Comparative Analysis of Quality Costs and Organization Sizes in the Manufacturing Environment

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Companies can lose money because they fail to take advantage of opportunities to improve their costs of quality. Most cost accounting data are not revealed to the public and are rarely exchanged among businesses. Also, there is no known study testing the effect of an organization's size on costs of quality. This study attempts to analyze and compare quality cost categories between small and medium enterprises (SMEs) and large organizations, and proposes an empirically based model for quality costs in the manufacturing environment.

The quality cost model—or prevention, appraisal, and failure (PAF) costs model—was used as the theoretical foundation for the research design. ASQ and Quality Progress *magazine helped in the announcement of the online questionnaire to manufacturing and quality professionals, resulting in 63 respondents. Excel spreadsheets were used in data analysis and analysis of variance was used in hypotheses testing.*

The results indicate no significant differences in prevention, appraisal, and internal failure costs between SMEs and large organizations, but there were external failure cost differences. The findings also suggest that total quality costs were on an average 8 to 10 percent of manufacturing expenses, or 2.6 to 4 percent of sales revenues. The failure costs were the major expenses and ranged from 70 percent to 80 percent of total quality costs. In addition, the primary problems in quality cost program implementation were culturally related in favor of correction over prevention, human mistakes, insufficient processes, and lack of proper information.

Key words: costs in manufacturing, failure costs, large organization, PAF model, quality cost model, quality costs implementation program, small and medium enterprise (SME)

INTRODUCTION

Many firms have worked hard to create methods and execute activities to minimize costs and improve the quality of their products and services. Some have wasted their vast resources and money because they did not take advantage of opportunities to improve their costs of quality. According to a study (Anderson 2007) by Chuck Cox, Master Six Sigma Black Belt, if companies do not conduct ongoing continuous improvement their costs of quality could be between 20 to 35 percent of the revenue stream, or equal to the product's selling price. For military and government contracts the figure could be as high as 45 percent. More than likely, upper management knows that every 1 percent decrease in costs will result in a 1 percent increase in profits. But the question is: What can a firm do to reduce its costs and earn more profits?

A quality cost program is an effective tool used to contribute to customer satisfaction and profits. Today, more and more enterprises—small, medium, and large—are spelling out quality cost requirements, from the collection of scrap and rework costs to the most sophisticated quality cost program. Most quality management consultants have quality cost programs for sale (ASQ 2003). Not only do quality cost programs increase economic performance, they affect other areas as well. Gryna (1999) discussed that the benefit to investment of measuring quality costs is that it aids in improving process capability, reducing customer defections, and increasing the number of new customers.

The ASQ Quality Cost Committee describes quality costs as a measure of costs specifically associated with

the achievement or nonachievement of product or service quality, including all product or service requirements established by the company and its contracts with customers and society (ASQ 2003). In fact, quality cost information from the quality and/or production department usually is not revealed to the public and rarely is exchanged among businesses. This makes it difficult for quality professionals and managers to learn and compare their quality costs and activities with those of other companies in the same industry. Moreover, there are no known empirical studies that test the effect of an organization's size on quality cost categories from the point of view of quality or industrial professionals. Company size and structure are linked to the economic significance of quality programs and performance. Small and medium enterprises (SMEs) and large organizations have some advantages and disadvantages in implementing quality programs due to different structure, size, and organizational culture.

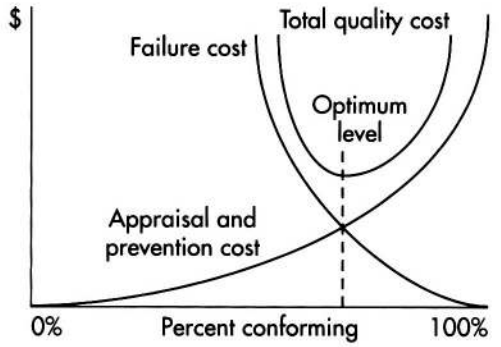
The purpose of this study is to compare the quality cost categories—prevention, appraisal, and internal and external failure costs—between SMEs and large organizations in manufacturing using financial data. In addition, the study attempts to identify problems and solutions that quality professionals experience in their quality cost program implementation efforts. The findings of this study may further help industrial and quality professionals measure the success of their quality costs program or assist businesses in setting up a system of quality cost implementation.

QUALITY COSTS CATEGORIES AND DEFINITIONS

This study used the quality cost model—or prevention, appraisal, and failure costs (PAF) model—as the theoretical foundation for the research design. The description of each quality cost is explained next in greater detail:

- *Prevention costs (PC)* are those costs associated with quality planning, designing, implementing, and managing the quality system; auditing the system; supplier surveys; and process improvements.

Figure 1 The quality economic model.



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- *Appraisal costs (AC)* are associated with measuring, evaluating, or auditing products and product materials to ensure conformance with quality standards and performance requirements.
- *Failure costs (FC)* are losses associated with the production of a nonconforming product; they can be divided into internal and external. *Internal failure costs (IFC)* are associated with failures and defects of processes, equipment, products, and product materials that fail to meet quality standards or requirements. *External failure costs (EFC)* are generated by defective products, services, and processes during customer use. They include warranties, complaints, replacements or recalls, repairs, poor packaging, handling, and customer returns (Cartin 1999).

Furthermore, the thesis of the Lundvall-Juran curve explains the relationship between conformance and quality-related costs, which include appraisal, prevention, and failure costs. Foster (1996) explained that as conformance improves (where 1 is 100 percent conforming), failure costs decrease, and prevention and appraisal costs increase. Figure 1 describes appraisal and prevention costs rising toward infinity as quality of conformance approaches 100 percent (perfection). Total quality costs (TQC) also are higher as failure costs increase. Total costs are optimized at some point when the sum of the two costs is at a minimum. The original idea of this figure was from *Juran's Quality Control Handbook* (1974).

LITERATURE REVIEW

One of the important principles of total quality management (TQM) and one of the main criteria of the Malcolm Baldrige National Quality Award is *fact-based management.* Today, industrial professionals live in the information technology society. It is vital that leaders and managers make decisions based on information and facts, not on precedent or opinion. Cartin (1999) stated that "there are no data more fundamental in an organization—in management decision making—than cost information" (p.131). Every organization—small, medium, and large—uses cost information, which varies from simple, all inclusive, accumulated data that indicate the gross picture, to volumes of data measuring everything.

In the manufacturing sector, the quality cost program becomes a useful technique in increasing business competitiveness and improving profit margin. Examples from the research studies of particular industries suggest that quality costs can range from 5 to 25 percent of a company's annual sales turnover (Dale and Plunkett 1991; Keogh, Brown, and Mcgoldrick 1996). Brinkman and Applebaum (1994) indicated that well-run manufacturing companies can reduce their quality costs to the range of 2 to 4 percent of sales. Gryna (1999), however, said that the quality-related costs were much larger than had been shown in the accounting reports. "For most companies, these costs ran in the range of 10 percent to 30 percent of sales or 25 percent to 40 percent of operating expenses. Some of these costs were visible, some of them were hidden" (p. 8.2). Furthermore, Burgess (1996) gathered quality cost data from several studies between the 1970s and 1990s; for example, Webb (1972) presented the percentage of TQC in the general industry: prevention costs (10 percent), appraisal costs (25 percent), and failure costs (65 percent); Veen (1974) indicated quality costs categories at average: prevention costs (9.1 percent), appraisal costs (27.3 percent), and failure costs (63.6 percent). In the service sector, Waress, Pasternak, and Smith's study (1994) shows the costs associated with quality at Lovelace Health Systems, in Albuquerque, NM. They found the mixture of cost categories as: prevention costs (10.1 percent), appraisal costs (5.2 percent), and failure costs (84.7 percent). They also concluded that more than 80 percent of the quality costs were losses related to nonachievement or inability to meet quality expectations, and internal and external failure costs. The results of these studies confirm that failure costs, not prevention or appraisal costs, are the major expenses of quality costs.

The Differences Between SMEs and Large Organizations

To analyze the impact of an organization's size on the cost of quality, this study examines the characteristics of SMEs and large organizations relating to TQM implementation. Welsh and White (1981) stated that a small firm is not just a little large firm. Small firms differ from large firms in several important ways. One key feature that differentiates large organizations and SMEs is the organization's structure and size. Both sizes have strengths and weaknesses in implementing quality systems. Wiele and Brown (1998) collected data from 160 ISO 9000-registered companies in Western Australia. The results show that the SMEs are less comfortable than large companies in implementing and developing TQM. The main reason for this is limited financial resources. Larger organizations, however, are not able to improve the quality of their products, services, and processes unless their suppliers or second-tier suppliers also grow to a higher level of quality maturity.

The Eurostat and European Observatory defines large organizations as those with 500 employees or more and defines SMEs as private enterprises outside the agricultural sector, employing fewer than 500 people (Ghobadian and Gallear 1997). The characteristics, including structure, procedure, process, behavior, people, and contact, can be used in analyzing the difference between SMEs and large organizations in areas relevant to the design and actuation of TQM.

Structure

Large organizations are usually highly structured in nature, leading to formalized procedures for all activities. Also, levels of specialization and standardization

are likely to be high. On the other hand, SMEs have a less complex organizational structure, fewer personnel, and fewer lines of communication, which makes it easier to measure and determine the costs of events that lead to poor quality (Youssef et al. 2002). Moreover, Stephens, Evans, and Matthews (2005) discussed that small firms tend to be engaged with entrepreneurial activities and recognize the value of high-performance management practices. With activity engagements and smaller structure, the quality costs program can be productive and less expensive.

Procedure and process

Because of a high degree of standardization and formalization, large organizations have a lot of activities and operations that are governed by formal rules and procedures. On the contrary, SMEs can operate with a single manager, less division of function, and more flexible and adaptable processes. It should be noted that "Quality tracking and improvement techniques such as benchmarking and statistical process control (SPC) may also be used less frequently and less effectively in small firms" (Ebrahimpour and Withers 1992; Stephens, Evans, and Matthews 2005, 24).

Behavior, people, and contact

It is generally recognized that size influences organizational behavior. In broad terms, large organizations are usually bureaucratic; that is, they rely on the formalization of behavior to achieve coordination. SMEs, on the other hand, are more likely to have an organic structure and informal working relationships (Ghobadian and Gallear 1997). Training and development programs for employees, however, are comparatively little in SMEs; the reason may be lack of business owner attention or budgets.

RESEARCH QUESTIONS AND HYPOTHESES

This study proposes three primary research questions:

1. What are the major expenses of quality costs for SMEs and large organizations? How do companies reduce these major expenses of quality costs?
2. Are there differences in total quality costs, prevention, appraisal, and internal and external failure costs as a percentage of sales revenue between SMEs and large organizations?
3. What are the problems that quality professionals experience when implementing a quality cost program?

Data collected from the survey are used in calculating the major expenses of quality costs and answer research question no. 1. The results from hypotheses testing respond to question no. 2 and descriptive data from the respondents help in answering question no. 3.

To answer research question no. 2, the following five hypotheses are posed:

- H1: There is no statistically significant difference in *total quality costs* as a percentage of sales revenue between SMEs and large organizations.
- H2: There is no statistically significant difference in *prevention costs* as a percentage of sales revenue between SMEs and large organizations.
- H3: There is no statistically significant difference in *appraisal costs* as a percentage of sales revenue between SMEs and large organizations.
- H4: There is no statistically significant difference in *internal failure costs* as a percentage of sales revenue between SMEs and large organizations.
- H5: There is no statistically significant difference in *external failure costs* as a percentage of sales revenue between SMEs and large organizations.

METHODOLOGY

The research population included professional members of ASQ who worked in the manufacturing environment. This study used a Delphi technique in developing a survey instrument that contained both qualitative and quantitative data, and the panel included eight experts in production, quality management, engineering, and finance. The 14 samples were gathered for a pilot test to assess the reliability of the instrument. The December 2004 issue of ASQ's *Quality Progress* magazine helped by announcing the online questionnaire to manufacturing and

quality professionals. Moreover, the author sent 267 e-mails directly to ASQ local section chairs, education chairs, and Web chairs, although only 178 addresses were delivered. The author developed an Internet Web site using the University of Central Missouri Survey-Builder software and server in data collection.

An Excel spreadsheet was used in coding and analyzing data. The Statistical Package for Social Science (SPSS) and analysis of variance (ANOVA) were used to test significant relationships between independent and dependent variables. The .05 level of confidence was established to determine whether the observed value was significantly different from the expected value. The results from the statistical analysis were interpreted in relation to quality costs in SMEs and large organizations based on sales revenue. This interpretation, together with the comments and feedback from respondents, lead to an empirical model of quality costs.

Limitations of the Study

This study was limited to the number of large organizations and SMEs studied. These samples are in the manufacturing environment, specifically, industry with ASQ membership. Findings may not be generalizable to other types of businesses outside of manufacturing (such as services, and retail and wholesale distribution) and to other geographical settings. Each type of industry has characteristics that may cause differences in calculating quality costs; the type of industry is a limitation in this study.

FINDINGS AND DATA ANALYSIS

The findings of this research are divided into four sections: demographic data of the samples, percentage of quality costs comparing SMEs and large organizations, testing research hypotheses, and problems in quality cost programs.

Demographic Data

The survey results were gathered from 63 respondents from the manufacturing environment. The companies were divided into two groups: SMEs and large organizations. More than half of the samples (65.1 percent) were SMEs with fewer than 500 employees. A majority of respondents (85.7 percent) worked in the manufacturing, operation, and quality departments. The biggest group of respondents (66.7 percent) was that of quality engineers and managers. About 66.7 percent of another group of respondents indicated that they used the quality cost model (prevention, appraisal, and failure costs) as the current quality cost technique in their companies; some others used the Taguchi loss function and mixed models.

The usable responses included nine (14.3 percent) in the metal industry; seven (11.1 percent) in automotive and automotive tooling; seven (11.1 percent) in aerospace and aircraft; six (9.5 percent) in rubber and plastic; three (4.8 percent) in medical devices, chemicals products, and machinery; two (3.2 percent) in food and beverage, electronics assembly, and pharmaceuticals; and 19 (30.2 percent) in other manufacturers. These other manufacturing areas included agriculture equipment, boating, closet, compressor, concrete masonry units, desiccant, furniture, home appliance, irrigation products, lighting fixtures, packaging, semiconductors, satellite simulators, telecommunication equipments, textile, and zinc, aluminum, and magnesium die casting.

Percentage of Quality Costs

This section analyzes quality cost categories based on sale revenues and manufacturing expenses. Forty-six respondents provided their quality costs based on sale revenues. Results of the calculation are shown in Table 1. The 28 SMEs had a TQC of 2.64 percent including prevention costs (0.28 percent), appraisal costs (0.45 percent), internal failure costs (1.23 percent), and external failure costs (0.68 percent). Large organizations

Table 1 Percentage of quality costs based on sales revenue.

Sizes	PC	AC	IFC	EFC	TQC
SMEs (28)	0.28	0.45	1.23	0.68	**2.64**
Large (18)	0.45	0.35	1.51	1.63	**3.94**

Table 2 Percentage of quality costs based on manufacturing costs.

Sizes	PC	AC	IFC	EFC	TQC
SMEs (25)	1.73	1.34	4.41	2.00	**9.48**
Large (17)	0.92	0.7	3.09	3.42	**8.13**

with 18 respondents had TQCs of 3.94 percent, including prevention costs (0.45 percent), appraisal costs (0.35 percent), internal failure costs (1.51 percent), and external failure costs (1.63 percent).

Forty-two companies provided their quality costs based on manufacturing costs (see Table 2). SMEs with 25 respondents had TQCs of 9.48 percent based on manufacturing costs. These included prevention costs (1.73 percent), appraisal costs (1.34 percent), internal failure costs (4.41 percent), and external failure costs (2.0 percent). Large organizations with 17 respondents had TQCs of 8.13 percent including prevention costs (0.92 percent), appraisal costs (0.70 percent), internal failure costs (3.09 percent), and external failure costs (3.42 percent).

Next, the study continued on the analysis of the quality cost categories comparing SMEs and large organizations. Pie charts were used in presenting percentage of prevention costs, appraisal costs, internal failure costs, and external failure costs when the TQCs equaled 100 percent. As shown in Figure 2, SMEs had the highest costs on internal failure costs (47 percent) followed by external failure costs (26 percent), appraisal costs (17 percent), and prevention costs (10 percent), respectively. Figure 3 presents quality costs in large organizations; the highest costs were external failure costs (42 percent), internal failure costs (38 percent), prevention costs (11 percent), and appraisal costs (9 percent), respectively.

Comparative Analysis of Quality Costs

Data analysis and interpretation of Tables 1 and 2 and Figures 2 and 3 helps to compare the quality cost categories between SMEs and large organizations and answer research question no. 1.

Figure 2 Percentage of quality costs based on revenues in SMEs.

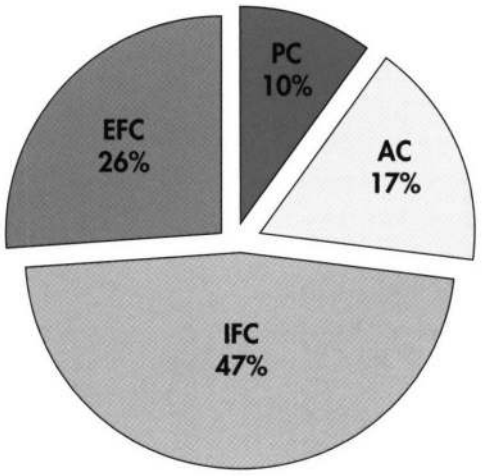
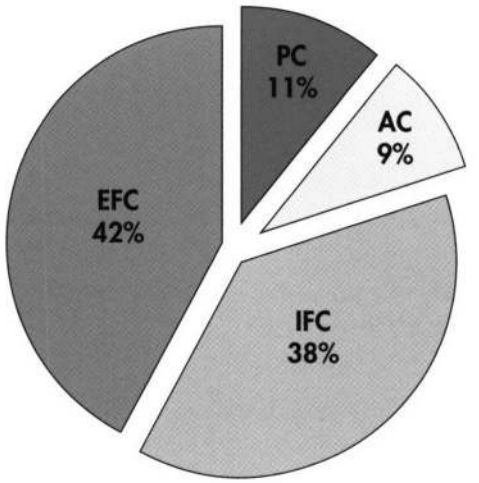


Figure 3 Percentage of quality costs based on revenues in large organizations.



- Failure costs are the major expenses for both SMEs and large organizations. On average, failure costs were about 70 to 80 percent of TQCs, while prevention costs were 10 to 11 percent and appraisal costs were 9 to 17 percent.
- SMEs had the highest percentage of internal failure costs and large organizations had the highest percentage of external failure costs. Recall costs, warranty claims, and lost sales are external failure costs that become excessive for large organizations.

- Using sales revenue or manufacturing costs as a base in quality cost calculation may have a difference in reporting. SMEs (2.64) had *lower* TQCs than large organizations (3.94) when using sales revenues as a calculation base. On the other hand, using manufacturing costs, SMEs (9.48) had *higher* TQCs than large organizations (8.13).

Figure 4 Quality costs from the literature reviews and this study's findings.

Quality costs	Literature reviews			This study's findings			
Based on sales revenues							
Dale and Plunkett (1991)	5-25%						
Brinkman and Applebaum (1994)	2-4%			SMEs: 2.64%			
Burgess (1996)	3.9-11%			Large: 3.94%			
Crosby (1996)	25%						
Gryna (1999)	10-30%						
Based on manufacturing costs							
Gryna (1999)	25-40%			SMEs: 9.48%			
Crosby (1996)—Service firms	40%			Large: 8.13%			
Percentage of quality costs	**PC**	**AC**	**FC**	**PC**	**AC**	**FC**	
Webb (1972) at average	10	25	65				
Veen (1974) general industry	9.1	27.3	63.6	10	7	73	SMEs
QC survey (1977) manufacturing	10.3	26	63.7	11	9	80	Large
Waress et al. (1994) healthcare	10.1	5.2	84.7				

- It was surprising to see SMEs had prevention costs and appraisal costs together at 27 percent, which was higher than large organizations (20 percent). Large organizations tend to reduce their failure costs by adding more activities into prevention and appraisal sections, and they can afford more costs on the improvement and training programs. These activities may include marketing research, design development, supplier quality planning, process validation, receiving or incoming inspections, field performance evaluations, and so on.

It is worth noting that the methods of categorizing and measuring quality costs may vary between organizations. A company's structure, product life cycle, and ongoing quality improvement programs (Six Sigma, Lean Systems, ISO, and other quality certifications) may have an impact on collecting quality costs.

In the past decade, studies have shown high but varied percentages of TQCs based on sales revenues and manufacturing costs. For example, according to Dale and Plunkett's research studies of particular industries in 1991, quality costs can range from 5 to 25 percent of a company's annual sales turnover. In another study, Crosby (1996) wrote in his book, *Quality Is Still Free,* and showed that quality costs were about 25 percent based on sales revenues or 40 percent based on manufacturing costs in service firms. More quality costs from different research and case studies compared with this study's findings are presented in Figure 4.

The analysis of quality cost categories from Table 1 and Figure 4 reveal that prevention cost and appraisal cost percentages vary little among businesses, and most companies have prevention and appraisal costs less than 1 percent of sales revenues. On the contrary, a number of previous studies (Burgess 1996; Campanella 2003) showed that appraisal costs were two to five times higher than prevention costs, when expressed as a percentage of sales revenues. Also, failure costs are the highest cost of three in the quality costs category that have been a critical problem for manufacturing companies, and they are increasing with the trend in product recalls.

Testing Research Hypotheses

Data in this section are from 46 respondents who provided completed information for the calculation. The one-way ANOVA was used to test research hypotheses one through five to see if there was a significant difference in each quality cost category as a percentage of sales revenue between SMEs and large organizations. Primary variables include TQC, prevention costs, appraisal costs, internal failure costs, and external failure costs; the testing results of the five research hypotheses are shown in Table 3. Sale revenues were used as a base in

calculation with a 95 percent confidence level that the independent and dependent were related.

- H1 tests whether an organization's size has a main effect on total quality costs. In Table 3, the F statistic for TQCs is 4.338. The observed significance level is 0.043, so the null hypothesis is *rejected* at the .05 level of confidence in favor of the alternative. Based on the sample results, there is a statistical difference of TQCs between SMEs and large enterprises.
- H2, H3, and H4 test whether an organization's size has a main effect on prevention costs, appraisal costs, and internal failure costs, respectively. Based on the sample results, there is *no* statistical difference of these costs between SMEs and large enterprises.
- H5 tests whether an organization's size has a main effect on external failure costs. Based on the sample results, there is a statistical difference of external failure costs between SMEs and large enterprises.

The statistical results helped to answer research question no. 2: Are there differences in TQCs, prevention, appraisal, and internal and external failure costs as a percentage of sales revenue between SMEs and large organizations? The answers are "yes" for TQC and external failure costs, and "no" for prevention costs, appraisal costs, and internal failure costs:

- Yes, there is a statistical difference in TQC and in external failure costs as a percentage of sales revenue between SMEs and large organizations.
- No, there is *no* statistical difference in prevention costs, appraisal costs, and internal failure costs as a percentage of sales revenue between SMEs and large organizations.

Problems in Quality Costs Program

In the final section of the questionnaire, the respondents were asked to explain problems they experienced when implementing quality cost programs (research question no. 3). Several respondents indicated a lack of cooperation from the senior leadership team, management's negative attitude, difficulty in collecting quality cost data, hidden costs, and lack of understanding of cost of quality concepts as problems they confronted in implementation of a quality cost program at their organizations. Some other difficulties from the survey's results included:

Table 3 Analysis of variance between groups (SMEs and large enterprises).

Quality costs	F statistics	Sig.
Total quality costs (TQC)	4.338	.043*
Prevention costs (PC)	2.098	.155
Appraisal costs (AC)	.317	.576
Internal failure costs (IFC)	.524	.473
External failure costs (EFC)	16.546	.000*

*p < .05, sales revenue as a base in calculation, the response (Y) is the quality costs per sale revenues.

- A culture that favors correction over prevention
- Process of collecting data; actual costs vs. estimated costs
- Management hiding expenses to make divisions appear more effective
- No one paying attention unless it is due to large quality costs
- The company being unaware of quality costs and lack of commitment
- Lack of consistency from plant to plant and no standardization within a corporation
- Resistance of employees to changes, particularly in troubleshooting opportunities for improvements
- No cooperation from accounting and finance people

There are a number of methods that helped in solving these problems that may lead to a successful quality cost program and help organizations reduce their quality costs. From a previous study, Rodchua (2006) collected data on the primary factors that aided the success of a quality cost program from the 59 responses; several participants indicated that the primary factors that aid the success of a quality cost program are management support, effective application and system, cooperation from other departments, and understanding the concepts of the cost of quality.

CONCLUSIONS AND RECOMMENDATIONS

This study was focused on gathering and comparing the quality cost categories between SMEs and large organizations. Since companies usually don't disclose their cost information to others, there was not much available data to support whether a business had excessive or moderate expenses in its quality activities. Data analysis and findings were from a survey of 63 respondents who worked in the manufacturing industry. The survey's results provided numbers of each quality cost category based on sale revenues that industrial and quality managers can use to compare with their organizations. The study found quality costs divided by enterprise size:

- Based on sale revenues, 28 SMEs had average TQCs of 2.64 percent, including prevention costs (0.28 percent), appraisal costs (0.45 percent), internal failure costs (1.23 percent), and external failure costs (0.68 percent).
- Based on sale revenues, 18 large organizations had average TQCs of 3.94 percent, including prevention costs (0.45 percent), appraisal costs (0.35 percent), internal failure costs (1.51 percent), and external failure costs (1.63 percent).

Although the different types of industry can impact the implementation of a quality cost program due to different needs at different points in their life span (Wood 2007), the types of industry were not a focus in this study. The intention was to suggest an average number for SMEs and large organizations used for comparison in calculating their quality costs. Company size and structure are linked to economic significance of quality programs and performance. The literature suggested that large organizations tend to have more complex structures and systematic processes than SMEs affecting the resources and expenses. Another study found that small firms have difficulty implementing quality management practices to their full extent due to limited resources in the implementation process (Stephens, Evans, and Matthews 2005). From this research, the author found that there were no statistical differences in prevention, appraisal, and internal failure costs between SMEs and large organizations, but there were external failure cost differences.

The findings suggest that the failure costs were about 70 to 80 percent of quality costs; large organizations had a high percentage of external failure costs. In the past few years, a number of customers have filed lawsuits against large organizations because of product and service dissatisfaction. With extensive news in product failures, such as tire recalls in 1999, name-brand prescription drug recalls in 2003 and early 2004, and pet foods and children's toys recalls in 2007, this has cost companies money and caused injuries and death to their customers. A study released by ASQ indicated that a recall costs more than $6 billion a year to the consumer products industry and an average of more than $8 million to the business for each recall; this includes reimbursement to consumers, recall execution, and compensatory damages from litigation (White and Pomponi 2003). On the other hand, SMEs had a higher percentage of internal failure costs than large organizations; perhaps small firms have fewer financial supports and less advanced technology in research and development compared to larger firms. Without high-efficient processes and proper systems in place, excessive product deficiencies might be found before delivery to external customers. In addition, data gathered from the respondents indicated the problems that industrial practitioners experienced while implementing quality cost programs. These problems included culturally related favor of correction over prevention, human mistakes, insufficient operational process, and a lack of proper information.

The information derived from this study will benefit companies, both SMEs and large organizations, in the manufacturing environment. An important part of managing a quality cost program is to clearly understand the goals and strategies of the system. The ASQ Quality Cost Committee suggested the following strategy for using quality costs: 1) make a direct approach on failure costs in an attempt to drive them to zero; 2) invest in the "right" prevention activities to bring about improvement; 3) reduce appraisal costs according to results achieved; and 4) continuously evaluate and redirect prevention efforts to gain further improvement. These four strategies are based on the premise that for

each failure there is a root cause, causes are preventable, and prevention is always cheaper (ASQ 2003).

RECOMMENDATIONS FOR FUTURE STUDY

For further study, it is recommended that this study be replicated with a larger population and wider range of industries, such as healthcare and services. A larger population of respondents would allow more complex levels of statistical analysis. Many other industries and businesses could benefit from this type of quantitative statistical analysis, and the results of analysis and quality cost models tend to improve as they are used in quality costs program implementation. Additionally, the analysis of quality cost categories comparing industry types was not included in this study. Further research may focus on the factors that affect internal and external failure costs; one could explore the nature of the factors and methods of controlling these quality costs.

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