Cost of quality usage and its relationship to quality system maturity

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Abstract

Purpose – The purposes of this study are to examine the relationship between the distribution of quality costs and the level of maturity of an organization's quality system, to assess the extent to which effective COQ systems and maturing quality systems affect organization performance, and to determine why some organizations do not utilize COQ systems.

Design/methodology/approach – A survey instrument was developed to determine the distribution of total quality cost among the four ASQ categories. The instrument also assesses the maturity of the organization's quality system using the ANSI/ISO/ASQ Q9004-2000 performance maturity level classification system. Correlation analysis was used to examine the relationships between quality costs and quality system maturity.

Findings – External failure costs were found to decline as a percentage of total cost of quality (COQ) as an organization's quality system matures. Total COQ was found to increase as an organization moved from a very low level of quality system maturity to a higher level. Sales and profit growth were not significantly correlated with the presence of a quality cost system or with the level of maturity of the quality system. Lack of management support was found to be the most common reason why organizations do not systematically track quality costs.

Research limitations/implications – Additional research is needed to determine the relationship between the presence of a COQ system and its effective integration with the quality system and organizational outcomes. Future research is needed to expand the study beyond the boundaries of the USA. Future research involving longitudinal studies would be beneficial in more accurately assessing the nature of the changes in COQ distribution over time.

Practical implications – The findings of this study suggest that organizations planning to implement a COQ system should ensure that management supports the program and is prepared for a short-term increase in total COQ. These findings also support the often-suggested expectation that in the long run the COQ system will lead to a significant reduction in external failure costs.

Originality/value – Systematic measurement of COQ is underutilized in practice. This study systematically examines why this is the case. In addition the study provides information that can be useful in justifying implementation of COQ measurement systems.

Keywords Accounting, Quality costs, Quality management, Surveys, United States of America

Paper type Research paper

Background

ANSI/ISO/ASQ Q9004-2000 (American Society for Quality, 2000, p. 6) suggests financial measurement as an appropriate way to assess "the organization's performance in order to determine whether planned objectives have been achieved". Reporting quality system activities and effectiveness in financial terms is an increasingly important approach to linking continual improvement of the quality system to performance improvement of the organization and is a keystone of the Six Sigma approach to quality. 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.

Allusions to quality costs first appeared in the 1930s in the work of Shewhart (1931) and to a lesser extent Miner (1933) and Crocket (1935) (Giakatis *et al.*, 2001). Formalization of the concept of cost of quality developed out of the work of Joseph Juran (1951), Armand Feigenbaum (1957), and Harold Freeman (1960). The American Society for Quality's (ASQ) Quality Cost Committee, established in 1961, worked to formalize the concept and to promote its use (Bottorff, 1997). Crosby's (1979) publication of *Quality is Free* provided probably the biggest boost to popularizing the COQ concept beyond the quality profession (Beecroft, 2001).

ASQ recognizes four categories of quality costs:

(1) prevention;

(2) appraisal;

(3) internal failure; and

(4) external failure (Bemowski, 1992).

These categories have been well accepted within the quality and accounting professions (Atkinson *et al.*, 1991; Riahi-Belkaoui, 1993; Jeffery, 2003/2004), and have been included in international standards such as BS 6143 (Dale and Plunkett, 1999). However, in many companies quality costs are not calculated explicitly but are simply absorbed into other overheads (Shepherd, 2001).

Viger and Anandarajan (1999) found that only about half of the companies they surveyed calculated quality costs. Gupta and Campbell (1995) cite two surveys that found only 33-40 percent of companies tracked quality costs. When quality costs are not visible, managers are unable to use this quality information in their decision-making processes. In their experimental study, Viger and Anandarajan (1999) showed that managers who have access to quality cost data make different decisions than managers who do not have quality cost data available.

While there is agreement that quality is a critical success factor for competitiveness in the business world (Tatikonda and Tatikonda, 1996), many companies are finding that their existing approaches to improving quality are ineffective. Two surveys reported by Schaffer and Thomson (1992) indicated that the majority of the quality systems in place failed to deliver real improvements or have a significant impact on improving competitiveness. Chase (1998) reports that many COQ programs are ineffective because they consist of little more than a vague estimate of the amount of scrap produced in the short term. One conclusion that can be drawn is that the mere

existence of a quality system or a COQ program is not evidence of their impact on operations.

COQ programs by themselves do not improve quality. They provide input and feedback to quality systems which are responsible for quality improvements. This leads to the conclusion that while the accuracy of a COQ system can be evaluated on a stand-alone basis, the effectiveness of that program is inextricably linked to how well the quality management system uses the COQ information in improving quality. Evaluation of the effectiveness of a quality system and a COQ program should be measured in terms of the improvements that result from their implementation and use.

Conceptually, as an organization's quality program matures, changes should occur in the distribution of costs across the four categories. Immature programs are envisioned as spending relatively more on appraisal and failure costs, while mature programs would spend relatively more on prevention costs (Evans and Lindsay, 1996; Sower *et al.*, 1999). Much of the empirical information that exists relating to the relationship between quality cost distribution and quality system maturity comes from one-shot case studies (Youde, 1992).

The purposes of this study are:

- to examine the relationship between the distribution of quality costs and the level of maturity of an organization's quality system;
- to assess the extent to which effective COQ systems and maturing quality systems affect organization performance; and
- to determine why some organizations do not utilize COQ systems.

This study utilizes the ISO 9000/2000 system for classification of the maturity of a quality system and the ASQ classification of quality costs. A survey instrument was developed to assess both quality system maturity and distribution of quality costs among the four categories. The approximately 3,200 subjects invited to participate in this study were randomly selected from the over 22,000 members of the Quality Management Division (QMD) of ASQ.

Quality costs – definitions and typologies

According to quality expert Philip Crosby (1979), quality is free. What costs money is all the actions that involve not doing things right the first time. According to Crosby, quality is measured by the cost of quality, which is the expense of non-conformance – the cost of doing things wrong. Joseph Juran's (1951) concept of the cost of poor quality as "the sum of all costs that would disappear if there were no quality problems" is similar to Crosby's.

The most commonly accepted typology divides quality costs into prevention, appraisal, internal failure, and external failure costs. This typology is often referred to as the PAF (prevention, appraisal, and failure) and is one of "the most commonly used general cost of quality model in the United States (Campanella, 1990), Great Britain (BSI 6143-2, 1990; BSI 6143-1, 1992), and based on the frequency of reference in the literature, world-wide (Plunkett & Dale, 1986)" (Jeffery, 2003/2004). The PAF model traces back to the work of Feigenbaum (1956). Campanella (1990) defines these costs as follows:

- *prevention costs* are "the costs of all activities specifically designed to prevent poor quality in products and services" (p. 22);

- *appraisal costs* are "the costs associated with measuring, evaluating, or auditing products or services to assure conformance to quality standards and performance requirements" (p. 23);

- *internal failure* costs are "the costs resulting from products or services not conforming to requirements or customer/user needs (which) occur prior to delivery or shipment [. . .] to the customer" (p. 23); and

- *external failure* costs are "the costs resulting from products or services not conforming to requirements or customer/user needs (which) occur after delivery or shipment of the product, and during or after furnishing of a service to the customer" (p. 23).

Quality system maturity typologies

Montgomery (1996) proposes a model for the evolution of a quality system. His model defines the maturity of a quality system based upon the predominant tools used. An immature quality system makes extensive use of acceptance sampling or end-of-line inspection. As the quality system matures, acceptance sampling is displaced by process control. In a mature quality system the primary tools used are design of experiments and process control. Montgomery relates this evolution to the systematic reduction in process variation.

In 1994, Executive Improvement Solutions announced formation of the Quality System Maturity Consortium (QSMC) to develop a maturity model defining quality system maturity (*Quality Progress*, 1995). Currently, the most widely accepted maturity model is the one in the ANSI/ISO/ASQ Q9004-2000 standard (American Society for Quality, 2000, p. 48). The ISO Q9004-2000 standard provides a formal framework for classification of quality systems based on performance maturity levels. These levels are shown in Table I. The document also provides guidance for assessing the

Maturity level	Performance level	Guidance
1	No formal approach	No systematic approach evident, no results, poor results or unpredictable results
2	Reactive approach	Problem- or corrective-based systematic approach; minimum data or improvement results available
3	Stable formal system approach	Systematic process-based approach, early stage of systematic improvements; data available on conformance to objectives and existence of improvement trends
4	Continual improvement emphasized	Improvement process in use; good results and sustained improvement trends
5	Best-in-class performance	Strongly integrated improvement process; best-in-class benchmarked results demonstrated

Source: American Society for Quality (2000, p. A8)

Table I.
ANSI/ISO/ASQ
Q9004-2000 performance
maturity levels

performance maturity level. This is the model used to classify the quality systems of participants in this study.

Criticisms of COQ systems

Montgomery (1996) suggests that the principle purpose of a cost of quality (COQ) system is cost reduction through identification of improvement opportunities. A number of companies testify to the effectiveness of COQ systems in reducing costs. Xerox, for example, claimed savings of $53 million in the first year of its COQ program (Carr, 1995).

However, Montgomery (1996) also lists a number of reasons why many quality cost programs fail:

(1) using COQ information as a scorekeeping tool rather than as a driver for continual improvement;

(2) preoccupation with perfection in determining the COQ figures; and

(3) underestimation of the depth and extent of commitment required to be made to prevention.

Shepherd (1998) suggests that one of the setbacks to the application of COQ has been that costs of failure are often based on costing variances which hide specific issues such as increases in scrap rates by the standard being adjusted to allow for a greater usage level.

Johnson (1995, p. 87) found a number of quality practitioners who viewed COQ systems as "administrative nightmares and as impediments to quality rather than as contributors to quality". Based on interviews with quality professionals, he attributes many COQ system failures "to poor management planning, implementation, and follow-up" rather than to flaws in the COQ concept itself.

Merino (1990), while finding no fault with the COQ concept, identifies difficulties in its application. One problem he cites is inadequate cost accounting methods, which are unable to deal effectively with an ever changing, highly automated manufacturing environment. He suggests that one reason that prevention costs are usually the smallest category of COQ is because outdated accounting systems are unable to provide management with the ability to evaluate the profit results from prevention activities such as planning, designing and communicating.

Dale and Plunkett (1999) point out the difficulties of applying COQ methodology outside of manufacturing. It is easier to understand scrap and waste in tangible manufactured goods, but less easy to understand wastage in service processes, which produce an intangible output.

Relationship between quality system maturity and quality cost distribution

The importance of tracking quality costs is accepted within the quality and accounting disciplines (Chase, 1998; Wheldon and Ross, 1998, Viger and Anandarajan, 1999). Conceptually, the correlation between the maturity of a quality system and the redistribution of quality costs is well established. Some research has been conducted to determine the actual effectiveness of COQ systems and the degree to which the redistribution of costs of quality follows the conceptual model. Among the leading studies in this area is an exploratory investigation performed by Ittner (1996). In his

study of 49 plants within 21 companies he found that increases in expenditures for prevention and appraisal costs were associated with reductions in failure costs in subsequent periods. However he also found that *reductions* in prevention and appraisal costs were also associated with reductions in failure costs – "a finding that is inconsistent with the traditional quality cost model" (p. 126). Ittner also found evidence for reduced failure costs as a percentage of sales over the lives of the plants' quality programs.

Quality experts (Crosby, 1979; Evans and Lindsay, 1996; Montgomery, 1996; Mitra, 1998; Sower *et al.*, 1999; Yasin *et al.*, 1999; Beecroft, 2001) have suggested that the distribution of quality costs among these four categories changes as the quality system matures. An immature quality system would be expected to have high total costs of quality (COQ) with most of the expense occurring in the external and internal failure categories. As the system matures, more of the expense occurs in the appraisal and internal failure categories while the external failure costs decline. In a fully mature quality system, the largest category of expenditure is prevention costs.

Older conceptual models show that there is an optimal level of quality that is below 100 percent conformance. At this optimal point total quality costs are minimized. The modern conceptual model (Juran and Gryna, 1993; Shank and Govindarajan, 1994; Yasin *et al.*, 1999) rejects the idea of an "optimal point" below zero defects and suggests that increased prevention expenditures on technologies such as factory automation make 100 percent conformance economically feasible. As Deming (Walton, 1986) has said, zero defects (or 100 percent conformance) is a misguided goal without a method. The method behind the modern conceptual model is the increased investment in prevention and appraisal activities that improve the process and in turn drive failure costs toward zero.

Another form of total cost model relates the distribution of quality costs to the maturity of the quality system (method) over time, as shown in Table II. The modern conceptual model and Table II are not in conflict, but are simply different representations of the same process. According to the model in Table II, failure costs dominate in relatively immature quality systems, but appraisal costs may be significant because of efforts to reduce external failure costs. As the quality system matures, more money is invested in prevention and appraisal activities. Because of lead times, total costs increase briefly before declining as the prevention efforts bear fruit. The necessity for increased investment in prevention activities in order to reduce internal and external failure costs has been documented by several authors (Liebert, 1976; Blank and Solorzano, 1978; Campanella and Corcoran, 1983; Godfrey and Pasewark, 1988). In mature quality systems, prevention and appraisal costs are larger relative to failure costs but overall quality cost declines.

| | Maturity level | | | | |
	1	2	3	4	5
Prevention	0-very low	Low	Moderate	High	High
Appraisal	Low	Low-moderate	Moderate	Low-moderate	Low
Internal failure	High	Very high	Moderate-high	Low-moderate	Very low
External failure	High	High	Moderate	Low	Very low
Total COQ	High	Very high	Moderate-high	Low-moderate	Low

Table II.
Conceptual model of relative COQ expenditures versus quality system maturity level

This project addresses the following research questions:

Research Question 1: Does the distribution of quality costs change in a systematic way as an organization's quality system matures?

The conceptual model in Table II and the work of other researchers (e.g. Liebert, 1976; Blank and Solorzano, 1978; Campanella and Corcoran, 1983; Godfrey and Pasewark, 1988; Ittner, 1996) suggest that in immature quality systems failure costs predominate. As the quality system matures, the proportion of total quality cost spent on prevention activities increases with a corresponding decrease in failure costs.

Research Question 2: Does the total cost of quality change in a systematic way as an organization's quality system matures?

The modern conceptual model predicts that total quality costs decrease as the quality system matures. The conceptual model in Table II predicts that total quality cost first increases as the organization moves from ANSI/ISO/ASQ Q9004 quality system performance maturity scale (QSPMS) level 1 to level 2, and then generally decreases as the quality system matures beyond level 2. Some evidence to support this position derives from the study by Carr (1995), which found that effective use of a COQ system reduces total quality cost.

Research Question 3: Are sales and profit growth higher in organizations with quality cost systems and maturing quality systems?

Some research (Schaffer and Thomson, 1992) suggests that the majority of the quality systems in place fail to deliver real improvements or have a significant impact on improving competitiveness. The modern conceptual model predicts that total quality costs decrease as the quality system matures. Reduced costs may lead to increased profits or an ability to capture additional market share if the savings are passed to consumers in the form of reduced prices.

Research Question 4: Are there common reasons why some companies do not track the cost of quality?

A number of researchers (Johnson, 1995; Pursglove and Dale, 1996; Wheldon and Ross, 1998; Williams *et al.*, 1999) have documented relatively low rates of adoption of COQ programs. Lack of knowledge, inadequate tracking systems, and lack of management support are suggested by these studies as the predominate reasons for the underutilization of COQ systems.

Methodology
Survey methodology was utilized for data collection. Surveys provide the ability to address a wider scope than case studies and are frequently used in studies of quality costs (Kumar *et al.*, 1998). A survey instrument was developed to determine the distribution of total quality cost among the four ASQ categories. Campanella's (1990) definitions of the four categories were provided as prompts for the respondents. The survey instrument used in this study was designed to elicit factual information rather than opinions so the prompts are important to define specifically what is being asked. The instrument also assesses the maturity of the organization's quality system using the ANSI/ISO/ASQ Q9004-2000 (American Society for Quality, 2000, p. 48) performance maturity level classification system. The ANSI/ISO/ASQ

Q9004-2000 performance maturity level guidance was provided as a prompt for the respondents to assess their performance maturity level. The survey instrument was pilot-tested using members of a local chapter of the American Production and Inventory Control Society (APICS) as subjects. Preliminary assessment of instrument validity was accomplished using the pilot test data, and the instrument was refined as necessary.

The population of interest is quality and accounting professionals working in manufacturing organizations based in the USA. The Quality Management Division (QMD) of ASQ agreed to co-sponsor the project by providing access to its membership list of over 22,000 quality professionals. The refined survey instrument was used to collect data from a sample of the quality and cost accounting professionals randomly selected from the membership list.

Approximately 3,200 randomly selected members of the QMD of ASQ were contacted in three waves by e-mail to request their participation in this project. Due to incorrect e-mail addresses 2,507 actual contacts were made. Subjects were asked if they systematically tracked quality costs. Those who responded no were asked for the reasons why they do not track COQ. Those who responded yes were asked if they would agree to complete a questionnaire which would be mailed to them. Within two weeks of the initial e-mail contact, survey instruments were mailed to the subjects. Two weeks after the initial mailing, all subjects were contacted again by e-mail to remind them to complete and return the survey. A total of 393 usable responses was obtained, for a 15.7 percent response rate. The response rate of 15.7 percent is typical for studies of this type (Mabert *et al.*, 2000, Dusharme, 2001). The respondents represent at least 29 states (13 respondents could not be identified by state) and at least 40 industries (three respondents did not list industry type).

Only 34 percent of the 393 responding organizations reported that they systematically track quality costs. This is at the low end of the range of 33-59 percent reported by some other studies (Viger and Anandarajan, 1999; Gupta and Campbell, 1995; Duncalf and Dale, 1985) and somewhat above the range of the five of 22 (23 percent) of the 1991 Malcolm Baldridge National Quality Award finalists who measure COQ (Baatz, 1992). The relatively small percentage tracking COQ is surprising given the wide publicity given to notable companies such as Xerox (Carr, 1995), Westinghouse, and Motorola (Gupta and Campbell, 1995) which have employed COQ programs so successfully.

Of the 393 usable responses, 245 stated that they do not track quality costs in a systematic way. Of these, 129 provided an explanation of why they do not track COQ. The remaining 148 respondents indicated that they did track quality costs and were sent a follow-up questionnaire by mail. Of the mail survey respondents, 14 organizations now reported that they do not track quality costs in the systematic way explained on the survey form. Mail responses were obtained from 52 companies which track COQ.

Two responses were requested from each participating organization – one from a manager in the quality/operations area, and one from a manager in the accounting area. Inter-rater reliability was determined to assess the reliability of the self-reported information.

Reliability of self-reported data
Survey respondents self-reported whether or not their organizations have a quality system and a COQ program, the maturity level of their quality system, and the distribution of quality costs over time. The reliability of self-reported information is a cause for concern. In this study, we requested two independent responses from each organization: one from quality/operations and one from finance/accounting. A total of 33 paired responses was received, of which 32 could be used for this analysis. Correlation analysis was used to assess the inter-rater reliability of the responses.

Inter-rater reliability "is the extent to which two or more raters independently provide similar ratings" on given measures (Saal *et al.*, 1980). Common approaches to assessing inter-rater reliability involve the use of analysis of variance (ANOVA) or procedures based on correlation analysis (Coleman *et al.*, 2002).

Spearman's rank correlation coefficient (ρ) was calculated to assess the inter-rater reliability of the self-reported level of quality system maturity since the maturity levels are ordinal data. The correlation coefficient obtained was $\rho = 0.508$ which is significant at the 0.003 level (two-tailed test, $n = 32$). The magnitude, direction, and level of significance of ρ provide evidence for reasonable inter-rater reliability. This provides confidence in the reliability of the self-reported level of quality system maturity. Based upon this evidence, the self-reported quality system maturity data from organizations with a single response were included in the further analysis.

Pearson's correlation coefficient (r) was calculated to assess the inter-rater reliability of the self-reported distribution of quality costs since these are ratio data. Thirteen of the 33 paired responses provided cost of quality distribution data. Table III shows the correlation matrix obtained. The magnitude, direction, and level of significance of Pearson's r for all four categories of quality costs indicate a high level of inter-rater reliability. This provides confidence in the reliability of the self-reported quality cost distribution data. Based upon this evidence, the self-reported quality cost distribution data from organizations with a single response were included in the further analysis.

Results
Changes in the distribution of quality costs
Research Question 1 examined whether the distribution of quality costs changes in a systematic way as an organization's quality system matures. Respondents reported the distribution of quality costs among the four categories as a percentage of total COQ. Because the quality system maturity data are ordinal, Spearman's rank correlation coefficient (ρ) was used to assess whether a relationship exists between the organizations' level of quality system maturity and their distribution of quality costs.

	Prevention-QA	Appraisal-QA	Internal failure- QA	External failure-QA
Prevention-Ac	0.970			
Appraisal-Ac		0.983		
Internal failure-Ac			0.946	
External failure-Ac				0.975

Notes: All values are significant at the < 0.01 level; QA, respondents in quality assurance/operations; Ac, respondents working in finance/accounting

Table III.
Accounting versus quality correlation matrix for quality cost distribution and QSPMS

The correlation matrix is shown in Table IV. The correlations between appraisal cost and external failure cost ($p < 0.01$); between prevention cost and internal failure cost ($p < 0.05$); and prevention cost and external failure cost ($p < 0.05$) were significant. The negative correlation coefficients are indications that external failure costs decline as appraisal costs increase, and internal and external failure costs decline as prevention costs increase. Only the correlation between quality system maturity (QSPMS) and external failure cost was significant ($p < 0.05$). The negative correlation coefficient indicates that external failure costs decline as the quality system increases in maturity level. This is consistent with the expectations underlying the PAF cost of quality framework.

Respondents were asked to provide COQ distribution data for the year prior to their implementing a quality system and for the most recent two years by indicating the percentage of quality expenditures in each category as a percentage of the total cost of quality (COQ). The median time since the implementation of the quality system is five years. The distributions of quality costs from the year prior to implementation and the most recent year were significantly different (see Table V). Paired t-tests showed that the differences in the mean percentage spent on prevention and external failure were significant at $p < 0.001$ ($n = 21$) and $p < 0.003$ ($n = 20$), respectively. The mean percentages spent on appraisal and internal failure were not significantly different. This implies that increases in the percentage of total COQ spent on prevention activities manifest as decreases in the proportion spent on external failure. The changes in these two categories of quality costs are consistent with the conceptual

	Prevention (percent)	Appraisal (percent)	Internal failure (percent)	External failure (percent)	QSPMS
Prevention (percent)	1.000				
Appraisal (percent)	0.095	1.000			
Internal failure (percent)	−0.341[*]	−0.083	1.000		
External failure (percent)	−0.345[*]	−0.447[**]	−0.133	1.000	
QSPMS	0.214	0.211	−0.044	−0.369[*]	1.000

Notes: [*]Significant at the $p < 0.05$ level ($n = 49$); [**]significant at the $p < 0.01$ level ($n = 49$); QSPMS is the variable name for the quality system maturity using the ISO 9004 rating system in Table I

Table IV.
Quality cost distribution versus quality system maturity (QSPMS) correlation matrix

	Prevention[b]	Appraisal	Internal failure	External failure[c]
Current year				
Mean	27.0	22.4	25.8	25.1
SD	16.3	12.6	14.6	16.2
Pre quality system				
Mean	9.6	22.7	30.4	39.2
SD	9.9	15.6	15.5	24.4

Notes: [a]Percentages may not sum to 100 percent due to rounding; [b]means are significantly different at the $p < 0.003$ level ($n = 20$); [c]means are significantly different at the $p < 0.001$ level ($n = 21$)

Table V.
Quality cost distribution pre-quality system versus current year as a percentage of total COQ[a]

model in Table II. The fact that appraisal and internal failure costs did not change significantly is not consistent with the conceptual model. That model predicts that both will decrease.

Forty-one of the organizations with a COQ system reported that the maturity of their quality system had changed over the past five years. All changes were to a more mature quality system. Nine respondents reported no change in quality system maturity over the past five years and one respondent omitted this item.

There is some evidence from this study that supports the premise that an organization's quality cost distribution will systematically change as the organization's quality system matures. There is evidence that external failure costs decrease as a percentage of total quality cost as the organization's quality system matures. There is also support for the premise that external failure costs decline with increased appraisal costs and that both internal and external failure costs decrease with increases in prevention costs.

Changes in the total cost of quality
Research Question 2 examined whether the total cost of quality changes in a systematic way as an organization's quality system matures. Respondents were asked how the current year's total cost of quality compared to last year's total cost of quality. Forty-six of the 51 respondents providing complete information reported a change in total cost of quality over the two-year period (see Figure 1). The ten organizations reporting higher total COQ this year versus last year all moved from a quality system of maturity level 1 or 2 to a higher level of maturity within the previous five years. This is consistent with the model in Table II which predicts a short-term increase in total quality costs as a quality system moves from a low level of maturity (level 1 or 2) to a moderate or high level of maturity (i.e. level 3, 4, or 5).

Spearman's rank correlation coefficient (ρ) was used to assess whether a relationship exists changes in the organizations' total cost of quality and a number of organizational variables. The correlation matrix is shown in Table VI. The maturity level of an organization's quality system (variable name: QSPMS) was significantly ($p < 0.10$) correlated with whether the organization tracks quality costs in a systematic way (variable name: TRACKS). Organizations with higher levels of quality system maturity are more likely to track COQ. There is also a significant ($p < 0.05$) correlation between the maturity level of the quality system (variable name: QSPMS) and an organization's size as measured by number of employees (variable name: EMPLOY). This indicates that larger firms tend to have more mature quality systems.
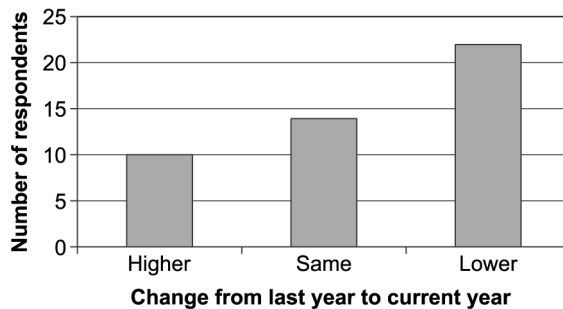

Figure 1.
Two-year change in total COQ

	TRACKS	EMPLOY	SALES	PROFIT	Q_SYS	YEARS	QSPMS	TCOQ_CHG
TRACKS ($n = 97$)	1.00							
EMPLOY ($n = 97$)	0.001	1.00						
SALES ($n = 94$)	−0.061	0.099	1.00					
PROFIT ($n = 94$)	−0.044	0.0193 ***	0.0689 *	1.00				
Q_SYS ($n = 97$)	−0.017	0.006	0.0130	−0.010	1.00			
YEARS ($n = 94$)	−0.118	0.112	−0.150	−0.035	0.034	1.00		
QSPMS ($n = 95$)	0.186 ***	0.247 **	−0.118	0.184 ***	−0.119	0.110	1.00	
TQOC_CHG ($n = 48$)	0.176 ***	−0.102	0.187	−0.008	−0.030	−0.229	−0.253 ***	1.00

Notes : *Significant at $p < 0.01$ level; **significant at $p < 0.05$ level; ***significant at $p < 0.10$ level. Variable names/descriptions: TRACKS, Does organization track quality costs in systematic way? EMPLOY, Number of employees in organization. SALES, Annual sales for organization. PROFIT, Annual profit for organization. Q_SYS, Type of quality system. YEARS, Number of years since implementation of COQ system. QSPMS, Quality system maturity using the ISO 9004 rating system in Table I. TQOC_CHG, Change in total cost of quality this year over last year

Table VI.
Changes in total cost of
quality versus
organization variables
correlation matrix

The maturity level of the quality system (variable name: QSPMS) was also significantly ($p < 0.10$) correlated with the change in profitability of the organization (variable name: PROFIT). Organizations with higher quality system maturity levels tend to report profits are increasing. The maturity level of the quality system (variable name: QSPMS) was negatively correlated ($p < 0.10$) with changes in total cost of quality (variable name: TCOQ_CHG). Organizations with more mature quality systems tend to report decreases in total cost of quality from last year to this year.

The absence of a significant correlation between the maturity level of the quality system (variable name: QSPMS) and the number of years since implementation of the COQ systems suggests that system maturity is related to factors other than the passage of time. This is consistent with both Montgomery (1996) and the ANSI/ISO/ASQ Q90004-2000 standard, which both relate quality system maturity to the predominant tools used rather than to length of use.

Changes in sales and profits

Research Question 3 examined whether sales and profit growth are higher in organizations with quality cost systems and maturing quality systems. The data in Table VI provide no support for the premise that higher growth rates in sales and/or profits are associated with the maturity level of an organization's quality system or whether or not the organization tracks quality costs. These findings lend support to the conclusions of Schaffer and Thomson (1992) that the majority of the quality systems in place fail to deliver real improvements or have a significant impact on improving competitiveness.

Many companies that have COQ systems in place may find that they are not living up to expectations. Chase (1998) reports that many COQ programs are often ineffective because they consist of little more than a vague estimate of the amount of scrap produced in the short term. Gupta and Campbell (1995) suggest that achieving success in a COQ program requires that the COQ program:

- supports the corporate strategy;
- is fully integrated with the operational strategy;
- has top management support and involvement;
- treats the source of quality problems and not the symptoms;
- is based on an accurately calculated cost of quality;
- is tied to reward and incentive programs;
- is long range in nature; and
- is well thought out and well planned.

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

- limited correlation between the accounting/finance numbers and those reported as a result of COQ;
- limited (or no) involvement of finance in creating the numbers;
- the impact of quality failure on administrative/overhead and selling costs was not well understood;

- 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);
- no accounting for opportunity costs, such as loss of market share;
- a lack of accounting for working capital costs, such as excess levels of inventory caused by quality problems; and
- 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.

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.

Why companies do not track cost of quality
Research Question 4 addressed whether there are common reasons why many companies do not track the cost of quality. One hundred and ninety-six respondents who did not track quality costs and for whom we had an e-mail address were contacted and asked to respond to an open-ended question as to why their organization did not track such costs. One hundred and twenty-nine individual responses (65.8 percent response rate) were obtained that cited reasons why no tracking occurred. In some cases respondents identified a single reason while in other cases they indicated a number of such reasons. The specific reasons were examined to determine whether they exhibited some type of commonality or pattern as to the nature of "why" the costs of quality were not tracked.

- The most frequent reason given for not tracking cost of quality (32 responses) was a lack of management support or absence of management interest in tracking such costs. Specific explanations concerning this lack of support included lack of concern for how much and in what way quality does pay, management philosophy and company culture not supportive of quality costing, quality costing being "paperwork" that management does not perceive to have enough value, and management belief that there is no value in any efforts to fully measure costs of quality.
- The second most common response (27 responses) indicated that company economic conditions or status contributed to the lack of cost of quality tracking. The most often cited conditions were 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.
- Lack of knowledge of "how" to track the cost of quality and of the benefits of a COQ program was a common reason cited for not tracking (26 responses). Explanations included 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.
- Another common reason given (24 responses) was the 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 report quality costs, no accounting mechanism provided in financial reporting system to track quality costs, and the accounting system and resources being not adequate to perform standard COQ calculations common in the industry.

- Eighteen respondents indicated that their organizations did not see the benefit of COQ or that they needed to focus on areas which they perceive to be more important.

Although this analysis of the responses does not provide measures of statistical significance, the reasons cited generally agree with previous suggestions and findings from both the quality and the accounting literature. For example, Pursglove and Dale (1996) cite the following as reasons for not tracking the cost of quality:

- a lack of understanding of the concept and principles of quality costing amongst the management team;
- an acute lack of information and data; and
- the profitable nature of the business.

From the accounting perspective, Wheldon and Ross (1998) suggest that tracking the cost of quality has not been widely developed (in Australia) because:

- quality reporting was seen to be the realm of the quality manager, who focuses on non-financial measures of quality;
- quality managers generally lack accounting knowledge;
- the concept of cost of quality has only been introduced in relatively recent times into the accounting discipline; and
- changes to accounting systems will always tend to lag behind technical innovations such as quality management.

Williams *et al.* (1999, p. 455), in a management review of quality costing, conclude that "it is clear that the existing accounting systems are the main limitations on more extensive application and use of cost of quality".

The reasons cited in this study and other studies (Johnson, 1995) appear to suggest that a lack of management support, the absence of adequate tracking systems, a lack of knowledge of how to track COQ, a perceived lack of value, and the economic and life-cycle status of the company all contribute to the absence of efforts to track the cost of quality.

Conclusion
This study provides some evidence that COQ tracking is not as widespread as some would believe. Insight was also developed into some of the reasons why companies are reluctant to track COQ. The study also provides some insight into how the distribution of quality costs changes when a quality system is implemented.

Among the conclusions that may be drawn from these findings are:

- As a company's quality system matures, external failure costs decrease as a percentage of total COQ concurrent with increases in internal failure and appraisal costs.

- As a company's quality system matures, the proportion of total quality cost spent on prevention activities increases while the costs of external failure decrease.
- Total COQ decreases over time for companies with quality systems and which track COQ, but the magnitude of the decrease diminishes the longer the quality system has been in place.
- No support was found for increases in sales or profits associated with the maturity level of the quality system and whether or not quality costs were tracked.
- There are other factors not addressed in this study which may be organization-specific which affect the relationship between the distribution of quality costs and quality system maturity. Additional research is needed in this area.
- Somewhat fewer organizations than expected systematically track quality costs.

Only 34 percent of the survey respondents systematically track quality costs. While this is somewhat low, it is in line with other studies which report as high as 40 percent adoption of COQ systems. The most frequently cited reasons for not tracking quality costs were lack of management support and inadequate information systems. Whether the portion of this sample that did not track the costs of quality is representative of all organizations in which that effort might be possible is a matter for further examination. Whether the various reasons reported in this study and the underlying nature of those reasons are representative of all organizations in which the costs of quality is a potentially important issue is also a matter for further research. Given that these reasons came from individuals in the quality areas of their organizations, the question of whether individuals from management, accounting, operations, or other areas would provide different reasons is also a matter for further investigation. This study provides some evidence that quality and accounting responses are reasonably correlated, but do not address the other areas of the business.

Enterprise resource planning (ERP) systems and activity based costing (ABC) systems provide companies with the information systems to easily track COQ. The influence of the implementation of these systems on management's willingness to implement COQ tracking is also a topic for future research.

"Results to be obtained from the establishment of a cost of quality program will be proportionate to the effort and care with which the program is thought out, set up, and implemented, including top management involvement" (Demetriou, 1982, p. 587). Perhaps this quotation provides some insight into why the study did not find more dramatic relationships between changes in the distribution of quality costs and maturity level of the quality system. Additional longitudinal studies are needed to examine this complex relationship. The relationships found in this study are consistent with expectations for the use of COQ systems – the quality cost distribution does change after organizations implement a quality system. Although many advocates of COQ systems have predicted this outcome, there is little published information documenting whether these expectations have been achieved in practice. The findings of this study, however, provide some empirical support for this proposition. The proportion of total quality costs spent on prevention increased and external failure

costs decreased while the proportion of total quality costs spent on appraisal and internal failure remained constant. In addition, evidence was found for decreases in total cost of quality over time, but the magnitude of the decreases become smaller over the time since a quality system was implemented.

Limitations

There are several possible limitations to this study. The sample consists of ASQ Quality Management Division members working in the USA. The results obtained may not be representative of the population of US business organizations and may not be representative of the situation in the rest of the world. However, the responses were geographically dispersed within the USA (at least 29 states) and represented a wide cross-section of industries (at least 40).

Accuracy is a consideration when using self-reported data. This was assessed by requesting responses from two members of the responding organizations. Paired responses were obtained from only 33 of the 393 responding organizations. While the correlations between the paired responses were quite high, indicating good reliability of the self-reported data, they may not be representative of the non-paired responses.

There is the possibility for errors due to non-response bias. The response rate of 15.7 percent, while typical for studies of this type (Mabert *et al.*, 2000; Dusharme, 2001), is lower than desired. However, no systematic differences were observed between early and late respondents to the survey.

The comparison of current quality costs to past quality costs was retrospective and subject to bias. However, the survey asked only for a retrospective comparison of last year's COQ and the current year's COQ, thus minimizing memory bias but limiting the visibility of longer term changes in quality costs. A longitudinal study would be a way to more accurately assess the nature of the changes in COQ distribution over time.

There are also a number of potentially confounding variables at work. These would include differences from industry to industry and company to company within an industry, the effectiveness of the company's cost of quality system in capturing all costs, the effectiveness of the company's quality system, and the nature of the company's starting cost of quality distribution. Only the last of these was assessed in this study.

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