

Cost of Quality Applications and Challenges: A Review

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Abstract

This paper presents cost of quality (COQ) its applications and challenges with the help of COQ models and the constituents components of the models. It describes different parameters responsible for COQ and also issues related with COQ. COQ is a measurement system that translates the language of management into a monetary language that every stakeholder can understand. COQ concepts affect operating costs, profitability, and consumer needs.

Keywords: COQ, P-A-F, ABC,

1. Introduction

Cost of Quality or Quality Costs

Burns (1976) measured the quality costs in a machine-tool company and these costs were the equivalent of 5 percent of the sales turnover. The allocation of the quality costs was prevention 3.3 percent, appraisal 40.3 percent and failure 56.4 percent. In a study of a steel foundry, Moyers and Gilmore (1979) reported the quality costs at 38 percent of sales. The quality costs were allocated as prevention cost 6 percent, appraisal cost 14 percent and failure cost 80 percent. Generally in the literature, quality costs are reported to be between 5 and 30 percent of sales. Wheelwright and Hayes (1985) brought out that IBM's quality costs in the early 1980s were 30 percent of its manufacturing costs.

A competitive product based on a balance between quality and cost factors is the principal goal of management. In general, the cost quality is the total of the cost incurred for quality control process and the cost of product defect. We should make a competent analysis of the quality cost to find out a best way to minimal the quality cost (Parker, 1995).

The competitive pressures facing firms in today's environment have led to increasing reliance on quality-oriented, results-based improvements. Many noted quality experts have extolled the need to focus on and improve quality and customer satisfaction as a way of meeting the challenges facing today's global organizations. Organizations throughout the world have made quality a priority in the form of Total Quality Management (TQM), Continuous Improvement (CI), and similar initiatives. The results of these efforts have ranged from excellent to poor, with many firms not fully realizing the benefits that had been expected prior to implementation (Lackritz, 1997).

Total costs of quality have been estimated by Kent (2005) at 5-15 percent of turnover for companies in Great Britain, by Crosby (1984) at 20-35 percent of sales for manufacturing and service companies in the USA, and by Feigenbaum (2001) at 10 percent of revenues. That the most conservative of these estimates might exceed a company's net profit highlights the potential importance of COQ. In recent years, the importance of the quality-related costs has been realized. Quality related costs represent a considerable proportion of a company's total costs and sales.

It should also be understood that the cost of quality is a comprehensive system, not piecemeal tool. There is a danger in responding to a customer problem only with added internal operations, such as inspection or tests, and ignoring other consequences of poor quality (Chiadamrong N., 2003).

Although it is possible to state that the costs of quality should always be collected and analyzed, mainly due to the fierce competition among a large portion of companies, this work only investigated a part of those costs, related to warranty claim (Cauchick P.A. et al., 2004).

COQ is a measurement system that translates the language of management into a monetary language that every stakeholder can understand. COQ concepts affect operating costs, profitability, and consumer needs. Several studies indicate that COQ is around 30% of total manufacturing costs. It is a significant cost driver that firms need to control effectively for sustaining competitive advantage (Srivastava S.K., 2008).

The scenario of incorporating COQ in supply chain network design will ensure the lowest overall cost, because it reduces the probability of defects and hence the probability of additional cost which might be due to corrective action (Ramudhin A. et al., 2008).

Manager with another view of world-class manufacturing, to implement quality cost concepts, and discusses building commitment for it. To succeed, firms should set goals and understand customer expectations, define the essential competencies needed to achieve those goals. As customers become more demanding and global competition intensifies, manufacturers feel the pressure to meet tighter quality cost targets. To effectively respond to these challenges, many manufacturers are striving to become world-class competitors. To meet the desires of the customers companies should continue their migration

towards a holistic quality cost management approaches (Jaju S. B., 2009).

Organizations should consider COQ as an integrated approach and long-term process, and focus on the cost factors in order to improve customer satisfaction (Kiani et al., 2009). The COQ had a directly impact on the overall financial goal of a company, even a small reduction in COQ may boost the profitability of a company by a significant amount.

Measuring the quality cost in a small-scale industry is very important and useful. It helps to identify the specific quality levels and ultimately improves quality (Chopra Arvind and Garg Dixit , 2011) .

Improvement efforts relate to increasing the efficiency and/or effectiveness of the processes and normally affect some corresponding quality costs. In simple terms, if the improvement reduces quality costs from 30% of turnover to 15%, the objective of controlling the performance of processes is to prevent the quality costs from rising above 15% of turnover. As a result, if a total quality cost function that integrates the cost of quality (COQ) of individual processes is properly defined, then one can claim that the overall performance of the organization can be monitored and controlled using this metric (Lari Alireza and Asllani Arben , 2013).

2. Cost of Quality(COQ) Models

The cost of poor quality as sum of all costs that would disappear, if where no quality problems (Juran , 1951).Quality is free. What costs money are all the actions that involve not doing things right the first time. Quality is measured by the cost of quality, which is the expense of nonconference the cost of doing wrong (Crosby,1979). Feigenbaum (1951) classified the costs associated with conformity along four dimensions: 1) Prevention Cost 2) Appraisal Cost 3) Internal Failure Cost 4) External Failure Cost.

Prevention cost increases, the total number of errors will decrease, thereby reducing the total error cost. Appraisal costs on the other hand, do not reduce the total number of errors. The only detect the error before the product is delivered to the customer. The improvement of quality through quality cost reduction (defect reduction, rework reduction waste elimination and machine idle time reduction) leads to productivity improvements (Harrington, 1987).

The combination of internal and external failure costs is always higher than prevention and appraisal costs, and the quality reject rate decreases with prevention and appraisal costs, and the quality reject rate decreases with increased volume output. This study suggests that only internal failure and external failure costs have a statically significant correlation with the level of quality (Carr and Ponoemon, 1994).

Quality means conformance to requirements more specifically quality cost are (Gryna, 1999).

- The costs of appraising a product for conformance to design requirements and to market specifications (e.g. Product inspection and design qualification).
- The cost due to failure to meet requirements (e.g. Redesign, Rework, Scrap and Warranty costs).
- The cost of preventing failures (e.g. Design Reviews, Vendor Qualification and Process Capabilities studies).

There are four categories uses of quality cost as mentioned below (Dale, 1999).

1. Promoting quality as a business parameter.
2. Giving rise to performance measures.
3. Providing the means of planning and controlling quality costs.
4. Acting as motivators

The use of COQ models in practice, i.e., the implementation of a quality costing system and cost of quality reporting in the companies. COQ models into five groups of generic models as mentioned below table 2.1(Schiffauerova, 2006).

Table 1 Generic COQ models and cost categories (Schiffauerova, 2006)

Generic Model	Cost /activity categories	Examples of publications describing, analyzing or developing the model
P-A-F models	prevention+ appraisal+ failure	Feigenbaum,1956; Purgslope and Dale,1995; Merino,1998; Chang et al, 1996; Sorquist,1997b; Plunkett and Dale,1998b; Tatikonda and Tatikonda,1996; Bottorff,1997; Israeli and Fisher,1991; Gupta and Campbell,1995; Burgee,1994.
Crosby’s model	Conformance + non- Conformance	Suminsky,1994; Denton and Kowalski,1998.
Opportunity or intangible cost models	Prevention + appraisal +failure + opportunity	Sandoval-Chavez and Beruvides ,1988; Modarres and Ansari ,1987
	Conformance +non-conformance + Opportunity	Carr,1992; Malchi and McGurk,2001
	Tangibles + intangibles	Juran et al, 1975.
	P-A-F (failure cost includes opportunity cost)	Heagy,1991.

Process cost Models	Conformance +non- Conformance	Ross, 1977, Marsh, 1989; Goulden and Rawlins, 1995; Crossfield and Dale,1990
ABC Models	Value-added + non-value-added	Cooper,1988; Cooper and Kaplan, 1988; Tsai, 1998; Jorgenson and Enkerlin, 1992; Dawes and Siff, 1993

The basic assumptions of the PAF (Prevention-Appraisal-Failure) model are that investment in the areas of appraisal will reduce failure costs and that further investment in prevention activities and other similar preventive measures will also reduce failure costs. They emphasized that PAF classification allowed practitioners to identify quality-related costs and expressed each category in terms of percentages of the total cost (Porter et al.,1992).Crosby’s model however, most of the time is only a different terminology describing a P-A-F model and the two costing structures are used interchangeably (Goulden and Rawlins, 1995).

Intangible costs that can be only estimated such as profits not earned because of lost customer and reduction in revenue owing to nonconformance. Chavez et al.(1998) incorporate opportunity losses into traditional P-A-F quality expenses. The use of a process cost model is suggested as a preferred method for quality for quality costing within quality management (TQM) as it recognizes the importance of process cost measurement and ownership, and presents a more integrated approach to quality than a P-A-F model (Porter and Rayner, 1992).

3. Hidden Quality Cost

Quality failures bear substantial hidden costs. Although they cannot be easily measured, they exist, they cost and they hurt. Among other things, such hidden costs include deterioration of the company’s reputation, loss of customers, project delays, increased overheads and liability payments. A company that cares about its long term performance and reputation must consider the hidden costs as if they were as tangible as the measurable costs (Rosenfeld Yehiel , 2009).

A significant portion of hidden quality costs which may be termed an “opportunity loss”. The findings indicate that the company’s total quality costs actually far exceed its current profit margin, and that the company could improve its competitive position if it focused on the elimination of these quality costs (Cheah S.J. et al. ,2011).

4. Benefits of COQ Systems

COQ has also been credited with the ability to impart many strategic benefits to the organization.

1. The information generated through the system may serve as a baseline by which improvement may be measured.
2. When viewed from a long-range perspective a COQ system can become a valuable input to the year-to-year and strategic planning

processes, providing information may be used to conduct analysis pertaining to the return on quality related and quality enhancement expenditures (Campanella, 1990; Greising, 1994).

3. Other benefits include the identification of time lags in quality pay-offs, insights to the nature of the relationship between cost categories, and the recognition of deficiencies in the organization’s quality system(Campanella,1990).
4. In essence, the COQ approach can become another weapon in the modern-day manager’s arsenal of managerial techniques and procedures.
5. A properly planned and integrated COQ measurement system should be designed such that it is readily compatible with the metrics of other continuous improvement (CI) efforts, such as benchmarking, and should contribute to organizational synergy as it facilitates the effective generation and utilization of quality-related information throughout the organization (Czuchry et al.,1995).
6. The operational and strategic benefits of a formalized COQ system are emphasized and reinforced in several quality documents and specifications, including the Malcolm Baldrige National Quality Award, MIL-Q-9858A, and the ISO 9000 quality system standards.

Quality cost collection and analysis have a number of advantages (Carson, 1986).

1. It establishes the economics of quality in the organization and can justify the implementation of a Quality Improvement Programme.
2. It promotes awareness of quality problems and provides motivation to solve them.
3. It defines major loss areas and enables targets to be set.
4. It provides an effective performance measure and control mechanism.

In short, the costs are the proof of the need for a Total Quality Management approach.

Gupta and Campbell (1995), suggest that requirements to achieving success in a COQ as mentioned below.

1. It supports the corporate strategy.
2. Fully integrated with the operational strategy.
3. Top management support and involvement
4. It treats the source of quality problems and not the symptoms.
5. It based on an accurately calculated cost of quality.

6. Tied to reward and incentive programs.
7. Long range in nature and well thought out and well planned.

The Cost of quality Audit offers a quick and simple framework to help any company to go back to basics: to cut out waste and improve performance and profitability company-wide. In short, it will show any company that it can improve quality and save money at the same time (Howard, 2001). He explains the following benefits of measuring and reducing Cost of Quality in any organization are given below.

1. Stimulate top management's interest in the financial and profit opportunities that could arise from a structured program of Quality improvement.
2. Act as an essential first step in any program of company culture, continuous improvement, business Process Re-engineering, Competitive Benchmarking or Total Quality.
3. Pin point the core business and operating areas that offer the most significant opportunities for improvement-in a way that no strictly financial audit even can.
4. Force senior management to recognise and acknowledge the crucial role that cross functional business process play.
5. Reduce waste, delays, mistakes dramatically.
6. Improve communications (both internally and with suppliers) at all levels of the organization.
7. Provide an overall index of the organization's ability and effectiveness in getting key tasks and processes performed "right first time".
8. Increase customer satisfaction levels and improve customer retention levels.
9. Help to prioritizes future improvement projects and clarify future business strategy decision right across the company.
10. Improve overall business competitiveness, foster innovation, and reduce the time taken to develop new products or services.

Measuring quality costs is an essential step for achieving competitiveness because these costs are strongly related to the company's annual revenue. One of the most important categories of quality costs is that of external failure costs. The consequences of these failures are not only related to the costs incurred through the failure in the field, but also to customer appeasement within this quality cost category, there are the claims against the warranty. The warranty costs can be significant and their reduction very important. The assessment of the warranty costs has proven to be feasible and effective (Cauchick P.A. and Pontel Miguel Silmar, 2004).

Eldridge et al. and Balubaid (2006) mentioned that, one of the most important techniques in quality management is quality costing. It is seen as a means of helping companies to reduce

manufacturing costs by identifying excessive cost and non-value adding activities. Ignoring it can make goods and services more expensive, which affect competitiveness, salaries, jobs and standard of living.

Arvaiova Maria et al. (2009) surveyed companies had implemented a quality cost system for which the main implementation reasons were to:

- Increase product/service quality
- Achieve significant cost reductions
- Prioritize improvement actions with the highest potential payoff
- Increase the company's competitiveness.

The implementation of the introduced model can benefit organizations in a number of ways, including the following (Lari Alireza and AsllaniArben,2013).

1. Identifying areas where quality cost savings are possible and reducing total quality costs.
2. Allowing unexplored or underestimated processes to become focal points for improvement opportunities.
3. Helping managers and employees understand and control processes.
4. Allowing the measurement of COQ to become more systematic and effective.
5. Improving customer service activities that will increase customer satisfaction.
6. Introducing organizations to a process-oriented business mentality (if they have not already been) that can also determine their cost accounting system.
7. Introducing the COQ as the central measure of organizational performance.

5. Issues and Difficulties for Cost of Quality system

Montgomery (1996) lists a number of reasons why many quality programs fails as follows.

1. Using COQ information as a score keeping tools rather than as a driver for continual improvements.
2. Preoccupation with perfection in determining the COQ figures.
3. Under estimation of depth and extent of commitments required to be made to prevention.

Shepherd (1998) suggests that setbacks to the success of COQ programs can be attributed to:

1. Limited correlation between the accounting or finance numbers and those reported as a result of COQ.
2. Limited (or no) involvement of finance in creating the numbers.
3. The impact of quality failure on administrative/overhead and selling costs was not well understood; Cost of quality usage.
4. The impact of process failures was often ignored, when this did not result in product

failures (e.g. down time from lack of quality maintenance).

5. No accounting for opportunity costs, such as loss of market share.
6. A lack of accounting for working capital costs, such as excess levels of inventory caused by quality problems.
7. Basing COQ on costing variances so that specific issues, such as increases in scrap rates, were often hidden by adjustments to the standard usage level.
8. One conclusion that may be drawn from these suggestions is that it is the quality of the implementation of a quality system or a COQ program rather than their mere existence that impacts operations. The degree of quality of the implementation affects the results that the COQ program can help the organization achieve.

Viger and Anandranjan (1999) found only possible by decreasing the costs required to achieve quality, and the reduction of these costs is only possible if they are recognized and measured and therefore, measuring and reporting the cost of quality (COQ) should be

considered a vital issue for managers. Roden and Dale (2001) examined the issues and difficulties of developing a quality costing system in a small engineering company as mentioned below.

1. Most of the difficulties encountered were addresses with the involvement of senior management, which should make any make any subsequent cost collections easier. This demonstrates the need for management commitment in any attempts to identify and measure elements of quality cost.
2. In comparison to the amount of cost incurred in internal and external failure, there is a low level of investment by the company in prevention activity, characterized by a lack of resources in the departments most closely related to prevention activities.
3. In many areas, a lack of accountability and responsibility was apparent, in particular, the lack of cost visibility, and this is a major stumbling block to the collection of quality cost data.
4. The culture of the firm is not particularly open and such is not conducive to an investigation as widespread and searching as quality costing.
5. The lack of information and accountability makes for operators and staff to cover up errors and also makes it difficult to collect cost data. It was found that some items of scrap are undeclared.

Sower (2007) addressed, why companies do not track cost of quality as mentioned below.

1. Lack of management support or absence of management interest in tracking such costs. management philosophy and company culture not supportive of quality costing. The

management belief that there is no value in any efforts to fully measure costs of quality.

2. The company being a start-up company, a growing company with business practice behind the times, a lean company with little overhead, company is too small, and downsizing.
3. Not knowing what elements to include in the cost of quality, lack of knowledge of quality principles from upper management on down throughout the organization, and lack of experienced manpower to accomplish the task.
4. Lack of adequate accounting and computer systems necessary to track cost of quality. Explanations in this regard dealt with a lack of tools to collect, organize, filter and the accounting system and resources being not adequate to perform standard COQ calculations common in the industry.
5. Organizations did not see the benefit of COQ, or that they needed to focus on areas which they perceive to be more important.

A major difficulty encountered during the setting up of the cost of quality system is (Arvaiova Maria et al., 2009);

1. Identify new quality improvement opportunities
2. Lack of top management support
3. Cooperation with other departments
4. Identification of quality related activities
5. Data collection and analysis are surprisingly not rated

6. Findings

1. The objective of the Quality Cost system is to identify areas where quality improvements can be achieved.
2. P-A-F model is a widely used model because it is applicable in most of the companies where the required systems for data collection are more or less available.
3. The main difficulties in developing the quality costing system relate to: a blame culture: a lack of visibility of how people, in particular inspectors, spend their time; and structure of the accounting system.
4. The company should develop a proper quality cost reduction programme. It is important than we should focus on how to achieve the cost-efficient quality and come to an acceptable quality level. We should treat the quality cost system as a worthy investment project and profit from it.
5. Poor-quality cost by itself cannot resolve your quality problems or optimize your quality system. It is only a tool that helps management understand the magnitude of the quality problem, pinpoints opportunities for improvement, and measures the progress being made by the improvement activities. The PQC system must be accompanied by an

effective improvement process that will reduce the errors.

6. Introducing the COQ as the central measure of organizational performance.
7. Indirect poor quality costs include the intangible costs of customer dissatisfaction, loss of reputation, and resultant loss of sales.
8. Quality Management supports to Cost of Quality
9. Ignoring COQ can make goods and services more expensive, which affect competitiveness, salaries, jobs and standard of living.
10. Quality costing system has the potential to become an excellent tool in the overall management of a business.
11. Organizations should consider COQ as an integrated approach and long-term process, and focus.
12. Most researchers agree that the magnitude of the hidden quality costs is just too big to be ignored on the cost factors in order to improve customer satisfaction
13. Systematic application of Six Sigma DMAIC tools and methodology within an automobile parts production results with several achievements. One of them is reduced COQ .

By considering point 12, above mentioned the next section 2.3, covered a detailed literature on Six Sigma and Lean Six Sigma.

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