

15 June 2005

### **Modeling Quality Costs!**

Quality has been considered a fundamental and critical success factor for competitiveness and customer value. Fierce market competition, global marketplaces, tough customer demands and falling margins have driven companies to focus on quality issues like never before. They invest heavily in quality and continuous improvement initiatives. However, many of these attempts to improve quality often fail to take into account the associated costs.

Experts emphasize that the aim of continuous improvement should not be just to improve quality and enhance customer satisfaction, but also achieving them at minimal costs. To reduce costs, it is essential to first identify all the costs associated with quality.

#### **Defining Cost of Quality (CoQ)**

Though there are various definitions, CoQ is generally recognized as the sum of costs of conformances and non-conformances. We all know that cost of conformance is the price paid for prevention of poor quality (like inspection and appraisal costs). Cost of non-conformance is the cost of poor quality caused by failure of products or services (returns and reworks). Companies must also remember the fact that CoQ also includes the costs involved in the design, implementation, operation and maintenance of a quality management system. This apart, CoQ comprises the cost of resources committed to continuous improvement, the cost of product, service or system failures and other activities required to achieve a quality product/service.

Though quality experts give varied opinions, all of them emphasize on the need to measure CoQ. According to Joseph Juran and Phillip Crosby, if CoQ were measured and efforts made to minimize defect prevention and non-conformance costs, there would be a drastic reduction in overall costs. This formed the basis for Crosby's statement "Quality is free". As per Crosby's analyses, CoQ links improvement actions with reduced costs and enhanced benefits for companies.

Ironically, Edward Demings, the top quality guru believed that any type of deviation, be it in terms of non-conformances, defects, poor services or bad performances causes irreparable damage. The resulting loss of reputation is very high and hence, Demings considered evaluating CoQ as unnecessary. He considered measuring CoQ a waste of time and resources. *According to Deming, the right objective is to have zero defects.*

True, most often time and financial resources invested on prevention activities tend to be wasted, as they do not bring in the expected and appropriate improvements. Yet some companies consider expenditure on improvement and prevention activities as a form of investment to reduce failure costs. They find it uneconomical to have a high level of quality. The assumption is that a compromise has to be made on absolute quality to achieve other critical objectives like reduced development cycle times.



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Companies need to make a realistic and correct trade-off between the level of conformance and non-conformance costs and arrive at an appropriate CoQ model. The objective of a CoQ system is to arrive at a level of quality that minimizes total cost of quality. Different companies have evolved different CoQ models. These are based on costing strategies, metrics used and best practices. Five popular generic models are detailed below.

**The P-A-F Model:** In early 1951, Joseph Juran took up CoQ analysis and 5 years later, Armand Feigenbaum classified quality costs as prevention, appraisal and failure (internal and external) 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 a process. Failures costs are incurred while correcting quality in products and services before (internal) and after (external) delivery to a customer. Basic assumptions in this model are that investment in prevention and appraisal activities will minimize failure costs and further investment in prevention activities will reduce appraisal costs.

**Crosby's Model:** Very similar to the P-A-F model, Crosby's model is based on his definition that quality is "conformance to requirements". Hence, CoQ is defined as the sum of costs of conformances and non-conformances. The cost of conformance is the cost involved in ensuring that things are done right the first time. This includes actual prevention and appraisal costs. Likewise, cost of non-conformance is calculated by quantifying the cost of correcting, reworking and scrapping and corresponds to actual failure costs. In short, Crosby's model is only a new terminology to describe a P-A-F model and the two models are often used interchangeably.

**The 'opportunities and intangible costs' model:** This is an extension of the P-A-F model. Here, the emphasis is on intangible costs, which include profits not earned due to lost customers and reduction in revenue as a result of non-conformances. Opportunity costs are further broken down into three components: under-utilization of installed capacity, inadequate material handling and poor delivery of services. Total CoQ in this model is defined as revenue lost and profit not earned. In the year 1975, Juran revised his P-A-F model to include cost of intangibles. The new model included measurable cost categories namely: tangible factory costs and tangible sales costs.

As companies focus increasingly on issues as diverse as quality, innovation, technology advancements and the like, they often neglect issues of quality costing. It is crucial that companies record and justify quality costs and avoid unreasonable spend on quality and continuous improvement issues.

Here, we look at the **process cost model**. As the name suggests, it is the total cost of conformance and non-conformance for a particular process. As it recognizes the importance of process cost measurements and ownership, the model presents a more integrated approach to quality. Here, the focus is on the cost of each process.

According to quality experts, the existing accounting systems of most companies are inadequate for generating reports on quality measurements. They are incapable of

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tracking all quality-related costs. Moreover, benefits resulting from improved quality are not measured. Most conventional accounting systems contain categories of expenses instead of cost of activities. In the absence of an adequate method to trace quality costs to their sources, CoQ elements have to be estimated or collected by other methods.

Cooper and Kaplan designed the fifth model, the Activity Based Costing (ABC) model in order to resolve the problems emerging from conventional accounting systems. The ABC model helps arrive at accurate costs for various objects by tracing resource costs to their respective activities.

In fact, the ABC approach is actually not exactly a CoQ model. It is an alternate approach some companies use to identify, quantify and allocate quality costs among products and hence, helps manage quality costs better. The long-term goal of ABC systems is to eliminate non-value added activities and to continuously improve processes, activities and quality so that defects are eliminated.

Whichever the model used, there are various parameters for CoQ models. However, there is no definite structure. The parameters and elements of CoQ models vary from one company to another.

Companies must take care that CoQ models and parameters are not just borrowed from successful companies, but tailor-made. Only then can they be well integrated into a company's structure and accounting systems. Moreover, it is essential that periodic comparisons are made and quality cost elements developed, deleted, modified or combined as required.

CoQ measurement systems must contain good feedback metrics. Experts suggest a combination of detailed and global metrics. Some examples of detailed metrics are:

- Costs of assets and materials
- Cost of preventive labor
- Cost of defects per 100 pieces
- Cost of late deliveries
- % of repeat sales
- Time between service calls
- Number of complaints received
- Number of non-conforming products

Some global metrics for CoQ are:

- $ROQ = \text{Increase in profit} / \text{Cost of quality improvement initiative}$
- $\text{Quality Rate} = (\text{Input} - (\text{quality defects} + \text{start-up defects} + \text{rework})) / \text{input}$
- $\text{Process quality} = (\text{Available time} - \text{rework time}) / \text{Available time}$
- First Time Quality is the percentage of products with no rework

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Return on Quality (RoQ), the ratio of increase in profits to the cost of the quality improvement initiative, is one among the popular metrics. It helps quality managers to select the best among various improvement initiatives.

Before developing CoQ models, companies seek practical evidence and advice about quality related costs. In this direction, researchers have taken up benchmarking sessions on CoQ to identify some best practices and gather information on quality related activities.

Xerox Corporation was the first company to use opportunity or intangible costs for CoQ improvement initiatives. The cost of lost opportunities was accounted for as profit not earned owing to lost customers and reduction in revenue due to non-conformances. According to Xerox, CoQ includes alternative costs in terms of lost sales, extra inventory, delays and unidentified scrap.

Likewise, Company X is a leading telecom company with highly complex products. Despite the opportunities for defects per unit being very high, its customers expect near-zero defects. Quality is thus a critical factor and the company constantly changes its CoQ model so as to derive an optimum solution. This is more so because its business cycle changes in less than a span of two years. Hence, it maps financial categories into activity costs. CoQ is measured at individual test stages. This enables trend analysis and comparison using mature products as the benchmark for new products. In a span of 18 months, the company achieved a 40% reduction in failure costs.

Company Y is in the aerospace industry and emphasizes the need for near zero defects. Its CoQ model is based on the 'iceberg' philosophy, where just a few categories for poor quality can be measured and monitored. Company Y's process helps track all non-quality events and associated root causes, corrective actions and lessons learned. The focus is on poor quality. Though Company Y has improved the value of non-conforming quality costs, it does not include the cost of quality in its calculating elements.

Company Z, a multinational manufacturer of microelectronics dedicates great efforts for quality improvement. This includes continuous improvement based on processes and extensive training and education on quality for all its employees. Despite the absence of a formal CoQ model, Company Z reduced costs due to poor quality and non-conformances substantially with its strong focus on process.

Thus, each company devises its own ways to track costs. These are the cases of some leading companies. Experts say that although quality and continuous improvement initiatives receive huge attention in most companies, there is minimal use of formal costing methods in many. What these quality gurus emphasize is that CoQ should be a part and parcel of every quality improvement initiative. The first step a company has to take in this direction is to develop the right CoQ model after careful and thorough analyses of its vulnerabilities.