing, and improving the integrated management systems of organizations. Costs of quality in operational and production activities and service and support activities have a major impact on increasing or decreasing total costs. Therefore, measuring and evaluating quality costs plays a vital role in organizations. In this paper, we provide a suitable solution for determining costs of quality for organizations with quality systems or organizations at the beginning of the implementation path of the quality system. Also, considering that quality is a basic solution to control the quality management system, it is recommended to review its practical indicators to control the organization.

Keywords: Cost of quality, Analysis and Improvement, Integrated Management System.

Introduction

Techniques for evaluating and calculating quality costs do not have a long history and are new knowledge. Quality Control Handbook written by J.M. Juran (1951) was one of the first references related to quality costs. This is one of the chapters of this book that examines the general concepts of costs of quality. In addition, in 1963, the Department of Defense published the Quality Plan Requirements Code, which set out "costs of quality" as a requirement for major and minor contractors. This regulation led to attention being paid to the importance of quality costs. Although this regulation is a general approach to costs of quality, it has succeeded in increasing public attention to this management tool. Today, with the

development of standards such as quality management standards (ISO 9001), the issue of costs of quality has gained its true status as a tool for quality improvement and management evaluation.

Because the challenge of "costs of quality" is directly related to quality economics, it has caused controversy. For example, at the National Quality Conference in 1982, it was stated that the term "costs of quality" is not the right term because quality is profitable, not costly. For this reason, some researchers have suggested the term "Cost of Poor Quality." The US Department of Defense has also replaced "Costs related to quality." At the same time, the term "Quality Costs" or "Costs of Quality" is more common.

Types of costs of quality

General definition of costs of quality

Experts classify costs of quality into four main classes. This classification is more popular than other common classifications. These four classes are:

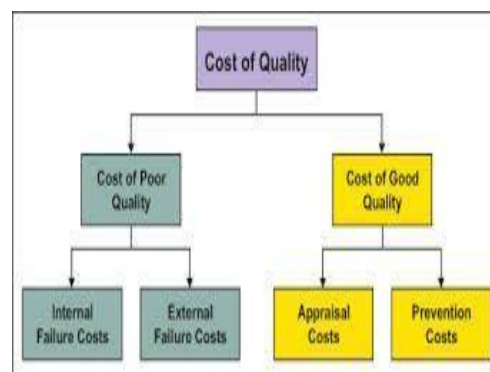


Figure 1: Costs of Quality Diagram

Prevention costs

Prevention costs are the costs of implementing measures to prevent non-compliance. Prevention costs prevent defects. Prevention costs, in particular, prevent poor-quality products or services. These costs include the cost of new product reviews, quality planning, supplier audits, process evaluations, quality improvement team meetings, quality improvement projects, and staff training and retraining.

Reporting costs

Quality reporting, product quality status and negative product scores, reports on customer survey results, inspection and testing activity reports, and reports required by middle managers and senior executives are costs that should be included in this subclass. In addition, the cost per person-hour, the relevant administrative costs are also considered.

Costs of planning, support, and quality tracking

This class includes the cost of activities necessary to prevent defects and breakdowns in products. Spending these costs reduces the breakdown and defects in the manufactured products in different stages (from the arrival of the products to the company to the delivery of the final product). The sub-classes in this class are:

Costs of quality planning

The cost of activities necessary to prepare quality plans for the production of various products, development of comprehensive quality plans in the company, quality information management system, assessment of the ability to meet needs, and so on. Also, the costs of compiling, reproducing, and

distributing instructions, procedures, and bylaws, and documents related to how to implement the developed plans are in this class.

Appraisal costs

The cost of implementing measures to ensure that quality requirements such as certification and quality control are met at all stages of design, procurement, production, shipping and distribution, and after-sales service. Simply put, evaluation costs include the cost of measuring, evaluating, or auditing products or services to ensure that they comply with quality performance standards and requirements. For example, costs of inspection and testing of purchased materials, inspection and execution of tests during the process and final product, audits of product, process or service, calibration of measuring equipment, testing, and costs of materials are in the class of evaluation costs.

Costs of controlling inspection and measuring equipment

This class includes costs related to controlling inspection and measuring equipment and keeping them in proper condition so that the values measured by these devices are reliable. Most of the costs of this class are related to the preparation of appropriate equipment and their calibration.

Assessing the quality of inventory

If healthy items are stored for a long time or in poor condition, the quality of materials may be reduced. Therefore, inventory should be evaluated in different periods. At the same time, the costs are related to evaluating the quality of the company's inventory to guarantee the quality required to use them in the production of products or to carry out inspection and testing processes. Nevertheless, warehousing costs for the company's annual audit should not be considered in this class.

Failure costs

Failure costs are due to non-compliance of products or services with customers/consumers' requirements. Failure costs include two sub-classes called internal failure costs and external failure costs.

Internal failure costs

Failure costs incurred before sending or delivering the product to the customer or providing customer service include costs of waste, rework, re-inspections, re-testing of products, material review, and reduction of product quality.

Costs due to improper storage of raw materials: Costs due to improper storage that lead to damaged items fall into this class.

Costs of retesting modified items: If a product is repaired or needs to be reworked, the inspection and testing processes must be re-run to ensure acceptable quality tolerable.

External failure costs

Failure costs imposed after sending or delivering the product to the customer or during service or after customer service, including the cost of reviewing customer complaints and products, returned from the customer, warranty costs, and product recall

Other costs

Total quality costs

Total quality cost equals the total cost of failure prevention and failure assessment costs. This criterion also reflects the difference between the actual costs of a product or service and the reduced costs if the service provided is not lower than the standard or the product is not defective or broken.

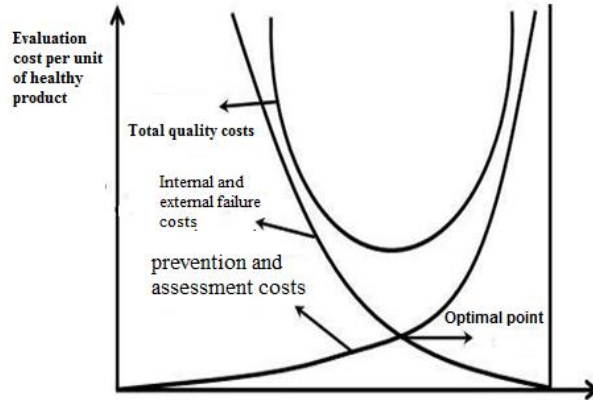


Figure2. Optimal costs of quality diagram

This class includes the costs imposed after the customer receives the product and before using the product. The components of this class of costs are:

Warranty costs: This sub-class includes warranty costs, replacement costs, repairs, product replacement, shipping, and re-installation.

Costs of returning the product by the customer and costs of customer complaints: Costs related to responding to the complaining customers and obtaining their satisfaction from the company, including the cost of telephone calls, person-hours wages required to complete customer survey forms, as well as costs of customer voice projects and customer compensation.

Costs of repairing customers' products: Costs of replacement, repair, or replacement of defective products by the company to eliminate product defects and gain customer satisfaction. Many automotive companies have acknowledged technical defects in their vehicles sold and freely corrected technical defects in their products in recent years. Such operations will often involve workforce costs, replacement parts, and so on.

Depreciation

Depreciation means a permanent reduction in the quality, quantity, or value of an asset. Depreciation is essentially a measure of the durability of a fixed asset. We expect that the performance of fixed assets that are consistently used in a particular business will decrease over time. This is exactly the equivalent of the definition of depreciation.

How is depreciation calculated?

Depreciation is equal to the initial cost of the asset minus the achievable value divided by the useful life.

Suppose Tojal Electronic Commerce Company has purchased a 3D printer worth 12 million Tomans and expects to use it for three years (the useful life of the printer). The value of this printer is constantly decreasing due to depreciation, and its estimated value after about three years is about 387,000 Tomans. Assets are always important to humankind, but they do not stay healthy forever or at a certain price, and they change over time. Depreciation is a value decrease in production that occurs even when properly maintained and used. For example, when using a hammer, the effect of repeated blows can cause the hammer head to erode, even if used properly. At the same time, with proper use and timely repairs, we do not expect the hammer to be destroyed by this depreciation. Depreciation is considered the highest cost of equipment, technologies, and assets. Depreciation generally equals a permanent reduction in the quality, quantity, or value of an asset. Depreciation is a measure of the durability of a fixed asset. In fact, over time,

the capabilities of assets that are consistently used in business are expected to diminish. Companies always pay attention to this cost criterion, record their annual profits and losses, and present it to various organizations (2).

Quality costing models

PAF model

The first method proposed in quality costing is the Juran technique, now called the "traditional method." In this method, quality costs are divided into four distinct parts:

a. Internal failure costs: The costs of evaluating, modifying, or replacing a product before the product reaches the customer.

b. External failure cost: The cost of evaluating, modifying, or replacing a product after it has reached the customer.

c. Evaluation costs: The costs associated with evaluating or auditing products or services to ensure that quality standards are met.

d. Prevention costs Costs related to the prevention of waste in manufactured goods or to prevent the production of low-quality products.

Spending money on prevention processes is certainly more cost-effective than evaluating and failing.

Juran's model emphasizes that the cost of quality for products delivered to customers is much higher than quality at other levels.

The PAF quality costing approach is often done for the whole organization, but it can also be implemented independently. This method is a quick technique to identify the gold inside the mine (according to the theory of the Juran gold mine) and guides the teams on the path to quality improvement. PAF quality costing approach is a modified model of the original and traditional model for quality costing of products in the manufacturing industry. Improvement in this method is possible by gaining short-term experience. What is clear is that many organizations have successfully implemented this method. Adopting improvement strategies in the PAF model is more familiar to system-level planners in organizational management. The rational and traditional approach of organizations, investing in prevention and evaluation activities to reduce the cost of internal and external failures and consequently reduce evaluation costs, and adjusting overall quality costs include the main strategies of the PAF quality cost approach.

Process costing model

This model was originally introduced in 1979 by Crosby. Crosby attributes quality costs to the performance of quality activities. Qualitative activities are performed to improve the quality of products, services, and processes. Crosby model divides qualitative activities into two classes:

1. Activities performed in the early stages to bring the quality level of products, services, and processes to the standard quality level.

2. Activities performed to eliminate defects, re-work, etc. (after achieving the initial quality level), and improve.

Crosby referred to the costs of first-class activities as Cost of Conformance (COC) or compliance costs, and the costs of second-class activities as Cost of Non Conformance (CONC) or non-compliance costs.

It seems that the process costing method has some more powerful semantic contexts.

- In the process costing approach, in addition to the usual quality-related costs, it is possible to monitor and reduce performance-related costs.
- The process costing model is more effective for organizations whose efforts to improve quality have been achieved to some extent and whose tangible quality costs are relatively low.
- Organizations implementing quality improvement systems and techniques (such as TQM and Six-Sigma, real-time delivery methods, reducing inventory turnover and production cycle) have achieved a relative level of quality maturity and a better platform to use.
- In the process costing approach, some traditional costs are not considered in the quality cost class. Nevertheless, it is quite certain that most non-value-added activities in a process lead to process complexity and are caused by quality problems. In order to reduce the stock of goods in the warehouse, eliminating unnecessary empty spaces in the warehouse, eliminating real-time orders, reducing errors, or improving the quality of the process is crucial. The reduced costs in this route are called hidden quality costs. The process costing model has developed a special method applicable to all organizational processes, manufacturing businesses, and service industries. This method proves the importance of process reliance, measurement and monitoring, and the functions of the process executor.
- The methodology of the process costing model is more complex than the PAF model and the qualitative losses model. Nevertheless, dividing costs into two classes in the process costing model (compliance and non-compliance costs) is simple and clear.
- Of course, implementing the PAF approach does not preclude the simultaneous development of a process costing model. This means that after fully implementing this model and ensuring progress in improving quality costs, we can directly plan and implement the main pivots and infrastructure functions of the process costing model.

BSC model

The BALANCED SCORE CARD or BSC method suggests that information managers record the costly quality components on a card for detailed analysis from four perspectives. These four perspectives are:

- 1- Customer perspective
- 2- Internal business processes perspective
- 3- Organizational growth, innovation, and learning perspective
- 4- Financial perspective

Balanced Scorecards are inherently developed to describe and evaluate past performance and execute the organization's future strategies and missions. They are also used because of the role of the controller in determining performance in quality costing processes. The quality costing process implemented by balanced scorecards is a qualitative process, i.e., the opinions of the organization's stakeholders are used to measure the extent and type of impact of poor-quality costs. From a financial perspective, stakeholders determine which costs of poor quality impose a greater financial burden on the organization. Customers also determine the effective quality costs of using products from their point of view. At the same time, from a business process perspective, the relationship between quality costs and competitive advantage is clear. Experts also determine how these quality costs will affect the organization's learning and growth.

After collecting this information and evaluating the collected data based on the four perspectives introduced, the performance of qualitative costs is estimated. Based on the estimated amounts, these costs can be calculated largely. As explained, the utilization of the recent method in quality costing processes varies depending on the type of industry and quality management perspective. Previous studies, however, reflect that the use of this method is not very significant. Numerous executive studies on the body of

industry have shown that quality is not a cost factor, but rather poor-quality that leads to the financial burden for organizations. So what we call the cost of quality is poor quality. Researchers have concluded that spending on quality adds value to an asset. Some researchers in the quality section of the balance sheet list the costs of compliance with quality standards on the right side of the balance sheet, i.e., they are considered a group of assets. However, industrial accounting approaches have not yet developed an independent method for assessing quality costs due to the many hidden aspects (lack of explicit audit headings). Reducing quality costs is uncertain, and no organization has eliminated quality costs. For this reason, researchers have decided to manage this challenge with a comparison-based approach based on benchmarking methods.

Iceberg model

The iceberg model was proposed by Planck and Dale in 1995. This model considers quality costs in the form of an iceberg. At first glance, the viewer sees only a small part or only the top of the mountain, but most of the iceberg is below the ocean. According to the Iceberg model, quality engineers directly monitor warranty costs, overwork costs due to poor quality, and rework costs. In contrast, the bulk of costs, such as customer costs, costs to improve quality programs, costs process control, customer loyalty costs, quality assessment, etc., are completely hidden from the view of quality experts.

External costs	Internal costs	Type of cost
Warranty costs, customer complaint costs	Waste cost, prevention cost, repair cost	Obvious costs
Cost of reducing the organization's credit from a customer perspective	Cost of performance reduction, cost of evaluation	Hidden costs

Qualitative losses method

Although the quality loss method provides an estimate of quality costs and is more lenient than other methods, in many cases, it is the only possible method due to the lack of access to cost data. Even when such data is available to experts, there are still several benefits to using this method. For current processes with relatively low product returns, the effects of subsequent improvements will often not be understood if only obvious losses are considered. This method considers hidden costs along with obvious costs, so the effect of subsequent improvements may be greater and more realistic. The qualitative loss model also estimates hidden quality costs (when appropriate data are unavailable) (3).

Establishment of quality costing system

COQ consists of two parts, namely poor-quality cost (COPQ) and high-quality cost (COGQ). Effective COQ implementation helps the organization accurately measure the resources needed to estimate good and poor quality costs. Based on this valuable information, the organization can determine the number of resources allocated to improve quality. Estimates of quality costs are usually between 15-40% of total business costs. The key goal of the COQ method is to maximize product quality and reduce overall cost. The COQ method provides management with accurate information to accurately identify defective areas and opportunities for improvement based on evaluating the effectiveness of its quality systems. (4)

Solution for establishing a quality cost system

Recognizing the current situation

At this stage, the various work processes of the company are examined to gain a full understanding of the overall situation of the organization. This stage can be achieved through observations, interviews, the study of financial reports, technical, quality systems, management, etc.

Determining goals and defining the problem

The objectives and reasons for this should be clearly defined before data collection so that data collection and application in operational contexts are useful.

Collecting data

Effective evidence and records such as financial reports, payroll, production and waste product reports, inspection and testing reports, after-sales service, etc., can be collected by various departments.

Data analysis

The use of various indicators and the study of the trend of cost changes are some of the methods of critical analysis. The most important challenge in classification analysis is reasonably classifying data to facilitate the analysis process. Various methods have been proposed for data collection and classification, such as:

- Prevention cost, evaluation, and error based method
- Organization-dependent cost components method
- Method of semi-structured determination and measurement

Cost components also include the following categories:

- Method of qualitative cost analysis based on departments
- Method of qualitative cost analysis based on teams
- Method of process-based qualitative cost analysis (5)

Report of quality costs

Quality cost reporting is the main part of establishing a quality costing system. These reports can be used in terms of cost type, product type, implementation details, or organizational units in bar charts, Pareto charts, and other charts.

Applications of quality costs in the path of continuous improvement

The main purpose of establishing quality costs is to collect and analyze reports and determine their applications because most organizations tend to make decisions in different situations based on cost information. Some of these applications in organizations are:

- A parameter or business entity in the field of competition
- Criteria of measuring quality performance and corrective measures
- An effective tool for planning and controlling the organization's costs in the future
- An assistant tool to estimate the organization's budget
- An effective tool for motivation making in the organization (6)

Analysis and conclusion

Given the results of an integrated management system, calculating quality costs is critical. The role of quality cost in organizations is very critical because based on the ratio of the percentage of quality costs to sales revenue, the ratio of quality costs to total costs of the organization and the quality cost portfolio (according to paragraph 1) show which area the most cost has been spent. Organizations are more inclined

to spend quality costs on preventive quality, although inspection costs can also be a good option if the organization can detect defects. Nevertheless, the costs of failure, especially the costs of external failure, are very effective and not only impose costs on the organization but also damage the credibility of the organization.

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