

# Managing Cost of Quality: Insight into Industry Practice

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## Abstract

This paper reports on the study of the quality costing practices at four large successful multinational companies. All four companies use systematic quality initiatives; however, a formal cost of quality (CoQ) methodology was only employed at one of them. This is in agreement with the literature findings arguing that a CoQ approach is not utilized in most quality management programs. The article discusses and compares the quality programs of all four companies and explains the benefits of the eventual adoption of a CoQ approach in each case. The analysis provides a new insight into company practice, useful not only for academic research, but also for use by industry.

**Keywords:** Cost of quality, CoQ, quality costing, industrial practice

## Introduction

Improving quality is considered by many to be the best way to enhance customer satisfaction, to reduce manufacturing costs and to increase productivity. Any serious attempt to improve quality must take into account the costs associated with achieving quality, since nowadays it does not suffice to meet customer requirements, it must be done at the lowest possible cost as well. This can only happen by reducing the costs needed to achieve quality, and the reduction of these costs is only possible if they are identified and measured. The identification itself is not straightforward because there is no general agreement on a single broad definition of quality costs. However, according to Dale and Plunkett (1995), it is now widely accepted that quality costs are the costs incurred in the design, implementation, operation and maintenance of a quality management system, the cost of resources committed to continuous improvement, the costs of system, product and service failures, and all other necessary costs and non-value added activities required to achieve a quality product or service. Measuring and reporting these costs should be considered a critical issue for any manager who aims to achieve competitiveness in today's markets.

There are several methods that can be used to collect, categorize and measure quality costs. The traditional *P-A-F method* suggested by Juran (1951) and Feigenbaum (1956) classifies quality costs into prevention, appraisal and failure costs. Prevention costs are associated with actions taken to ensure that a process provides quality products and services, appraisal costs are associated with measuring the level of quality attained by the process, and failure costs are incurred to correct quality in products and services before (internal) or after (external) delivery to the customer. The cost categories of *Crosby's model* (Crosby, 1979) are

similar to the P-A-F scheme. Crosby sees quality as “conformance to requirements”, and therefore, defines the cost of quality as the sum of price of conformance and price of non-conformance (Crosby, 1979). The price of conformance is the cost involved in making certain that things are done right the first time and the price of non-conformance is the money wasted when work fails to conform to customer requirements. Another formal quality costing approach is the *process cost model*, which was developed by Ross (1977) and first used for quality costing by Marsh (1989); it represents quality cost systems that focus on process rather than products or services. Several references propose CoQ models that include the additional category of intangible costs. These are costs that can be only estimated such as profits not earned because of lost customers and reduction in revenue owing to non-conformance. The importance of opportunity and *intangible costs for quality costing* has been recently emphasized in the literature. Dale and Plunkett (1999) describe a less formal method based on *collecting quality costs by department*. Another recently proposed CoQ methodology is a *method based on a team approach*, in which the aim is to identify the costs associated with things that have gone wrong in a process (Robison, 1997).

No matter which quality costing approach is used, the main idea behind the CoQ analysis is the linking of improvement activities with associated costs and customer expectations, thus allowing targeted action for reducing quality costs and increasing quality improvement benefits. Therefore, a realistic estimate of CoQ, which is the appropriate tradeoff between the levels of conformance and non-conformance costs, should be considered an essential element of any quality initiative and a crucial issue for any manager. A number of organizations are now seeking both theoretical advice and practical evidence about quality related costs and the implementation of quality costing systems.

A reasonable amount of detailed information on various methods of categorization, collection and measurement of quality costs can be found in the literature (Plunkett and Dale, 1987; Williams et al., 1999; Schiffauerova and Thomson, 2004). However, there are only a few published, practical examples from industry that give specifics about the costs that are included or excluded in quality costing and about how the costs are practically collected and measured. More detailed descriptions of CoQ systems from industry can be found in Whitehall (1986), Hesford and Dale (1991) and Purgslove and Dale (1996). This paper intends to contribute to this area by providing an analysis of the quality costing practices of four successful companies.

### **Research Intent and Methodology**

The objective of this research was to obtain and analyze data concerning the practices of successful companies in the area of quality management. Specifically, the main interest was to investigate if these companies collect, measure and monitor quality costs, which kinds of costs were considered in the calculations, and whether any formal CoQ approach was used. The analysis provided a new insight into company practice, useful not only for academic research, but also for use by industry.

Four companies were selected to participate in the research. The main objective of the selection was to identify the organizations with well established quality programs belonging to the different industrial sectors. Companies serving the same market could have been reluctant to share details concerning their quality practices with competition. This paper keeps the company names confidential and refers to them as Company A, B, C and D.

A benchmarking session took place at McGill University. The quality management programs running at the four companies were described by company representatives. The organizations utilized this occasion as an occasion to obtain new information on the practices used at other companies and to mutually compare their experiences, efforts and successes.

**Summary of the Benchmarking Session**

This section summarizes the initiatives in the field of CoQ for the four participants. A comparative analysis of their quality strategies and final remarks follow.

Company A

Company A is a telecommunication company. It has very complex products, and therefore, the number of opportunities for defects per unit is very high (45,000 defect opportunities per assembly). However, Company A’s customers expect zero defects. Quality initiatives therefore play an important role in the company’s product management.

Company A’s model for cost of quality measurement and calculation follow the P-A-F model, where  $CoQ = (P + A + F \text{ (internal + external) + other costs}) / \text{cost of goods sold}$ . Company A is well aware of formal cost of quality methods and it has clearly determined its CoQ definitions. It knows exactly what are its conformance and non-conformance costs; however, it struggles to find out the shape of its CoQ curves, and hence, an optimum CoQ tactic. The search for an optimum CoQ is difficult because the business cycle changes often (every 2 years or less); product lines are released in phases, and component obsolescence and multiple engineering changes are quite common. Every change causes a new search for an optimum CoQ; moreover, different product lines require separate review, and variable volumes reduce optimization opportunities.

Company A uses an activity based management approach, which means that it uses activity-based costing (ABC) to determine cost categories. It maps financial categories into activity costs, and activities performed at cost centers are rolled up to aggregate quality costs and percentages. In this way, the company obtains exact information about every category: prevention costs, appraisal costs, as well as internal and external failure costs. An example of activity costs is given in Table I, and the resulting CoQ chart is shown in Figure 1.

*Table I: Example of activity costs in Company A*

<b><i>Activity - primary</i></b>	<b><i>Cost of quality category</i></b>	<b><i>Activity %</i></b>	<b><i>Cost categories</i></b>
OPD	Failure - Internal	8%	Salaries
Change Management	Prevention	12%	Depreciation
Internal Quality Issues	Failure - Internal	17%	Suppliers
External Quality Issues	Failure - External	9%	Others
DFX, NPI support	Prevention	4%	
Proto Support	Prevention	6%	
PLC Deliverables	Appraisal	22%	
Mfg Tools	Prevention	6%	
Quality Reporting	Appraisal	10%	
Other	Cost of Business	6%	
	Totals	100%	

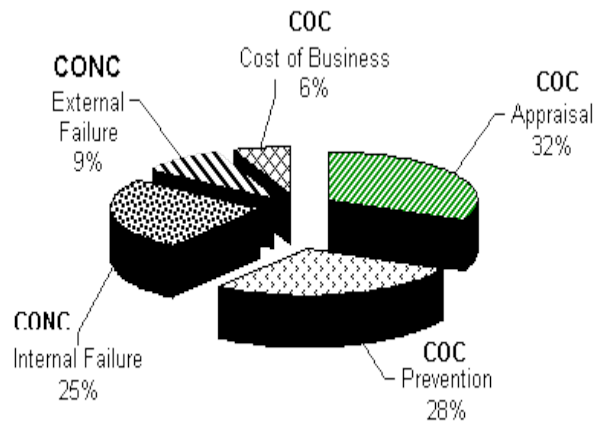


Figure 1. CoQ chart for Company A

Company A uses other metrics for performance comparisons, such as ‘new versus mature product’ or ‘part number based CoQ ratio’. CoQ is measured at individual test stages, which allows trend analysis and comparison using mature product as the benchmark for new product. Figure 2 shows the decreasing trend of CoQ for manufacturing operations. The graph shows a decrease for all CoQ components; however, it is failure costs which show the biggest reduction, about 40 % over 18 months. The breakdown of CoQ and its cost values are measured quarterly.



Figure 2: CoQ in manufacturing operations for Company A shown on a relative cost scale.

Company A has been using their CoQ methodology successfully. The company declares savings in quality costs, has quality improvement in every part of their process, and achieves very aggressive improvement targets. Moreover, the end customer directly benefits from the in-house quality initiative. As a result, customer satisfaction is increasing.

### Company B

Company B is a multinational microelectronics company, which dedicates a lot of effort to quality improvement. Their far-reaching and successful quality improvement program is the main axis of their quality initiatives. The program includes continuous improvement focused on process as well as extensive education and training on quality for all employees.

Despite the fact that there is a great interest in reducing non-conformance cost, Company B does not measure, report or chart CoQ. It does not use any formal CoQ model and does not try to optimize cost of quality. Nevertheless, it does reduce cost due to poor quality through its continuous improvement activities. The company has a strong operations and process focus, where emphasis is put on process yield and cycle time improvement. It believes that a continuous quality improvement program focused on process will provide the opportunities for quality improvement and thus reduction in cost of quality.

### Company C

Company C is in the aerospace industry and emphasizes products with near zero defects. Company C describes its cost of poor quality model as an iceberg philosophy, where just a few categories for poor quality cost are measured and monitored. This is, however, just the tip of the iceberg, since most of the cost factors leading to poor quality are non-visible or completely hidden (and non-quantifiable).

Company C has implemented a process that allows tracking of all non-quality events and associated root causes as well as corrective actions and lessons learned. It puts full attention into measuring the cost of poor quality. It has 4 main quality ratings, which measure non-conformities (scrap, rework, etc.), poor adherence to specifications (internal, external, customers', suppliers'), number of defective parts in parts per million, and on-time delivery. Their cost of non-quality is systematically reduced through a corporate-wide initiative based on continuous improvement. It also uses a sophisticated IT system for tracking quality. Although Company C has had success in improving the value of non-conforming quality costs, it does not use any CoQ model, and it does not include the cost of quality among its calculation elements.

### Company D

Company D is a manufacturer of home products. It has set its quality level at a fixed warranty rate, and it attempts to optimize its quality effort to achieve this target. At the time of the benchmarking session, the company did not measure CoQ; however, it was planning to do so and was building a CoQ model. The envisioned CoQ program was based on a P-A-F model. The strategy of Company D was to directly attack failure costs in an attempt to drive them down, to invest in the right prevention activities to bring about improvements, to reduce appraisal costs according to achieved results, and to continuously evaluate and redirect prevention efforts to gain further improvements.

## Discussion

Table II shows a comparison of the quality initiatives and CoQ effort carried out by the four companies. The following discussion is focused on the relation between the quality strategies and the industrial sectors, on the kinds of CoQ models used, on the satisfaction with company efforts, the results stemming from the quality costing programs, and the recommendations by the authors of this paper.

*Table II: Comparison of quality initiatives of four companies*

<i>Company</i>	<i>Industry sector</i>	<i>Quality strategy</i>	<i>Quality costs</i>	<i>Formal CoQ model</i>	<i>Quality efforts</i>	<i>Program satisfaction</i>
<b>A</b>	telecom	zero defect	CONC + COC	P-A-F + ABC	intensive	high
<b>B</b>	electronics	zero defect	CONC	none	intensive	high
<b>C</b>	aerospace	zero defect	CONC	none	intensive	high
<b>D</b>	home products	% of allowable defects	CONC	none	moderate	moderate

COC cost of conformance

CONC cost of non-conformance

P-A-F traditional model including: prevention + appraisal + failure costs

ABC activity-based costing

### Quality Strategies

The business environment, which is the industry sector and product line, dictates the strategy adopted by the companies to assure achievement of the required level of quality. Companies A, B and C all work in high-tech industries that require very high levels of quality, and therefore, they all have quite elaborate quality and productivity improvement systems with the objective to achieve zero or near zero defects. Company D, which serves home product markets, uses a fixed rate of return through its warranty policy as its quality limit. The company, however, does have a continuous improvement program.

### Quality Costs

Table II suggests that Company A is the only one that in fact measures both kinds of quality costs, conformance and non-conformance. This allows the company to search for the right balance between the amount spent on quality and the resulting benefits.

Companies B and C both regard reducing non-conformance cost as a high priority, and therefore, they exert substantial efforts in measuring and monitoring failures and other non-conformances. At the same time, they use elaborate, systematic quality improvement programs in order to reach a zero defect quality level. The direction of these initiatives is consistent with the industry quality environment, which tolerates absolutely no defect, no matter what the cost is. Conformance costs are consequently given much less attention in the quality management programs and measuring them together with the cost of non-conformance is therefore disregarded.

The situation for Company D is however quite different. Even though the company also does not measure conformance costs, the nature of its own quality strategy suggests that it would benefit greatly if it started doing so. Identification and measurement of both kinds of the quality costs would certainly improve the quality policy that Company D follows. The policy has a determined rate of return as its quality limit. Being able to find an appropriate trade-off between conformance and non-conformance costs would help Company D determine an optimal level of effort towards achieving quality.

### Formal CoQ Methods

Literature (for example, Porter and Rayner, 1992; Schiffauerova and Thomson, 2004) suggests that, if quality costs are measured by companies, then the classical P-A-F model is the one most frequently used in practice. Even within the limited sample of four companies, P-A-F was the only model encountered. Company A is currently calculating its quality costs according to the traditional categorization of prevention, appraisal and failure costs. Moreover, Company D claims that it is planning to utilize this model in the near future as well. The results of this research therefore confirm other researchers' findings on the frequency of the use of the P-A-F method in industry. Focus by companies on the classical P-A-F methodology is not surprising; however, there are several other alternatives available for monitoring CoQ. Other quality costing methods, such as Crosby's model or process cost model, are being used with success (Schiffauerova and Thomson, 2004). Every company has to choose an appropriate CoQ method that suits its needs and its situation best. For a detailed checklist of the issues to be considered when deciding on a CoQ approach, see Dale and Plunkett (1995)

Activity-based costing (ABC) is considered to be more compatible with quality cost measurement systems than traditional accounting. Although most CoQ measurement methods are activity/process oriented, traditional cost accounting establishes cost accounts by the categories of expenses instead of activities. Thus, many CoQ elements need to be estimated or collected by other methods. There is no consensus method on how to allocate overheads to CoQ elements and no adequate method to trace quality costs to their sources (Tsai, 1998). The use of ABC for a CoQ calculation is therefore an appealing alternative, and Company A is benefiting from this powerful combination. The employment of a CoQ approach together with ABC enables Company A to obtain exact information about every CoQ category: prevention costs, appraisal costs as well as internal and external failure costs.

Companies B and C do not utilize any formal quality costing system. This is in agreement with the common suggestion that the CoQ approach is not fully appreciated by organizations and the practical use of formal quality costing in industry is quite rare.

### Satisfaction with Quality Efforts

The quality initiatives of companies A, B, and C are very elaborate and the amount of effort is intensive. Whether they use a formal CoQ method or they solely aim at a reduction in the cost of poor quality, the companies obtain excellent results from their quality programs. All three companies mentioned a high satisfaction with their quality efforts during the benchmarking session. Judging by the success of Company A with its CoQ program, we suggest that companies B and C would benefit from measuring CoQ, and that they would be surprised if they knew their real quality costs. These companies should select an appropriate CoQ model that suits the

company's situation and implement the quality costing methodology in order to improve the efficiency of their quality initiatives. Monitoring quality costs would allow them to better identify target areas for cost reduction and quality improvement. Moreover, sufficient savings should occur to justify CoQ measurement expenses.

Company D has a continuous improvement program that brings it moderate results and is already looking to improve it by implementing a CoQ strategy. As mentioned above, the implementation of a suitable CoQ method would secure reduced costs and improved quality benefits for Company D.

### **Summary**

Even though quality is nowadays considered to be a critical success factor for achieving competitiveness, the CoQ approach is not fully appreciated by organizations, and only a minority of them use formal quality costing methods. The four companies that participated in the benchmarking session with McGill University on cost of quality have systematic quality initiatives, and have been successful in improving quality and reducing the cost of non-conformance. However, the only company that measures cost of quality and uses a formalized CoQ model is Company A. Company D is at the point of starting to use this quality measurement tool as well; however, it is at the beginning of this path. On the other hand, Company B and Company C focus their quality efforts solely on continuous quality improvement. They measure, monitor and work mostly with the cost of non-conformance, and do not formally include cost of conformance in their analysis.

It was recommended that companies B, C and D set up a suitable formal quality costing system compatible with the needs and the situation of each company. For companies B and C this program will mainly facilitate identification of the target areas for quality improvement and cost reduction in quality effort. For Company D it would also help balance its quality costs and establish an optimal level of effort towards achieving quality. CoQ programs should be part of any quality management program. The methodology is not complex and is well documented. CoQ programs provide a good method for identification and measurement of quality costs, and thus allow targeted action for reducing CoQ. Further education on the practical level is needed for managers to understand better the CoQ concept in order to appreciate fully the benefits of the approach, to increase their ability to implement a CoQ measurement system and to save money.

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## **Autobiographical Note**

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