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Factors, Measures, and Problems of Quality Costs Program Implementation in the Manufacturing Environment

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Abstract

Companies can lose money because they fail to use significant opportunities to reduce their costs of quality. This study identified important factors and measures contributing to a successful quality cost program implementation and developed an empirically based model for quality costs in the manufacturing environment. Also the study presented the cause and effect diagram of difficulty that industrial professionals experienced in their program implementation.

This research survey instrument collected descriptive data from manufacturing and industrial professionals. The American Society for Quality (ASQ) and *Quality Progress* journal was used in announcement of the online questionnaire, resulting in 63 respondents.

The study found the primary factors that aided the success of a quality cost program were management support, effective application and system, cooperation from other departments, and understanding the concepts of the cost of quality. It was recommended for further study to explore the nature of factor analysis and methods of controlling internal and external failure costs.

Keywords: *quality costs model, factors and measures in quality costs program, problems in quality costs implementation, successful quality costs program.*

Introduction

Today, more and more enterprises of all sizes are defining quality cost requirements, from the collection of scrap and rework costs to the most sophisticated

quality cost programs. Almost all quality management consultants have quality cost programs as an integral part of their repertoire (Campanella, 2003). Money is the basic language of upper management. Evans (1997) states that quality problems expressed as the number of defects have little impact on top managers. When quality problems are presented in the form of financial language, top management understand these problems and they can help managers evaluate the relative importance of quality problems and also identify major opportunities for cost reduction.

Manufacturing industries in a new era have the emergence of advanced tools and technologies and the pertinent changes in organizational structures and process design. A variety of factors have combined to alter the cost of quality in the new manufacturing environment. Quality costs include the results of factory operation and support operations as well. The adoption of automated process equipment leads to more uniform production and a decline in defects. Many firms have seen five to tenfold reductions in waste, scrap, and rework when manual operations were replaced with automated equipment. This leads to significant reductions in expenditure related product quality (Chase & Aquilano, 1995). McAllister (2005) adds that cost of poor quality (e.g., costs associated with goods returned from customers, scrap and rework) can and should tie to financial data.

Monitoring and controlling quality costs are becoming critical activities of quality improvement programs.

Several companies have implemented and executed Total Quality programs, but failed, when they could not achieve their goals due to lack of effective quality costs methods. A recent survey of mid-sized manufacturers by Grant Thornton International showed that “while 83% of the respondents said they considered improving quality as a top priority, only one-third said they currently calculate quality costs” (Morse, 1993, p.6). The study shows why some total quality management effort yield only partial success. Without the guidance of quality cost information, efforts to improve quality may be misdirected (1993).

Theoretical Foundation

The definition and categories of *quality costs* may be given differently by diverse authors. Some use the terms “quality costs”, “costs of quality,” “economics of quality,” “poor quality cost,” “price of non-conformance,” or “cost of poor quality.” The American Society for Quality (ASQ), Quality Cost Committee defined ‘quality costs’ as a measure of the costs specifically associated with the achievement or non-achievement of product or service quality. The total of the quality costs includes prevention costs of nonconformance to requirements, appraising costs of product or service for conformance to requirements, and failure costs of products not meeting requirements (Campanella, 2003). As the quality function evolved from inspection (quality control) to more preventive activities (quality assurance), quality cost collection was expanded into prevention, appraisal, and failure costs. Failure costs are divided into two subcategories: internal and external. This has been the standard categorization used by industry and service since the 1950s (Cartin, 1999), as shown in Figure 1.

Several studies (Gryna, 1999; Cartin, 1999 and Campanella, 2003) described meanings of these quality cost categories as follows:

- *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.

- *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 those 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.

Statement of Problem

Implementing effective quality cost program has made most companies reduce scraps/rework and costs of poor quality. It also has led to the development of a strategic quality improvement plan consistent with overall organizational goals. Quality cost information is rarely exchanged among businesses. Quality professionals are still trying to determine the main factors and measures aiding in the successful quality cost programs and what problems can be incurred in the quality cost program implementation. The purpose of this study was to identify main factors and measures that aid in the success of the quality costs program and problems that quality professionals might experience in implementation. The three

primary questions are:

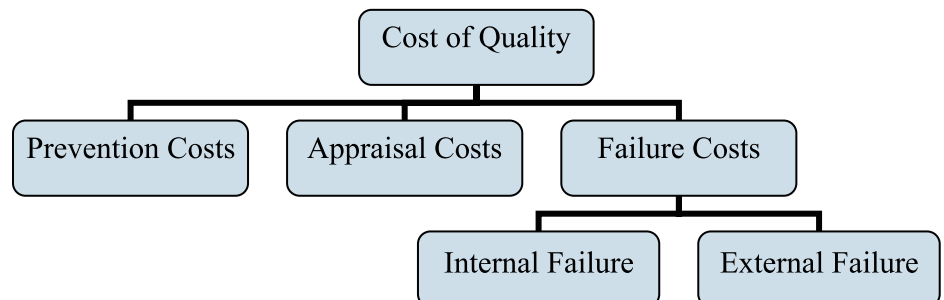
- Research Question 1: What are the main factors and measures that aid the success of the quality costs program at the surveyed organizations?
- Research Question 2: What are problems experienced in implementation of the quality costs program at the surveyed organizations?
- Research Question 3: For each of the four categories of the cost of quality (prevention, appraisal, internal failure, and external failure), which category is the highest priority for cost reduction?

These factors, measures and problems identified from the survey results were then used in developing an empirical model of quality costs to assess the quality management systems in the manufacturing environment.

Methodology

The study used the online quality cost questionnaire in collecting data. This questionnaire was reviewed for the validation purpose by a panel of eight experts in the field of quality, management, and manufacturing. They were selected based on experience in their fields, their positions within the quality professional community, and references to their work by their colleagues. The panel included quality engineers, plant managers, an accountant, and quality consultants. Then, the study’s website (<http://faculty.cmsu.edu/qcsurvey>) was created and linked to the questionnaire. The study asked respondents to answer survey questions and write feedback and/or suggestions regarding their experience in quality costs program implementation.

Figure 1. Quality Costs Categories



The research population consisted of professional members of the American Society for Quality (ASQ) who worked in the manufacturing environment. The ASQ is the world leading membership organization devoted to quality. Currently, ASQ is a 104,000 member professional association with 250 local sections in the United States, Canada, and Mexico (ASQ, 2004). The ASQ website (<http://www.asq.org>) and *Quality Progress Journal*, December 2004 issue, announced the online questionnaire to manufacturing and quality professionals, resulting in 63 respondents. A vast majority of respondents (85.7%) worked in the manufacturing, operation, and quality department and the largest group of respondents (66.7%) were quality engineers/managers. The comment and feedback from respondents were used as empirically based factors and measures to design the quality costs model.

Findings

In order to answer the research questions, the descriptive data from 63 respondents were summarized and divided into three sections.

Factors and measures

Research question one: What are the main factors and measures that aid the success of the quality costs program at the surveyed organizations?

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. Table 1 presents the factors that aid in the successful quality cost program.

Next, the measures used in managing a quality cost program, only 25 respondents answered this part. The respondents' answers can be grouped into three categories.

1) *Percentage bases.* The bases include sale revenues, manufacturing expenses, purchasing material, training, direct/indirect labor, production costs, and others.

- 2) *Volume of outputs.* Respondents indicated the uses of amount of scrap/rework, numbers of corrective and prevention actions, and numbers of units produced.
- 3) *Qualitative data.* The responses contain feedback from customers and suppliers, such as vendor call backs, field calls, and customer satisfaction surveys.

Problems in quality costs implementation

Research question two: What are problems that you experienced in implementation of the quality costs program at your organization?

The answers from participants were varied and can be summarized into four groups: measurements, people, process, and information. Each group has components that caused unsuccessful quality cost programs in the manufacturing environment.

- 1) *Measurements* include lack of an appropriate system and incorrect methods of collecting quality cost categories.
- 2) *People* issues were lack of support from the senior leadership team, and lack of cooperation from the accounting and finance departments, and managers and employees who are deficient in knowledge of 'Cost of Quality' and training.

- 3) *Process* contains inconsistency from plant to plant and ineffective process standards.
- 4) *Information* indicates lack of clear instruction and inadequate information to properly design and process.

Furthermore, several respondents indicated that a culture that favors correction over prevention also led to an unproductive quality cost program.

Quality cost reduction

Research Question three: For each of the four categories of the cost of quality (PC, AC, IFC, and EFC), which category do you think is the highest priority for cost reduction?

A number of respondents expressed that PC and EFC were the highest priority for cost reduction. They agreed that prevention costs provided tools and training for reducing wastes in the process. Among forty respondents who answered this question, fifteen voted for EFC, fourteen for PC, nine for IFC, and two for AC.

Conclusions and Discussion

The findings of this study should be helpful to industrial/quality professionals to continuously improve the quality management programs and to increase profitability. The presentation of factors, measures, and problems in

Table 1. Factors Aid the Successful Quality Cost Program

Factors	Frequency	%
Management support and commitment	17	28.8
Effective application and system	12	20.3
Cooperation from other departments (accounting & finance)	10	16.9
Understanding concepts of cost of quality	7	11.9
Active Six Sigma	3	5.1
Reviewing internal and external failure costs	2	3.4
Developing and installing a process focusing on a few key measures	1	1.7
Identify the ownership of all sections	1	1.7
Adherence to policies and procedures	1	1.7
Accurate data collection, bill of material, employee persistence	1	1.7
Files management, procedure purchasing, channel management	1	1.7
In house inspections	1	1.7
Actual and residual costs contribute to non-value-added effort	1	1.7
Warranty cost and cost allocation to appropriate accounts	1	1.7
Total	59	100.0

implementing quality cost program can assist a business in setting up a proper quality costs system in the manufacturing industry. Based on the findings and review of literature, the study found the primary four significant factors and three categories of measures that aid in the success of a quality costs program. Figure 2 shows a model of factors and measures that aid a successful quality costs program in the manufacturing industry.

The Figure 2 presents the relation of four factors (upper management support, understanding concepts of cost of quality, effective system & application, and cooperation from accounting and finance departments) and three categories of measures (percentage bases, volume of outputs, and qualitative measures) to quality cost program implementation. The majority of respondents stated that management support is one of the most significant factors effecting on the program achievement. Dr. Deming and other quality gurus agreed in the main principles of Total Quality Management that top management must provide the leadership for quality. Management support can help in making decisions, creating a positive company environment, and providing appropriate tools and resources. These factors interact with each other and can be explained in greater details.

- *Management Support and Commitment.* Upper management and executives must drive for cost saving and understand the impact of quality costs implementation. The roles of top managers are to establish an organizational culture that favors prevention over correction, organize quality cost steering committees, meet monthly or quarterly to discuss the work progress of the quality costs program, and provide opportunity for training and learning the costs of quality for involved departmental managers and supervisors.
- *Effective Systems and Application.* The tools used in data collection and analysis are very important in order to obtain accurate and complete information. Each organization has a different structure; hence, quality

professionals must set up the quality cost system and methodology that fit their own needs and work well with the financial and accounting systems. An effective system should be user friendly and integrated with cost drivers and collect costs related to incurred (hidden) costs. Commercial software and training for quality cost programs from the Juran Institute and the American Society for Quality are available in today's industry.

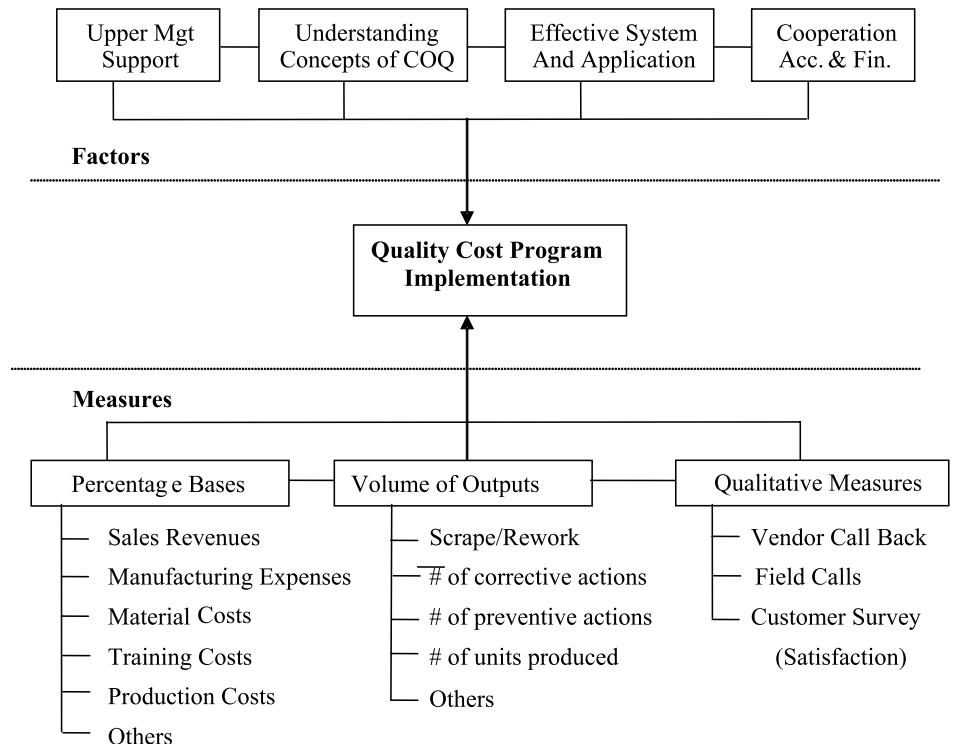
- *Understanding Concepts of Cost of Quality.* A group of respondents indicated that lack of knowledge of cost of quality caused unsuccessful quality cost implementation. It is important for everyone involved with the programs to understand the concept and elements of quality costs. There are a number of current quality cost techniques used in today's manufacturing industry, such as the quality cost model (prevention, appraisal, and failure costs), the Activity Based Costs (ABC) model, Taguchi Loss Function, Total Cost Management (process analysis and ABC), and others. These techniques might have different methods, but they all

focus on the foundations of learning and training.

- *Cooperation from other departments.* Most respondents discussed the importance of cooperation from the financial and accounting departments to the quality cost program. Department managers should understand and accept the value of looking at information and acting with positive steps toward improvement. Moreover, employee involvement is also a vital issue. If workers have high job satisfaction and value preventive actions, the products will meet customers' demand as well as decrease IFC and EFC.

Based on the survey findings and the literature reviews, the study found the causes of difficulty that companies might experience in implementing a quality cost program. These causes can be divided into four main issues: measurement, people, process and information. Figure 3 presents the difficulty of implementation quality costs program; the effect of this diagram is an unsuccessful program.

Figure 2. Factors and Measures of Quality Costs Program Implementation



Last topic is quality cost reduction; studies have showed high but varied percentages of total quality costs based on sales revenues and manufacturing costs. For example, according to Dale and Plunkett's research (1991) of particular industries, quality costs can range from 5 to 25% of a company annual sales turnover. Another study, Gryna (1999) wrote in his article that for most companies, quality costs ran in the range of 10-30% of sales or 25-40% of operating expenses. Rodchua (2005) conducted a study with 46 companies in the manufacturing industry and found that the average total quality costs can range from 2.5 to 5% of sales revenues or 7-10% of manufacturing expenses; and the internal and external failure costs are about 70-80% of total quality costs. This study's results indicated that prevention and external failure costs were the highest priority for cost reduction; prevention costs provided tools and training for reducing wastes in the process.

Recommendations for Quality Professionals and Further Study

The findings of this study will further help industrial/quality professionals in measuring the achievement of their quality costs program or assist businesses in setting up a system of quality cost implementation. The researcher recommends that quality professionals should simply present to upper management the concepts and benefits of the quality costs program as well as give concrete examples of successful companies who have used a similar program. Moreover, quality professionals should consider ways to provide more feedback on workers' progress in the quality costs program; workers might want to know how they are doing and how they can improve their work. The feedback can be shown by several means, such as giving the overall re-

sults in a meeting, posting responses on the workers' charts, talking with each worker, and opening more opportunities for questions and answers in the discussion.

It is important to note that various elements and their relationship are addressed through the diagrams indicated. The effective factors and measures are suggested as a successful model of a quality cost system that could help increase profits for today business in the manufacturing industries. The further study may focus on the factors that affect internal and external failure costs; one could explore the nature of the factor analysis and methods of controlling these poor quality costs.

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Figure 3. Difficulty of Implementation Quality Costs Program - Cause and Effect Diagram

