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The Use of Quality Cost Measurement Systems for Improving Profitability

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THE USE OF QUALITY COST MEASUREMENT SYSTEMS FOR IMPROVING PROFITABILITY

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ABSTRACT

The focus of this study was to determine if the use of a quality cost measurement system will allow companies to track and analyze costs and provide a means of improving profitability. Focusing on the philosophies and theories developed by W. Edwards Deming, J.M. Juran, and Philip Crosby, three of the leading authorities in the quality control field, a quality control system can be designed to track and analyze quality costs. Quality costs have been grouped into three categories: Prevention costs, Appraisal costs, and Failure costs. Prevention costs are those associated with preventing poor quality such as, new machinery, inspections, and training. Appraisal costs are associated with analysis of finished products and other such functions. Failure costs are divided into two further categories: Internal failure and external failure. Internal failures occur as a result of problems within the company. External failures are caused by problems with raw materials from suppliers or

problems with consumers. Failure costs include such items as scrap, rework of product, and placating irate customers. The purpose of this study was to determine if a correlation exists between quality cost measurement and profitability. Information was gathered through secondary data collection. Magazine articles and published studies were the primary source of secondary data. Hypothetical case scenarios were also utilized.

The following hypothesis was tested:
If quality costs are tracked and analyzed, they can be controlled in order to increase profitability.

Results of the analysis failed to supply sufficient information to support the hypothesis completely, but a positive correlation between quality cost measurement and profitability was revealed. Because of insufficient data, it was concluded that the study needed to be revised by changing the sampling frame and determining more useful analysis calculations.

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TO: MOM, DAD, AND ST. JUDE

THANKS A MILLION!

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CHAPTER I

INTRODUCTION

Quality

Imported goods account for an increasing portion of all products purchased in the United States (Greenwood 36). Why are foreign corporations flooding the U.S. markets with goods? How are they able to compete for market share? These are questions that domestic corporations have been seeking to answer. Marketing techniques and product quality have become key issues in determining how to attack competition. For both foreign and domestic companies, marketing techniques and strategies have been built upon a foundation of quality. Time spent conducting consumer surveys is necessary in determining what the consumer wants, but without a level of quality that appeals to their sense of value, customers will turn to the competition. Therefore, the highest priority should be put on product quality and the quality of the system in order to provide a superior product or service. Management has realized the need for increased quality and is beginning to attack the problems associated with poor quality by enhancing and improving quality systems (Shetty 33).

Total Quality Management (TQM) for the entire firm should be the ultimate goal of manufacturers. To achieve this goal it is necessary to install quality management systems, at all levels, that can operate simultaneously to enhance each others' performance. This is not to say that several quality management systems are necessary, one may provide the desired performance. When everyone from the beginning to the end of the process, i.e., from suppliers of raw materials to the start of production to shipping and even sales, has been made responsible for the quality of goods produced, a Total Quality Management (TQM) system has been put in place. Making suppliers responsible for the quality of materials makes techniques such as Just-in-Time manufacturing work more productively. Assurance of supplier quality without having to inspect incoming materials saves time and money and frees personnel to be utilized elsewhere in the system if necessary. Once in place, the effectiveness and efficiency of the system depend upon the consistence with which controls in the system are utilized. The TQM system can be used to control product quality and enhance efficiency at all levels of production. (For purposes of this research project, I shall focus on quality in production facilities. Some issues concerning quality may apply to businesses in general but more specifically to manufacturing environments).

American business tends to examine quality largely from the perspective of management when, in actuality, it is the customer who defines quality (Shetty 33). Quality must be viewed and defined from the customers' perspective. A firm's products must be compared with competing products or services from the customer's perspective. Conformance can be tested and problems can be corrected once quality is defined from the consumers' perspective (Simmons 5).

The word quality means different things to different people. The first house a young person buys appears to him to be of superior quality, even though it is an older home and in need of some repair. To an established business man wanting a new, modern dwelling, the same house would be undesirable. For this reason, quality is usually defined as "fitness for purpose." While the older home may be satisfactory for the young man to begin a family, it would be inadequate for the business man with a family to shelter and peers to impress. However, it is important to remember the driving forces behind the choice of a quality level include consumer needs, wants, and perceptions. In determining "fitness for purpose," the concepts of necessary and sufficient versus superior and excessive come into play. Both men in the previous example have determined that a house is necessary. While a small bungalow may be sufficient for the young man, it would not fulfill the needs and wants of the business man. On the other hand, a mansion with 30 rooms may be considered by both to be superior to the bungalow. While the business man views the mansion as being adequate to suit his needs and wants, the young man will find the mansion excessive. The young man may only need a five room house or bungalow to suit his needs and wants. Quality in Products can be viewed in the same way. An item one consumer finds inadequate, i.e., necessary and sufficient, another consumer may view as insufficient. Yet another consumer may consider the item to be superior in quality but excessive, i.e., the item is superior to the others but the additional quality is more than needed or wanted.

Perceptions of quality and the concepts previously mentioned are influenced by which needs and wants have been satisfied and which have yet to be fulfilled. According to Abraham Maslow, each individual has basic needs that can be arranged into a hierarchy. As the most basic needs, physiological needs, are satisfied, they give way to other higher needs, safety needs. Satisfying safety needs gives way to yet even higher needs, social needs and esteem needs (Maslow 83). To illustrate the effect of this hierarchy, consider the two home buyers. Both men, having plenty to eat and drink, have satisfied their physiological needs and have been motivated to satisfy their safety needs, protection from physical harm and the environment. The first time buyer finds the bungalow immediately adequate but the business man has satisfied some safety needs and is now motivated to satisfy even higher needs. He has a home but wants a better one to impress friends, to gain social acceptance and self-esteem. Therefore, in addition to being a function of how satisfactorily the intended purpose is served, quality, or perceived quality, is a function of consumer needs and wants. It is important to note that consumers will demand quality from foods and materialistic items utilized in satisfying basic needs. Food is a basic need, yet most consumers demand quality in their foods. Consumers will have predetermined levels of quality to satisfy basic needs and "fitness for purpose" which may or may not change depending upon the urgency of the need and other extraneous variables such as time constraints or cash flow.

Price is another important consideration. The price we pay for something will influence the perceptions of the quality we expect from it. When we pay $50,000 for a house 30 years old, we do not expect the same quality as if we were paying $250,000 for a brand new one.

Value in quality is established by comparing equal or comparable items. When a product is purchased, not only is it weighed against similar products (houses the same age in the same neighborhood), but also compared to others (a bungalow or mansion) to determine the relative value of the product level. For another example consider the following: A person buys six pairs of shoes for $20 each and scraps them as they wear out instead of buying one pair for $120 that will last longer and have higher prestige value. Assuming the decision is not affected by cash flow or other extraneous influences, this is a comparative value measured from the customer's perspective defined by the customer's terms. This emphasizes that because customers usually have a choice, the value and quality must be customer oriented. The quality of design and manufacture of the $120 shoes is not the only factor in determining value.

Therefore, setting quality standards must consider the criteria customers use when they judge value. Standards are usually set to control the product features that consumers consider to be important. For example, the customer may not know the specific amount of carbonation in a drink. However, if the drink is flat (lacking carbonation) when opened, the consumer is unhappy. The value consumers receive is judged by the product features found most beneficial to them, not the manufacturer. Value cannot be expressed as a mathematical formula but the concept of relative value can be expressed in the following model:

PERCEIVED VALUE = PERCEIVED QUALITY as a function of comparative PRICES

Stated another way: Product preference is determined by the perceived value or perceived quality relative to the price ratio of one product compared to a competing product. For example, the perceived value of a Ford Pinto is different from that of a Rolls Royce. The high price and the perceived quality of the Rolls Royce tend to make it more valuable than the Pinto. This is not to be confused with making a good deal and getting a bargain. If the Rolls Royce is purchased for the same price as the Pinto, that doesn't make the Rolls Royce less valuable. The purchaser has made an extremely good deal so long as the Rolls is in top quality condition. Again, the needs and wants of the individual consumer come into play when determining value. It is important to remember, value and quality, like beauty, are in the eye of the beholder -- the consumer. Although quality is a complex concept, it is a key attribute used by customers to evaluate products or services.

General Dimensions of Product Quality

There are several reasons why it is difficult to define quality precisely. First, attributes associated with quality vary among products. For an automobile quality may include performance, durability, styling, speed, ease of handling, safety, comfort, value, and ease of repair. Hotel quality may include ease of check-in, room cleanliness, room service, maid service, non-smoking room or other aspects. Quality attributes and standards also vary among firms. For example, the standards for Famous Barr may differ from those for Wal-Mart. Second, quality attributes include both product and service. While some companies distinguish between product and related services, others may combine them. Delivery, repair and maintenance, sales contact, technical support, complaint handling, ordering, and billing are typical service attributes. Quality is difficult to define but for individual items quality must be defined specifically. Defining the quality of a product is done through the use of various specifications that differentiate it from other products. Quality has numerous components of dimensions. General dimensions of product quality include the following:

Performance. These are the primary operating characteristics of products. For example, shoes are used for running, walking, jogging, and to protect feet.

Features. These are the secondary characteristics that supplement the products' basic characteristics. Padded insoles, arch supports, gripping treads, etc., would be secondary features of a pair of shoes.

Reliability. The probability of a product failure within a specified period of time is a measure of reliability.

Conformance. Quality of conformance is the degree to which a product's design and operational characteristics match pre-established standards, i.e., size, shape, etc.

Durability. How long will it last? Durability is the amount of use before the product physically deteriorates.

Serviceability. Ease, speed, courtesy, and competence of repair are encompassed by serviceability. These are tangible qualities that have been designed into the product and intangible qualities in the form of service.

Aesthetics. How does the product look, feel, taste, sound, or smell to the customer? This is an appeal factor.

Perceived Quality. This is transmitted through the image, reputation, and name of the product (Shetty 34).

Quality Control

As for any business function, a systems approach to quality is required to assure maximum operational effectiveness. A quality system is a network of administrative procedures designed to deliver a quality product to the customer. A quality management system provides and coordinates operations to ensure an optimum quality product at a minimum manufacturing cost. A properly designed system will serve this purpose. The determination of optimum quality will be influenced by what the targeted consumers consider to be necessary and sufficient vs. superior and excessive. Before the era of measurement, the look, feel, size, appearance or any other characteristics of a product were determined by each individual craftsman as he manufactured his product. Some physical attribute was generally used as the center of design. For example, a blacksmith fitting a knight.

In the early 1600's, machines came into use as a supplement to human skills but the quality of the product continued to depend upon the crafstman for fitting, filing, and adjusting as the product was being built. With the introduction of the assembly line technique in the 1800's, more than one person contributed to the quality of the product. The need for interchangeable parts spurred the development of mass production and the need for measurable specifications to ensure a quality product. The use of inspectors lessened the operating burden on foremen and provided a standard for quality within an area of the production process.

Statistical control systems were brought into the picture by World War II. These systems used standard deviations, averages and ranges, and other statistical tools. The statistical control systems have been slowly replaced by quality control systems that emphasize prevention of defects using statistics as a tool rather than a system itself (A more detailed history of quality control is presented in Chapter II). Today a typical quality control system includes quality engineering, quality measuring programs, product and process control, statistical techniques, special studies, advanced quality planning, customer quality relations and complaint analysis, quality training, and administration of the quality system (Simmons 9).

Objectives of Quality Control

Satisfying the customer, producing a quality product as inexpensively as possible, and meeting delivery requirements are the primary objectives of quality control. The highest quality possible is not required as long as the fitness for purpose meets the requirements of the customers and they receive it within a specified time for the going market price.

There are five basic stages in quality control that help meet the primary objectives. First, specifications and design standards are set. Second, the materials and tools necessary to produce the product are gathered. Third, the product is manufactured. Fourth, mistakes are corrected and precautions are taken to prevent them from recurring. Finally, the product is inspected and possible adjustments in specifications and/or processing are considered.

Quality Costs

The challenge of every competitive firm is to survive and produce a profit. Continually operating at a loss will cause a business to eventually fold. Determining the amount of profit involves keeping track of costs. Profit is the difference between the selling price and all manufacturing costs, research and development, advertising, distribution, overhead, etc. Substantial reduction in manufacturing costs, etc., will increase profits. A decrease in costs as a result of a cost reduction shows up as an increase in profits, provided the prices are not lowered and sales are not decreased. In the area of quality, costs are not so easily accounted for since nearly everything a company does has to do with quality. For our purposes, quality costs will be limited to those incurred during the production process and service after the sale. Such costs include, but are not limited to, inspection of incoming materials, preventive maintenance, machine repairs, specification revision, scrap, placating irate customers, and service calls. These items, and others, are referred to as operating quality costs because they are considered in the identification, analysis and control of quality costs incurred as part of normal business operations.

In tracking and analyzing quality costs three general categories are normally used:

Prevention costs, appraisal costs, and failure costs. Failure costs can be subdivided into internal failures and external failures. These components of quality costs will be discussed in further detail in Chapter II.

The cost of quality is closely related to the quality standard. To illustrate, consider the following scenarios;

In a disorganized production shop where defective work is made continually, the smallest quality control will show a marked improvement. When defects have been reduced to a reasonable level because of obvious quality control remedies, a larger effort will be necessary to further reduce defectives. If a production shop is set up to produce zero defects regardless of cost, eventually a point will be reached at which no matter how much effort is spent on quality control, product quality will not increase significantly.

These scenarios illustrate that the relationship of quality cost to a quality standard is similar to the laws of diminishing returns. There is also a point at which an increase in quality is of no added value to the customer. Therefore, there is some point below the absolute highest quality standard that will provide quality products at a minimum total cost for quality.

Statement of the Problem

The purpose of this report is actually two-fold: First, methods for analyzing quality costs will be presented. Determining which costs to include and putting them into understandable measurable terms will be the focus of the analysis methods. Second, once costs have been analyzed, there will be a presentation on how these results can be used to determine where costs can be reduced or where certain plans of action will produce the most desired results. As previously mentioned, this research project will be focused on production facilities. Even though some aspects of quality mentioned may apply to businesses in general, they will be referring more specifically to manufacturing environments.

CHAPTER II
LITERATURE REVIEW

What is Quality Control?

Faced with international competition, heightened customer awareness and expectations, and declining profitability, U.S. companies are finding that quality is an integral part of their existence. Product quality is an issue that is being emphasized more in many business strategies in order to compete in an increasingly competitive market (Shetty 33). A major concern of management is the cost associated with providing and improving product quality. An understanding of quality costs can lead to a system of tracking and analyzing these costs. Once tracked and analyzed, the impact of quality costs on profitability can be determined. The challenge is developing a method or system that can be used to control quality costs in order to improve profitability.

In order to comprehend a quality cost system, one must have a basic understanding of what quality is. As stated in Chapter I, the basic meaning of the word quality is "fitness for purpose or fitness for use" (recall the scenario of the men purchasing houses). In industrial companies quality is also given meanings such as grade, quality of conformance, quality characteristic, the quality function, or a department. "Control as a process is defined as a planned cycle of activities incorporated in order to achieve an intended goal, objective, or standard." Other commonly used definitions of control include: 1) a device which directs, verifies, or corrects; 2) the act of directing or influencing; 3) the name of a department which conducts control activities; 4) a standard of comparison as determined by a statistical test usually referred to as a state of statistical control (Juran 4).

With these definitions in mind, quality control can be viewed as the entire collection of activities used to achieve "fitness for use," i.e., the process by which a company's quality functions are carried out. These activities include, but are not limited to, measure of actual quality performance, comparison with standards and actions taken on the difference between standards and actual measurements. A quality control department devotes itself full-time to monitoring and coordinating the quality activities.

History of Quality Control

The convergence of people into communities gave birth to the marketplace where the maker of an item was separate from the user. Maker and user met face to face in the marketplace to buy, sell, or trade. There were no specifications for goods. Each man had to determine product value and quality through the use of his own senses of sight, feel, and taste. Congregation of people into communities of sizable population, such as the early Temple City, provided substantial, stable markets which allowed for development of specifications for products and processes.

The earliest forms of organization came from the construction projects in the cities. Because human life and safety depended upon structurally sound dwellings, components used in construction, i.e., bricks, and processes, i.e., clay tempering, were widely standardized. Instruments such as the square, level, and plumb bob were commonly used to help ensure conformance to specifications. Design of such construction projects was entrusted to architects and engineers with proven reputation and inspectors closely monitored the quality of components and processes.

In the pre-industrial marketplace, problems with quality could be resolved fairly easily since producer, user, and the goods were present simultaneously. When products began to be produced in small shops and moved between cities the need arose for specifications, samples, and warranties because now merchants intervened and the maker and user no longer met face to face all the time. Trade guilds appeared and flourished between the thirteenth and eighteenth centuries. These guilds were monopolies for a given trade in a particular city but they benefitted the public by insisting that guild members adhere to minimum quality standards. Specifications and regulations for governing the quality of materials used, the nature of the process, and the quality of the finished product were spelled out in great detail. Since the reputation of all guild members was reflected in the work of each individual member, finished goods were often inspected and sealed by the guild.

The expansion of the manufacture and consumption of goods was made possible by the Industrial Revolution. Growth of large companies with huge factories aided in the solution of some quality problems and technological advances made it possible to increase product quality. New quality problems were created but were mainly managerial. For example, in the small shop, the master was present with the craftsmen and could personally oversee operations. In the huge factories there were specialized departments and the president could not personally oversee all operations.

When mass production was made possible by the use of power-driven machinery, the emphasis for attaining quality rested more on the quality of design, process, and machine and tools rather than the individual craftsman. Mass production is based on mass consumption. Widespread use of products provided feedback that could be used for quality improvement. The use of interchangeable parts or components also put emphasis on quality of design, process, and machine and tools. Quality of components was, and still is, of utmost importance in producing a quality finished product.

Technology has increased to the point where manufacturing process systems have become quite complex. Work may be subcontracted to other contractors, who in turn may subcontract to a third layer of subcontractor, etc., each level allowing the chance for problems with product quality to arise. Technological advances have benefitted every facet of human life. People have come to depend on many of these advances. Just as human life and safety were the inspiration for development of specification and standardized processes, the importance placed on quality control and conformance to specifications today is even more essential. The well-being is dependent upon product quality. A defective circuit breaker can result in a power failure for an entire community or a highly publicized missile fails to launch and a nation is humiliated (Juran 22). Technology will continue to advance, which means the sophistication necessary to monitor and control quality must also advance.

Trends and Emerging Concepts

Throughout the past several decades noticeable trends or movements have emerged to proliferate and enhance quality control techniques. Statistical quality control (SQC), traced back as far as 1924, initially emphasized the application of statistical methods to manufacturing problems. SQC contributed to the development of statistical sampling plans (Juran 24). Emerging in the early 1950's, the total quality control movement emphasized that a quality control program should be comprehensive to include nearly every aspect of control from design to incoming material to special process studies (Juran 24). The reliability movement of the mid 1950's emphasized product design and techniques for quantifying reliability (Juran 24). In the early 1960's the product assurance (product effectiveness) movement emphasized that maintainability should supplement reliability (Juran 25). Also in the early 1960's was the zero defects movement emphasizing the motivational aspects of quality control during the manufacturing phase (Juran 25).

Each movement initially emphasized a new aspect not previously stressed, but all inevitably overlapped. Contributions to the quality field have been made by each movement. The overall effect of these movements has been a long, slow trend of changing emphasis on particular parts of the quality function. Early movements focused on identifying problems and now emphasis has slowly shifted toward prevention of quality failures. The zero defects and product assurance movements continue on with new technologies providing a means of enhancing the total quality control function. All movements were accompanied by different philosophies and concepts. Among the most prevalent philosophies today are those of W. Edward Deming and Philip Crosby. Deming has been given the credit for helping to turn Japan into a major power in the global trade market (Greenwood 36). Philip Crosby is best known as the creator of the "Zero Defects" and "Buck a Day" concepts and a strong advocate of quality through prevention of defects (Crosby i). Both men have developed theories containing fourteen steps or points of interest to be considered when developing a quality control system (see Appendix A). The steps of each are similar and in some cases overlapping. Even so, they both provide for consideration of factors involved with management, the production process, the employees, and the finished product. Another prominent figure in the specialty of quality control is J.M. Juran. Juran is the author of the leading international reference literature and training programs in the quality control field and today remains one of the top quality "gurus."

Quality Costs

The price that can be charged for a product is determined by how much consumers are willing to pay which, as previously discussed in Chapter I, is influenced by the perceived value and quality of the product. Due to competition and heightened customer awareness, among other things, producers cannot add any profit margin desired to the costs of manufacture. There is a maximum price that can be charged before no one will purchase the products. If the costs for providing and improving quality are too high, profits will be reduced. Cost of poor quality is higher than for good quality to a point. A model for optimum quality costs will be presented in Chapter IV. Profit is determined by the selling price and costs to market the product. Profit is the selling price less the costs of production, distribution, R & D, marketing, overhead, etc. Even though quality costs have such an impact on profits, many manufacturers are mostly concerned with finished product quality and do not realize the total costs involved with achieving this quality. Quality costs are not easily measured because nearly everything done in a company relates to quality. To help classify, quality costs are usually considered under one of three headings: Prevention costs, Appraisal costs, and Failure costs. Prevention costs are those incurred to ensure faulty work is not done in the first place. These costs include quality engineering, inspection during production, training of operators, and maintenance of machines and equipment. Appraisal costs are incurred when determining if the quality of the finished products to determine their conformance to specific standards and eliminating defects, at any stage, that do not conform to these standards is the primary function of appraisal. Failure costs are incurred when products fail to comply with specifications. Scrap loss generated by unusable product, rework and corrective actions, design modifications, loss of production capacity, service after sale, engineering investigation and change orders, placating irate customers, and the loss of future orders due to product failure all contribute to failure costs. Failure costs can be subdivided into internal failure and external failure. Internal failures are those which normally occur at the point of manufacture such as scrap, rework, trouble shooting, problems with further production of the product, and are usually caught before leaving the factory. External failures are those associated with products that have left the manufacturer or are incurred as a result of errors in engineering or installation of equipment. For example, complaints, product repair and customer service, warranty replacement, and poorly installed equipment needing adjustment are all external failures that add costs due to poor quality. In general, prevention costs and appraisal costs are discretionary costs incurred only to the extent that management deems appropriate. These could be referred to as voluntary costs because only the costs management voluntarily includes will be assessed. Failure costs, on the other hand, are involuntary. Costs due to failure are not discretionary and can usually be determined with the help of the accounting department. The total quality cost is the sum of the costs voluntarily attributed to prevention and appraisal and the involuntary failure costs. Failure costs are generally in some proportion to the quality of product desired, i.e., the higher the quality, the lower the failure and vice versa. Appraisal costs generally stay the same unless additional inspection is required. Prevention costs are related to quality in a different manner. With low quality, prevention costs are relatively low. As prevention efforts are increase to improve quality, prevention costs increase similar to the laws of diminishing returns. This means that at a certain point, no matter how much money is supplied to prevention, the quality of the products will not improve significantly enough to justify the expense. Therefore, the minimum total cost of quality is found somewhere just above zero defects. There is a minimum cost percentage of defective work below which it is unwise to go (Caplen 16).

As just discussed, as quality increases, the cost of production increases also, to a point where additional effort to improve quality is too costly and undesirable. Likewise, the value of a product to consumers increases as quality increases, to a point where improved quality only slightly enhances the customers' perception of value. Therefore, in order to achieve maximum profitability, a quality standard must be set at the point where the difference between production costs and customer value is the greatest. This means that the highest quality product is not always the most profitable.

Determining quality costs is the first step in controlling them. How quality costs are controlled will depend upon how they are interpreted. Standing alone, the quality costs may not generate much attention. Some method of determining whether the sum total of quality costs is good or bad is necessary. One approach is to compare the quality costs of one company to others to determine if costs incurred are normal for the industry. This may be difficult because of the reluctance or inability of companies to share data and the use of different accounting systems. A second approach is to determine which costs are avoidable. Computing what costs are avoidable if certain actions are taken can help determine if quality improvement is a problem, how big of an improvement is indicated as necessary, and where are the best points of attack? A third approach is to estimate how much of the quality costs can be recovered. In essence, what kind of "return on investment" can be expected? In other words, if money is spent on improving quality, what savings will be realized in the long run?

Hypothesis

With the preceding information in mind, the focus of this research will be in the area of quality costs, or, more specifically, the cost of quality related to product quality and profitability. The challenge will be determining how to track and analyze quality costs in order to reduce these costs and increase profits. Research will be conducted to support the following hypothesis:

If quality costs are tracked and analyzed, they can be controlled in such a manner that profitability is improved.

CHAPTER III

RESEARCH METHODOLOGY

Purpose

The purpose of this research study is to determine if measuring and analyzing quality costs can lead to the development of a system that will help manufacturers improve the quality of products, while at the same time reducing the cost of quality and increasing profitability. The importance of measuring and analyzing can be stressed by pointing out that leading authorities in the quality control field have provided examples of firms where quality costs ranged from 5% to 30% of sales. When total quality costs of a firm begin to reach one-quarter to one-third of the cost of goods sold, there is cause to take actions to reduce these costs. The professional literature on the topic estimates that 50% of quality costs can be cut with a relatively low investment. This study investigated the hypothesis that investing in the reduction of quality costs can yield an overall cost reduction which in turn will yield higher profits.

Subjects

In this research study, manufacturing firms which have implemented quality cost measurement systems were chosen for analysis. These firms were chosen to provide data to show actual prevention costs, appraisal costs, and failure costs. The information from these firms came from both published sources and confidential files. The data and sources were not identified and came from firms in different types of industries and systems in different stages of development.

To determine the nature and scope of quality cost measurement in major industrial corporations, a survey was done by Thomas N. Tyson, CMA, Ph.D., an agent with the IRS. Tyson contacted 125 randomly selected corporate controllers of the 1985 Fortune 500. Telephone interviews with personnel from 94 of these firms resulted in a 75.2% response rate. In no case were interviews conducted with personnel from organizational levels lower than the controller's department, but referrals to other members of the controller's department were accepted. This was to ensure that the information reported related exclusively to corporate controller department involvement in quality cost measurement. Tyson asked the survey participants, "At your corporation, does the corporate controller's department specifically measure quality costs on a regular basis?" (39). In another study done by K.S. Krishnamoorthi, associate professor at Bradley University, Peoria, Illinois and a member of the American Society for Quality Control (ASQC), 23 quality systems provided data. Krishnamoorthi's study provided information on the relationship between the costs of failure - appraisal and between failure - prevention (53). Information necessary for evaluation and creation of data was provided through published work of the top "gurus" in the quality control field. These gurus include: J.M. Juran, Philip Crosby, and A.V. Feigenbaum.

J.M. Juran is the chairman of the Juran Institute, Inc., Wilton, Connecticut, which offers consulting and management training in quality. He is an honorary member of the ASQC and editor in chief of The Quality Control Handbook as well as author of several other quality control books.

Philip Crosby has 34 years of firsthand experience in quality improvement. He was corporate vice president of ITT, responsible for worldwide quality operations for fourteen years. Crosby is the chairman of Philip Crosby Associates, Winter Park, Florida, a firm which consults with other firms and teaches executives through its Quality College. Over 15,000 executives have attended Crosby's Quality College. The author of Quality is Free and Quality Without Tears, among others, he is also well known as a lecturer.

A.V. Feigenbaum was manager of Manufacturing Operations and Quality Control of General Electric Company, New York, and president of the ASQC.

Instrument

The information for this study was provided through the use of secondary data collection, as noted above. Collection of the primary data was done by researchers through the use of surveys and actual observance of several firms' quality cost measurement systems. The reason data was collected by the primary researchers in this manner was required because the observance of actual systems is the only practical way to provide examples of how such systems function. Secondary data was used as the instrument for this study, due to the time and budget constraints of the researcher. Another reason for the use of secondary data was the reluctance or the unavailability of firms to provide information to the researcher. In order to offset the lack of data from real companies, three hypothetical scenarios were created. Using information provided through the literature, the scenarios were created to show the effect change of emphasis on monitoring parts of a quality cost system have on quality costs overall. As previously mentioned, the literature reveals that firms have provided examples where quality costs amounted from 5% to 30% of sales. Therefore, the scenarios were set up to reflect a major portion of that range. They were set up as follows:

Scenario 1 - a company with no formal quality cost control system and emphasis on correction of failures. Quality costs amounting to 25% of sales.

Scenario 2 - a company with a limited quality cost control system with emphasis on appraisal. Quality costs amounting to 15% of sales.

Scenario 3 - a company with a detailed quality cost control system with emphasis on all cost categories, particularly prevention. Quality costs amounting to 5% of sales.

Calculations were performed and charted on tables and graphs that will be presented in Chapter IV.

Procedure

Evaluation of the data is a primary concern in determining if a correlation between quality costs and profitability exists. Different companies use various bases for measuring costs. An analysis of these bases shows that is necessary for different industries to use various bases in order to determine quality costs accurately for each particular company in these industries. The major function in determining if a correlation exists between quality cost measurement and profitability was the amount of cost savings realized by implementing a quality cost measurement system. An evaluation of cost increases is also necessary. Secondary data provided actual company experiences for evaluation of improved quality and achieved cost savings and productivity. To find the data, The

Readers Guide to Periodical Literature and the Business Literature Review were utilized. Articles were found by using the headings "cost," "quality," and the subheading "cost" under the heading of "quality." Once articles were obtained, the references cited at the end of each was examined. This provided references to books that could be found in the library by searching through the card catalog. (Books for this study were obtained from the libraries at Washington University, St. Louis University, UMSL, and the public library system of St. Charles County in Missouri.

Determining if the book or article was useful in the study required setting some sort of criteria for acceptance. The source needed to provide information on quality costs, more specifically the measuring of quality costs, or show an example of a company that measured quality costs. General information on quality costs was obtained from the books while most of the data on companies measuring quality costs came from magazine articles. The only major drawback to this criteria was that it limited sources to a small number. Another problem arose when some of the researchers did not provide information as to how their data was collected. This was done in order to maintain confidentiality. For example, one article specifically states that data was collected from published material and confidential sources.

<u>Analysis</u>

As noted, this study was performed to determine if measuring and analyzing quality costs can improve product quality, reduce quality costs and increase profitability. For this study, companies that utilize quality cost measurement systems were observed. Also, the industries in which these companies compete was observed. This allows for comparison between systems and industries. Data was collected from the reports of experts and authorities in the quality control and quality costs field. Once the savings (or additional costs) had been determined, the effect on profitability was estimated by using profitability ratios. The profit margin on sales, computed by dividing net income by sales, gives the profit per dollar of sales. This ratio gives an idea of whether sales are high or low and whether costs are high or low and provides a relationship between them (Brigham 778). The basic earning power ratio is calculated by dividing earnings before taxes and interest by total assets and is useful in comparing firms in different tax situations and firms with different degrees of financial leverage (Brigham 779). Gathering this data and evaluating it for use in one study provided significant information for consideration in determining whether or not designing a quality cost measurement system would be profitable.

CHAPTER IV

RESULTS

Sample Population

This chapter shall be devoted to presenting accumulated data. The data has been collected from various books and magazines. It will be presented in table and graph forms. Upon researching the available literature, it was discovered that the exact data desired for this study was not contained in the literature. The desired data would have included a summary of quality costs before implementing a quality cost measurement system and a summary of the same costs after system implementation. Although the sample population, companies that have implemented quality cost measurement systems, and the sampling frame, articles and studies published about these companies, remained the same, the criteria for determining acceptability had to be changed. The criteria was changed to allow articles and studies which reported percent change in quality costs as well as those that reported actual figures. To help illustrate the effect of measuring and controlling different areas of quality costs, hypothetical cases were also used.

Raw Data

Quality cost reports can be done at nearly any interval of time desired. Typically, intervals of a week, a month, a quarter, or a year are used. The amount of time necessary to gather information will be a determining factor in choosing a reporting interval. The measurement of actual quality costs is essentially an accounting function. However, the development of the quality cost system requires the close interaction of the quality control and accounting departments (Besterfield 304). A significant amount of quality costs can be obtained from the accounting department, because accounting cost data is established by department codes. However, some quality cost data crosses departmental lines and may require special forms to make collection of quality costs possible. For example, a rework cost may have to be reported on a special form to determine the cause of failure and department responsible (see Figure 1).

The form in Figure 1 requires the person responsible to write down quantities and times. The accounting department can then determine dollar amounts. The person responsible for reworking can also be supplied with the necessary information to complete the form. Forms such as the one in Figure 1 can be used any time several departments are involved. For example, installation of new equipment may require the use of the engineering and maintenance departments. Any costs that cannot be acquired through the use of normal departmental codes may require the use of a special form. Special forms should be designed to accumulate the necessary data quickly and easily. Special forms should only be used when the information needed cannot be obtained through already existing sources. Creation of too many special reports and forms introduces additional costs into the system. In order to provide sufficient information for quality cost analysis, quality costs should be collected by: department, work center, operator, product line, project and defect classification.

Once all quality cost data has been accumulated, it is put into report form, usually by the accounting

Figure 1

Scrap and Rework Report

Date

Product

Quantity Reworked ____________ @ $______ each

Time required to rework ____________ @ $______ each

Quantity Scrapped ____________ @ $______ each

Total cost $______

Reason for scrap and/or rework:

Ways to prevent recurrence of the problem:

department. The operating quality cost report is the basic instrument used in controlling quality costs. Table 1 provides an example of such a report. This report shows the monthly quality cost as well as a year-to-date total. Costs are broken down into categories and variances from budgeted or planned costs are also reported. Using the variances, trouble areas can be spotted and plans may be developed from controlling these areas. In order to present the information in relation to some aspect of the business that is sensitive to change, indexes of quality costs per various measurement bases are shown at the bottom of the report. Table 1-A shows another example of a quality cost report.

Monthly reports themselves are of limited use. Therefore, it is necessary to do trend analysis. Trend analysis provides information for long-term planning. Information needed for trend analysis comes from the monthly quality cost reports. Trend analysis can be accomplished by category, by subcategory, by department, by measurement base, by product, by plant within a corporation, and by any combinations thereof. As previously mentioned, any time frame may be used,

Table 1

Typical Monthly Quality Cost Report (Values in thousands of dollars)

October			*Year-to-date*	
Actual	*Variance*	*Category*	*Actual*	*Variance*
		A. Prevention cost		
18.3	3.2	1. Quality engineering	190.1	10.1
4.6	0.6	2. Design and development	61.8	7.5*
2.6	0.9	3. Quality planning by others	20.7	7.3
7.3	2.1	4. Quality training	46.8	20.3
2.4	3.4	5. Other	31.2	25.0
35.2	10.2	Total prevention cost	350.6	55.2
7.7%		% of total quality cost	9.4%	
		B. Appraisal cost		
9.6	1.8*	1. Inspect and test incoming materials	87.3	7.1*
32.5	15.4*	2. Inspection and test	323.0	105.0*
14.1	27.4	3. Product quality audits	140.9	269.7
1.4	1.1	4. Materials and services consumed	16.5	8.8
4.1	1.6*	5. Equipment calibration and maintenance	23.4	0.0
61.7	9.7	Total appraisal cost	591.1	166.4
13.5%		% of total quality cost	15.9%	
		C. Internal failure cost		
14.6	9.6*	1. Scrap	50.0	8.0
197.2	124.3*	2. Rework	1305.6	557.6*
25.2	8.1	3. Failure analysis	185.1	0.4
6.8	2.3	4. Reinspection	88.0	3.0
14.1	6.6*	5. Fault of supplier	152.1	77.2*
0.8	0.2	6. Downgrading	8.1	1.9
258.7	129.9*	Total internal cost	1788.9	621.5*
56.4%		% of total quality cost	48.1%	
		D. External failure cost		
8.6	1.6*	1. Complaints	75.3	5.3*
41.8	1.2	2. Rejected and returned	403.6	26.4
25.6	0.3*	3. Repair	256.5	3.5*
21.9	27.0	4. Warranty charges	226.6	263.4
4.9	4.0	5. Errors	28.5	10.2
0.0	0.0	6. Liability	0.0	0.0
102.8	30.3	Total external cost	990.5	291.2
22.4%		% of total quality cost	26.6%	
458.4	79.7*	Total operating cost	3721.1	108.7*
		Measurement bases		
6.5		1. Direct labor ($/man-hour)	5.3	
8.8		2. Sales (%)	9.0	
16.7		3. Manufacturing cost (%)	16.3	

*Unfavorable variance.

SOURCE: Dale H. Besterfield, Quality Control, 2nd ed. (1986) p. 307.

Table 1 - A

QUALITY COST ANALYSIS $000 BY QUARTERS

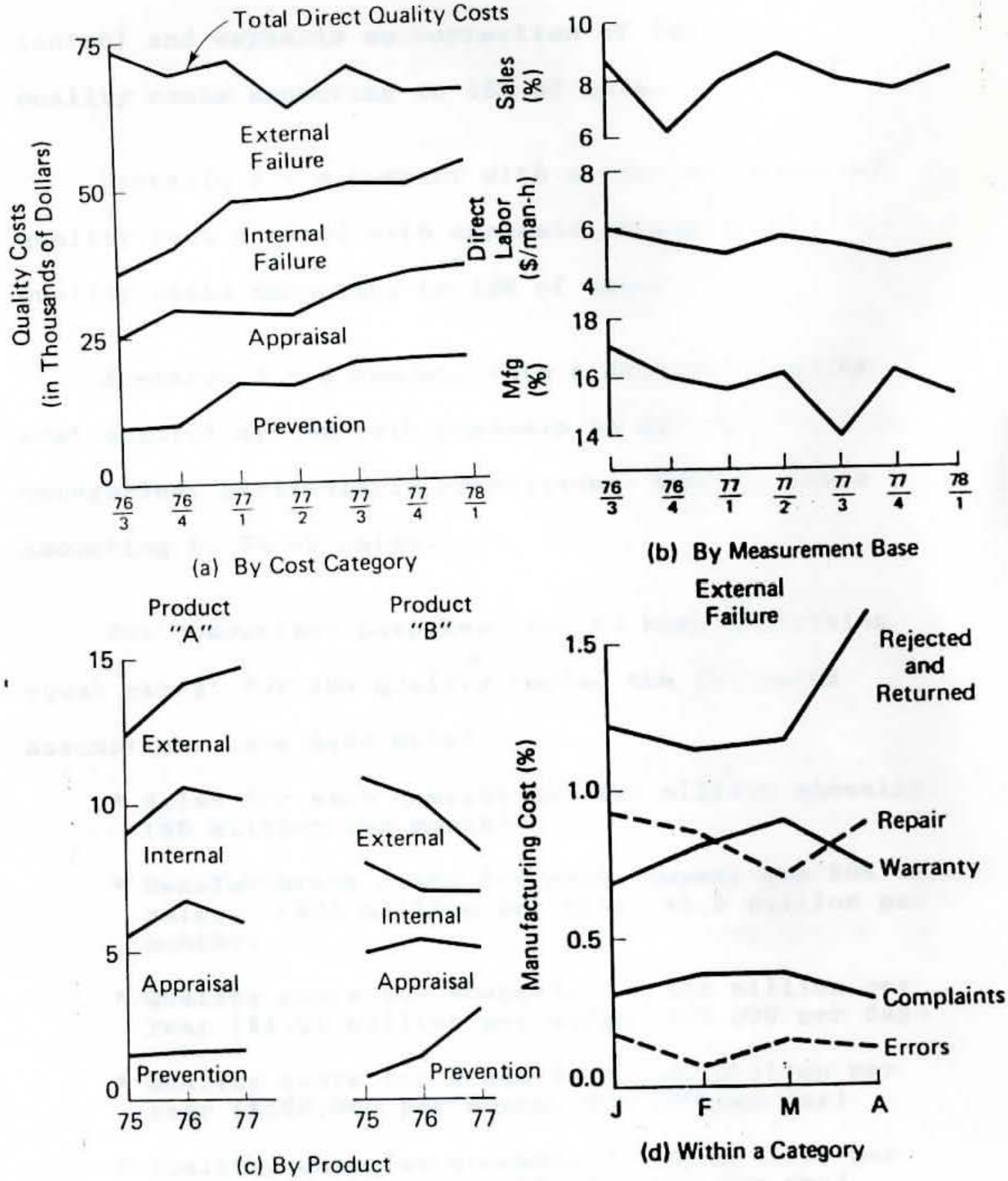
Cost Categories	*Quarters* *1st*	*2d*	*3d*	*4th*
Quality control engineering	5	5	5	5
Tool maintenance	4	5	2	4
Gage control	1	1	1	1
Other	1	—	1	—
Total prevention	11	11	9	10
Inspection	66	72	51	66
Test	24	30	10	18
Test materials	12	22	12	27
Vendor inspection	8	9	6	8
Other	21	20	19	22
Total appraisal	131	153	98	141
Complaints	601	51	668	1,318
Rework	74	98	55	69
Spoilage	58	20	30	35
Other	24	30	22	26
Total failure	757	199	775	1,448
Grand total	899	363	882	1,599
Standard direct labor	226	296	124	138
Net sales billed	4,359	3,557	2,707	1,987
Cost of sales	2,341	2,068	1,646	1,174
Contributed value	1,545	3,171	1,592	1,171

SOURCE: J.M. Juran, Quality Planning and Analysis, (1978) p. 66.

such as a month, quarter, or year, depending upon the purpose for analysis. Figure 2 provides examples of some of these graphs. Figure 2-a uses the four cost categories by quarters and shows cumulative amounts, i.e., each line on the graph includes the ones below it. Figure 2-b shows costs for different measurement bases over quarters. Figure 2-c shows trend analysis of two different products. Graphs such as this can be used to determine which products should be "Weeded out" (discontinued) or improved. Figure 2-d is a trend analysis of one cost category over a period of months with manufacturing costs as a base.

Due to the reluctance of manufacturers to share information with regard to costs, particularly quality costs, the following data is hypothetical. Although the numbers are not real, the graphs and tables still represent actual cause and effect situations. The information used in the following scenarios could all be from one company or three separate companies. For identification purposes they will be referred to as follows:

Figure 2



SOURCE: Dale H. Besterfield, Quality Control, 2nd ed. (1986) p. 306.

Scenario 1 - a company with no quality cost control and emphasis on correction of failures. Quality costs amounting to 25% of sale.

Scenario 2 - a company with a limited amount of quality cost control with emphasis on appraisal. Quality costs amounting to 15% of sales.

Scenario 3 - a company with a detailed quality cost control system with emphasis in all cost categories, particularly prevention. Quality costs amounting to 5% of sales.

For comparison purposes, and to keep everything equal except for the quality costs, the following assumptions have been made:

* Sales for each company are $60 million annually. ($5 million per month)
* Manufacturing costs for each company are 50% of sales. ($30 million per year, $2.5 million per month).
* Quality costs for scenario 1 = $15 million per year ($1.25 million per month, $60,000 per day)
* Quality costs for scenario 2 = $9 million per year ($750,000 per month, $36,000 per day)
* Quality costs for scenario 3 = $3 million per year ($250,000 per month, $12,000 per day)

* Figures for each month based on 250 work days per year with the appropriate number of days allocated to each month: Jan-22, Feb-20, Mar-22, Apr-21, May-23, Jun-21, Jul-19, Aug-20, Sep-19, Oct-23, Nov-21, Dec-19.

See Tables 2-A through 2-C for data based on the preceding assumptions. Notice that variations in percent of total operating cost for each category have been kept the same for all scenarios. Each percent change in one scenario is matched by an equal change in the other two. For example, the percent of total for prevention in scenario 1 varies from 5.0 to 4.0 to 6.0 in the months January through March. In scenario 2 the percentages vary 20.0 to 19.0 to 21.0, and in scenario 3 they vary 35.0 to 34.0 to 36.0 for the same months.

To support the data and calculations made in Tables 2-A through 2-C, actual company experiences and surveys are presented in Tables 3 through 6. Cause and effect relationships for quality costs are provided in Figures 3 through 5. Explanations of these tables and figures follow:

Table 3 shows the difference in quality costs as a percent of shop cost output before a quality cost measurement system was implemented and after implementation. After spending $26,900 on prevention

Table 2-A

Case Scenario 1 ($ in 000)

SALES = $60 million
MFG COST = $30 million

Category	Jan	Feb	Mar	Apr	May	Jun
Prevention	66.0	48.0	79.2	88.2	110.4	50.4
% of total operating cost (O.C.)	5.0	4.0	6.0	7.0	8.0	4.0
Appraisal	198.0	192.0	211.2	189.0	234.6	176.4
% of total O.C.	15.0	16.0	16.0	15.0	17.0	14.0
Int. Fail.	330.0	312.0	343.2	302.4	372.6	302.4
% of total O.C.	25.0	26.0	26.0	24.0	27.0	24.0
Ext. Fail.	726.0	648.0	686.4	680.4	662.4	529.2
% of total O.C.	55.0	54.0	52.0	54.0	48.0	42.0
Total Operating Cost	1320.0	1200.0	1320.0	1260.0	1380.0	1260.0
Sales (%)	26.4	24.0	26.4	25.2	27.6	25.2
Mfg Cost (%)	52.8	48.0	52.8	50.4	55.2	50.4

Category	Jul	Aug	Sep	Oct	Nov	Dec
Prevention	46.0	35.4	58.0	110.4	87.5	79.8
% of total operating cost (O.C.)	4.0	3.0	5.0	8.0	7.0	7.0
Appraisal	161.0	141.6	162.4	234.6	225.0	171.0
% of total O.C.	14.0	12.0	14.0	17.0	18.0	15.0
Int. Fail.	276.0	259.6	266.8	386.4	337.5	285.0
% of total O.C.	24.0	22.0	23.0	28.0	27.0	25.0
Ext. Fail.	483.0	743.4	672.8	648.6	600.0	604.2
% of total O.C.	42.0	63.0	58.0	47.0	48.0	53.0
Total Operating Cost	1150.0	1180.0	1160.0	1380.0	1250.0	1140.0
Sales (%)	23.0	23.6	23.2	27.6	25.0	22.8
Mfg Cost (%)	46.0	47.2	46.4	55.2	50.0	45.6

Table 2-B

Case Scenario 2 ($ in 000)

SALES = $60 million
MFG COST = $30 million

Category	Jan	Feb	Mar	Apr	May	Jun
Prevention	158.4	136.8	166.3	166.3	190.4	143.6
% of total operating cost (O.C.)	20.0	19.0	21.0	22.0	23.0	19.0
Appraisal	316.8	295.2	324.7	302.4	347.8	294.8
% of total O.C.	40.0	41.0	41.0	40.0	42.0	39.0
Int. Fail.	158.4	151.2	166.3	143.6	182.2	143.6
% of total O.C.	20.0	21.0	21.0	19.0	22.0	19.0
Ext. Fail.	158.4	136.8	134.6	136.1	107.6	173.9
% of total O.C.	20.0	19.0	17.0	18.0	13.0	23.0
Total Operating Cost	792.0	720.0	792.0	756.0	828.0	756.0
Sales (%)	15.8	14.4	15.8	15.1	16.6	15.1
Mfg Cost (%)	31.7	28.8	31.7	30.2	33.1	30.2

Category	Jul	Aug	Sep	Oct	Nov	Dec
Prevention	130.0	129.6	136.8	190.4	166.3	150.5
% of total operating cost (O.C.)	19.0	18.0	20.0	23.0	22.0	22.0
Appraisal	266.8	266.4	266.8	347.8	325.1	273.6
% of total O.C.	39.0	37.0	39.0	42.0	43.0	40.0
Int. Fail.	130.0	122.4	123.1	190.4	166.3	136.8
% of total O.C.	19.0	17.0	18.0	23.0	22.0	20.0
Ext. Fail.	157.3	201.6	157.3	99.4	98.3	123.1
% of total O.C.	23.0	28.0	23.0	12.0	13.0	18.0
Total Operating Cost	684.0	720.0	684.0	828.0	756.0	684.0
Sales (%)	13.7	14.4	13.7	16.6	15.1	13.7
Mfg Cost (%)	27.4	28.8	27.4	33.1	30.2	27.4

Table 2-C

Case Scenario 3 ($ in 000)

SALES = $60 million
MFG COST = $30 million

Category	Jan	Feb	Mar	Apr	May	Jun
Prevention	92.4	81.6	95.0	93.2	104.9	85.6
% of total operating cost (O.C.)	35.0	34.0	36.0	37.0	38.0	34.0
Appraisal	92.4	86.4	95.0	88.2	102.1	85.7
% of total O.C.	35.0	36.0	36.0	35.0	37.0	34.0
Int. Fail.	52.8	50.4	55.4	47.9	60.7	47.9
% of total O.C.	20.0	21.0	21.0	19.0	22.0	19.0
Ext. Fail.	26.4	21.6	18.5	22.7	8.3	32.8
% of total O.C.	10.0	9.0	7.0	9.0	3.0	13.0
Total Operating Cost	264.0	240.0	264.0	252.0	276.0	252.0
Sales (%)	5.3	4.8	5.3	5.0	5.5	5.0
Mfg Cost (%)	10.6	9.6	10.6	10.1	11.0	10.1

Category	Jul	Aug	Sep	Oct	Nov	Dec
Prevention	77.5	79.2	79.8	104.9	93.2	84.4
% of total operating cost (O.C.)	34.0	33.0	35.0	38.0	37.0	37.0
Appraisal	77.5	76.8	77.5	102.1	95.8	79.8
% of total O.C.	34.0	32.0	34.0	37.0	38.0	35.0
Int. Fail.	43.3	40.8	41.0	63.5	55.4	45.6
% of total O.C.	19.0	17.0	18.0	23.0	22.0	20.0
Ext. Fail.	29.6	43.2	29.6	5.5	7.6	18.2
% of total O.C.	13.0	18.0	13.0	2.0	3.0	8.0
Total Operating Cost	228.0	240.0	228.0	276.0	252.0	228.0
Sales (%)	4.6	4.8	4.6	5.5	5.0	4.6
Mfg Cost (%)	9.1	9.6	9.1	11.0	10.1	9.1

efforts over a two year period, a quality cost improvement, "savings," of $276,500 was realized.

Table 4 presents actual company experiences in controlling quality in order to reduce rejection rates of products. For some companies, the amount of savings achieved has been provided.

Table 5 shows companies that have controlled quality costs and reports the level to which the costs have been reduced. The original levels of costs were not reported by the source. One company reported costs as low as 3% of gross sales with the anticipation of reducing that amount by another 2%.

In a study done by Thomas N. Tyson on quality cost measurement, respondents were divided into 50 industries (39). A survey of corporate controllers of the 1985 Fortune 500 resulted in 94 respondents in 20 different industries. The purpose of that study was to find out the nature and scope of quality cost measurement in major industrial corporations. Table 6 shows respondents by industry. Table 6 implies that industries utilizing interchangeable parts and assembly line techniques make the most use of quality cost measurement systems.

Table 3

Quality Cost Changes

	Before	After
Quality cost as % of shop cost output (divides as follows)	9.3	6.8
Prevention cost	0.2	0.4
Appraisal cost	2.8	2.4
Failure cost	6.3	4.0
Reduction in Appraisal cost		$ 43,000
Reduction in Scrap & Rework		206,800
Reduction in Customer complaints		53,600
Investment in Prevention		26,900
Quality cost Improvement		276,500

SOURCE: A.V. Feigenbaum, Total Quality Control, (1961) p. 99.

Table 4

Company Experiences

Company	Action taken	Reduction in Rejection rate	Savings
Spectrum Control Inc.	change vendors modified mfg. process, trained employees	75% (from 32% to 8%)	$800,000
Pitney Bowes	implemented new "do it right the first time program"	50%	
Terant Company	trained employees	52%	
Nashua Corp.	implemented quality improvement program	79% (from 34% to 7%)	$800,000

NOTES:

* Hewlett Packard calculated as much as 25% of its manufacturing assets were tied up in reacting to quality problems.

* IBM estimated 30% of its manufacturing cost was a direct result of not doing it right the first time.

SOURCE: Advanced Management Journal. "Managing Product Quality for Profitability," by Y.K. Shetty. Autumn, 1988, 33-38.

Table 5

Levels of Quality Cost Reduction

Company	Level of Quality Cost
Kabelwerke Reinshagen GMBH	to 3% of firm's gross sales
N.V. Philips	by 10% of gross turnover
Metalurgica de Santa Ana S.A.	reduced from 13% to 5.6% in a 3 year period
A.B. Electrolux Vastervik	to 5% of gross turnover
Joseph Lucas Birmingham	by 3% of gross turnover

SOURCE: Quality Control in a Developing Economy, by The Council of the Centre for Policy Studies (1970). 157-159.

Table 6
Respondents by Industry

Description	Measurers	Non-measurers	Total
Motor Vehicles & Parts	4	0	4
Industrial & Farm Equip.	4	3	7
Electronics	4	5	9
Scientific & Photo Equip.	2	1	3
Computers & Office Equip.	2	1	3
Building Materials	2	3	5
Food	2	5	7
Petroleum Refining	2	8	10
Textiles	1	0	1
Rubber Products	1	1	2
Pharmaceuticals	1	2	3
Mining & Crude Oil Prod.	1	3	4
Publishing & Printing	1	4	5
Forest Products	1	6	7
Chemicals	1	10	11
Apparel	0	1	1
Furniture	0	1	1
Aerospace	0	2	2
Metal Products	0	4	4
Metals	0	5	5
TOTAL	29	65	94

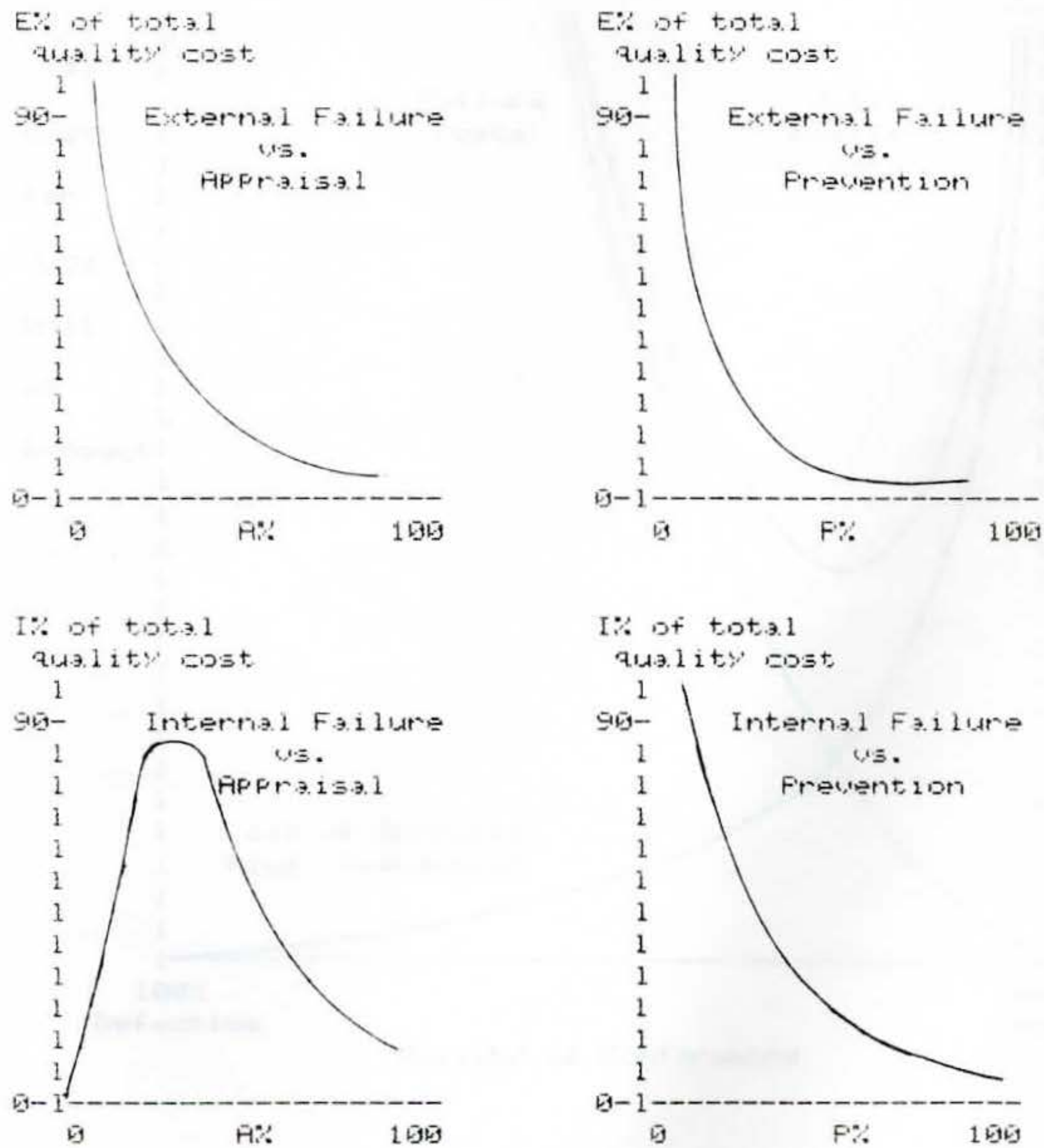
SOURCE: Thomas N. Tyson, "Quality and Profitability," Management Accounting (Nov. 1987): 39.

A study done by K.S. Krishnamoorthi on interrelationship of cost components provided graphs showing relationships between failure costs versus appraisal and prevention costs (see Figure 3). These graphs suggest that as appraisal and prevention are increased, failure decreases.

From J.M. Juran's Quality Control Handbook (5-12), we are provided with a model for optimum quality costs (see Figure 4). In his book, A Practical Approach to Quality Control, Rowland Caplen provides a graphic representation of the relationship between failure, appraisal and prevention costs and the quality of production (16). See Figure 5. These graphs show that there is an optimum mixture of quality control efforts that will provide a minimum total quality cost. Initial quality efforts cause an increase in costs but as the appropriate mix is approached, so is the minimum cost point. Beyond this point, additional quality efforts tend to increase costs without providing a cost effective increase in product quality.

Figure 3

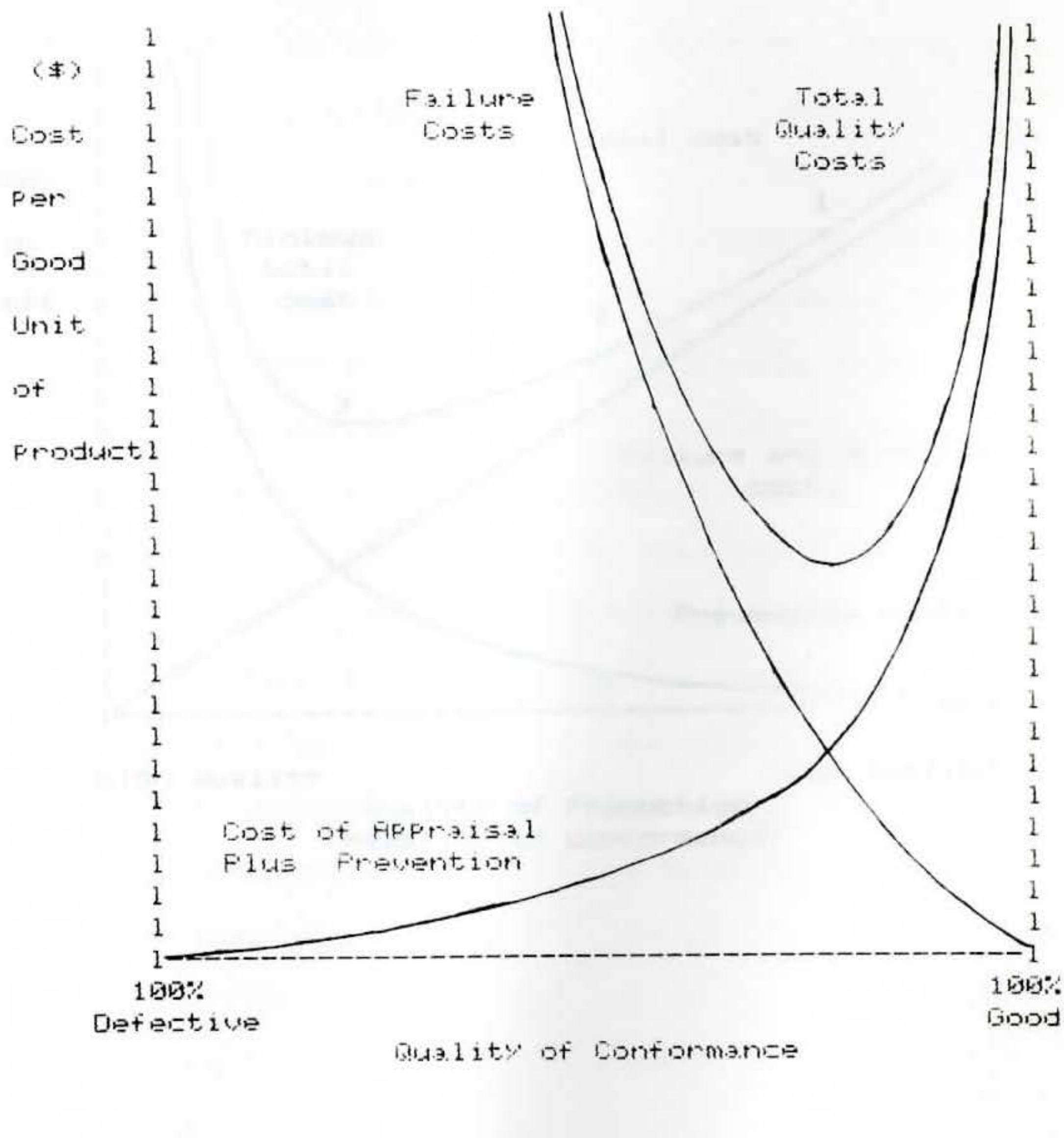
Quality Cost Relationships



SOURCE: K.S. Krishnamoorthi, "Predict Quality Cost Changes Using Regression." Quality Progress (Dec. 1989): p. 53.

Figure 4

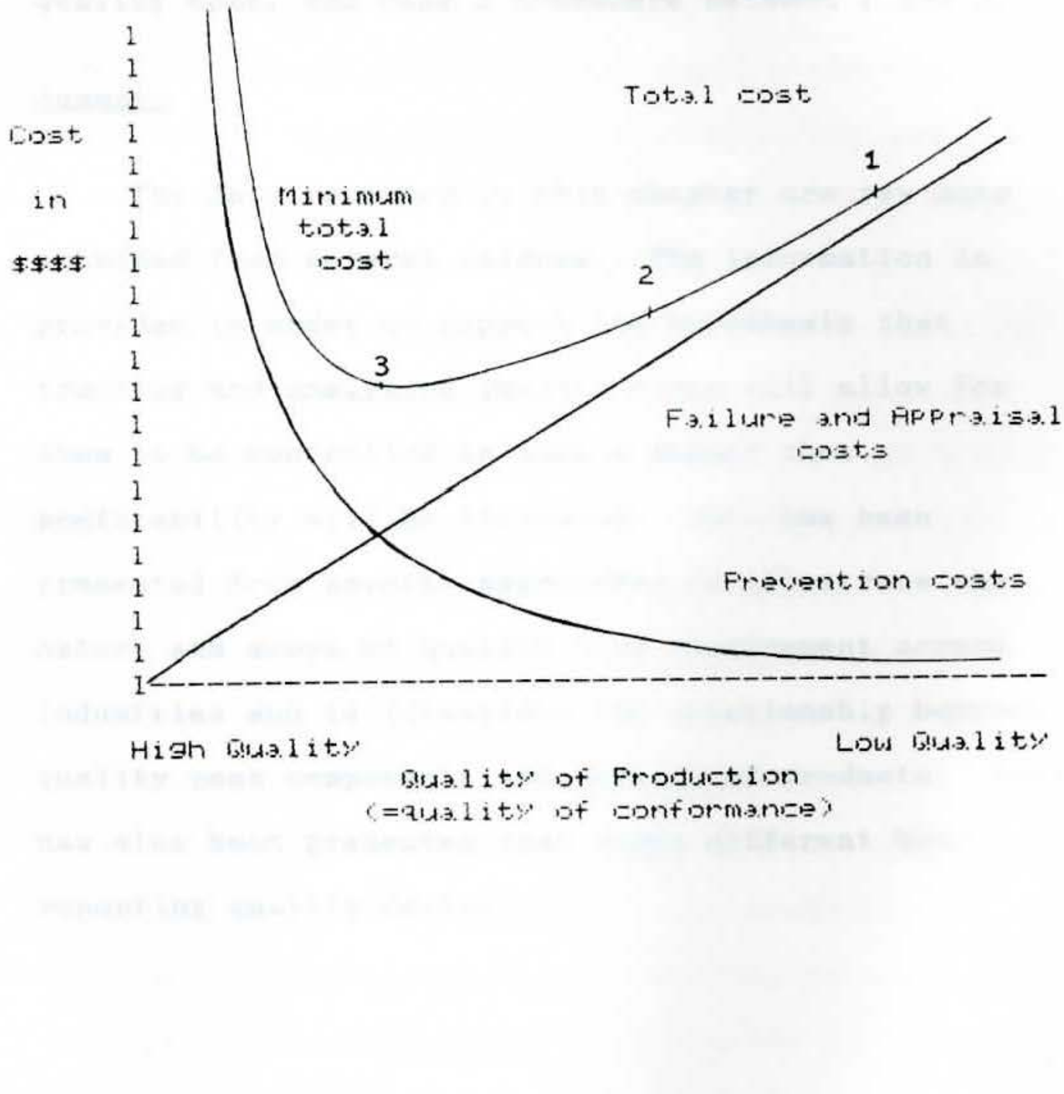
Model for Optimum Quality Costs



SOURCE: J.M. Juran, Quality Control Handbook, 1974) p. 5-12.

Figure 5

The Relationship Between Failure, Appraisal and Prevention Costs, and the Quality of Production



SOURCE: Rowland Caplen, A Practical Approach to Quality Control, (1969) p. 16.

Also note in Figure 5 where each of the case scenarios presented earlier fall. Case 1 representing high failure and appraisal, case 3 minimum total quality cost, and case 2 somewhere between 1 and 3.

Summary

The data reported in this chapter are raw data obtained from several sources. The information is provided in order to support the hypothesis that tracking and analyzing quality costs will allow for them to be controlled in such a manner that profitability will be increased. Data has been presented from several approaches to illustrate the nature and scope of quality cost measurement across industries and to illustrate the relationship between quality cost components and quality of products. Data has also been presented that shows different bases for reporting quality costs.

CHAPTER V
Discussion

Explanation of Results

Examination of the results immediately reveals that 100% of the companies studied reported some sort of improvement. For example, the company in Table 3 showed a quality cost improvement of $276,500. Spectrum Control, Inc., (Table 4), reduced rejection rate and showed a savings of $800,000 as did Nashua Corp. All of the companies in Table 5 indicated an improvement by reducing quality costs to lower levels. Upon closer examination, notice that the data ranges over a period of 27 years with concentration in three years, specifically, 1961, 1970, and 1988. In the beginning of this study it was decided that a correlation between implementing a quality cost measurement system and profitability would be researched. Profitability measures try to relate profits to sales in order to measure the relative efficiency of these policies and decisions within a corporation or industry. Profitability measures also provide a means of measuring investment potential of a corporation or industry. As previously stated, the intention of this study was to correlate profitability and the implementation of a quality cost measurement system. The information necessary to calculate profitability rations is not available from the data collected. Key figures, such as net income available to stockholders and total assets, were not provided by any of the sources. Although these figures were not made available, the effects of quality cost improvement and cost savings are such that an increase in either will increase profitability, provided everything else remains the same. For example, if the company in Table 3 has a net income of $1 million and net sales of $10 million, the profit margin on sales would be 10%. If the costs associated with producing the product are reduced, i.e., a quality cost improvement/cost savings, then the net income will increase causing an increase in the profit margin on sales. Again, this is provided all other variables remain the same. A savings of $276,500 would cause the profit margin on sales to increase toward 12.7%. With regard to the research data, there is not a perfect positive correlation between cost savings and profitability, but a positive correlation does appear to exist. The amount of increase in profitability will depend upon extraneous variables such as the size of the company or the tax bracket the company is in. Quite possibly, other things may happen to mask the contribution made by quality cost improvement to profitability. The consumers may stop buying the product or the price could be changed considerably, both affecting the net income and net sales.

The calculations and figures presented in Tables 2-A through 2-C were made based on the assumptions stated in Chapter IV. The assumptions were made based on information provided by leading authorities in the quality control field. Figures 3 through 5 support the assumption that a reduction of total costs occurs as prevention and appraisal efforts increase. There is an initial cost increase at the beginning of prevention and appraisal implementation and a point at which these efforts become optimal. Prevention and appraisal efforts beyond the optimum increase costs. For Table 2, it was assumed that manufacturing costs for each company were 50% of sales or $30 million per year.

This was done to keep figures for each scenario on an equal basis. From the studies of Krishnamoorthi, Juran, and Caplen (Figures 3-5) the true effect of a quality cost measurement system reduces operating quality costs and therefore, manufacturing costs as well. In case scenario 1 (Table 2-A) total operating costs amount to an average of 50% of manufacturing cost. In case scenario 2 (Table 2-B) the average operating cost is 30% of manufacturing cost and the average operating cost is 10% of manufacturing cost in case scenario 3 (Table 2-C). This means that $15 million, $9 million, and $3 million are the quality costs of case scenarios 1, 2, and 3 respectively. The reduction from $15 million to $3 million represents a $12 million savings in manufacturing costs, i.e., manufacturing costs that may not have been incurred due to implementation of a quality cost measurement system that emphasizes prevention and appraisal. If not incurred elsewhere, this $12 million cost becomes an immediate addition to net income and cash flow. An increase in net income provides for an increase in profitability. This means that the profit margin on sales increases. The basic earning power increases, provided a change in total assets, tax bracket, or interest rate do not have a negative effect. $12 million amounts to 5% of sales. For larger companies, the savings could be higher. Depending upon the company or industry, such savings could prove to be significant.

From the survey done by Thomas N. Tyson, it can be seen that only 31% of the respondents measure quality costs on a regular basis. Of this 31%, most are in industries that utilize assembly lines and interchangeable parts while most of the non-measurers are in industries that do not utilize such techniques. This is not to say only industries utilizing assembly lines and interchangeable parts can benefit from quality cost measurement. Tyson's study provides us with data showing industries in which measurement systems are prevalent. If a company is operating in one of these industries and has not implemented a quality cost measurement system, it may be time to consider doing so in order to compete with companies that have the systems.

K.S. Krishnamoorthi's study provides data that shows a correlation between failure, appraisal and prevention costs. Knowing there is a correlation and knowing how to apply it will allow for the controlling of these costs once a measurement system has been implemented.

Summary

As previously mentioned, there appears to be a positive correlation between quality cost improvement and profitability. Our hypothesis states that tracking and analyzing quality costs will lead to the development of a quality cost measurement system that will allow quality costs to be controlled and profitability to improve. Development of a quality cost measurement system will provide a means of tracking and analyzing quality costs. Knowing what these costs are and where they are incurred will allow for some control (Juran 5-10) but the data gathered for this study is not sufficient enough to show, with any measurable confidence level, that profitability will increase because of that control. The data supplied supports the hypothesis, but there is not enough evidence to allow the hypothesis to be used as an absolute fact. Therefore, utilizing the information that supports the theory that profitability can be increased through the use of a quality cost measurement system, will enhance the performance and improve quality. Enhanced performance and improved quality affect profitability in a positive manner.

Limitations

The biggest problem encountered in this study was the collection of data using the specified sampling frame. Data was collected from magazine articles and studies done on companies that implemented quality cost improvement systems. This information is very sparse and dated since most companies have only recently seen any benefit to using such systems. In the industries surveyed, less than one-third measured quality costs on a regular basis (Tyson 39). The data collected did not readily lend itself to statistical analysis to allow specific inferences to be made. The sources did not provide the necessary information for computing profitability ratios. The study should have been designed with specific statistical analysis and desired calculations in mind. Such analysis and calculation may have been possible with cooperation from several corporations. The hypothetical case scenarios provide raw numbers that show improvement through implementation of a quality cost measurement system, but they were formulated using theories and broad assumptions. Time and budget constraints placed a significant limitation on this study. To obtain accurate up-to-date data, several companies need to be studied directly. Data would need to be collected before system implementation to provide a base from which improvements can be measured. Collection would have to continue over several years to provide enough information to allow an accurate correlation between quality cost measurement and profitability to be calculated.

Suggestions

The main reason for existence for every major corporation is to provide income to the stockholders. Any possible means of increasing this income should be explored. Determining if there is a correlation between quality costs and profitability is one of these means. It has been pointed out by the leading authorities, Juran, Deming, and Crosby, that quality costs for some corporations can be very high and that a reduction in these costs is an immediate savings. If this study was to be replicated, the most important improvement would be to change the sampling frame. There is not enough information available in magazine articles and published studies. To provide the necessary data, a survey should be done firsthand on companies that have implemented quality cost measurement systems. Data collected should include the companies' quality costs before and after implementation of a system. This will allow the researcher to see absolute and percent changes in quality costs. With actual accounting data, profitability ratios can be accurately calculated. Specific statistical analysis should be targeted and kept in mind during data collection so that inferences can possibly be made industry-wide about quality cost measurement and profitability. A new empirical study will also provide current up-to-date information.

APPENDIX A

DEMING'S 14 POINTS

1. Create Constancy of Purpose for Improvement of Product and Service: Dr. Deming suggests a new definition of a company's role. Rather than make money, it is to stay in business and provide jobs through innovation, research, constant improvement, and maintenance.

2. Adopt the New Philosophy: Americans are too tolerant of poor workmanship and sullen service. We need a new religion in which mistakes and negativism are unacceptable.

3. Cease Dependence on Mass Inspection: American firms typically inspect a product as it comes off the line or at major stops. Defective products are thrown out or reworked (both unnecessarily expensive). Quality comes from improvement in the process and with instruction, workers can be enlisted in this process.

4. End the Practice of awarding Business on Price Tag Alone: Purchasing departments seek the lowest priced vendor. Frequently, this leads to supplies of low quality. They should seek the best quality and work to achieve a single supplier for any one item on a long term relationship.

5. Improve Constantly and Forever the System of Production and Service: Improvement is not a one-time effort. Management is obligated to continually look for ways to reduce waste and improve quality.

6. Institute Training: Too often, workers learn jobs from workers who were never trained properly. They are forced to follow unintelligible instructions. They can't do their jobs because no one tells them how.

7. Institute Leadership: The job of a supervisor is not to tell people what to do or punish them but to lead. Leading consists of helping them do a better job and using objective methods, to determine who needs help.

8. Drive Out Fear: Many employees are afraid to ask questions even when they do not understand what the job is or what is right or wrong. The economic loss from fear is appalling. It is necessary for better quality and productivity that people feel secure.

9. Break Down Barriers Between Staff Areas: Often staff areas are competing with each other or have goals that conflict. They do not work as a team to solve or foresee problems and continue to cause trouble for each other.

10. Eliminate Slogans, Exhortations, and Targets for the Workforce: These never helped anybody do a good job. Let people put up their own slogans.

11. Eliminate Numerical Quotas: Quotas take account only of numbers, not quality or methods. They are usually a guarantee of inefficiency and high costs. A person, to hold a job, meets a quota at any cost, without regard to damage to the company.

12. Remove Barriers to Pride of Workmanship: People are eager to do a good job. Too often, misguided supervisors, faulty equipment, and defective materials stand in the way. These barriers must be removed.

13. Institute a Vigorous Program of Education and Retraining: Both management and the workforce will have to be educated in the new methods, including teamwork and statistical methods.

14. Take Action to Accomplish the Transformation: It will take a special top management team with a plan of action to carry out the quality mission. Workers can't do it on their own, nor can managers. A critical mass of people in the company must understand the 14 Points, 7 Deadly Diseases, and the Obstacles.

(APPENDIX A continued)

CROSBY'S 14 STEP PROCESS

1) Management Commitment
   Purpose: To make it clear where management stands on Quality.

2) Quality Improvement Team
   Purpose: To run the Quality Improvement Process.

3) Quality Measurement
   Purpose: To provide a display of current and potential non-conformance problems in a manner that permits objective evaluation and corrective action.

4) Cost of Quality Education
   Purpose: To define the ingredients of the Cost of Quality and explain its use as a management tool.

5) Quality Awareness
   Purpose: To provide a method of raising the personal concern felt by all toward the conformance of the products and the quality reputation of the company.

6) Corrective Action
   Purpose: To provide a systematic method of resolving forever the problems that are identified through previous action steps.

7) Zero Defect Planning
   Purpose: To examine the various activities that must be conducted in preparation for the formal launching of Zero Defects Day.

8) Quality Education
Purpose: To define the type of training all individuals need in order to carry out their part of the Quality Improvement Process.

9) Zero Defects Day
Purpose: To create an event that will let all employees realize, through a personal experience, that there has been a change.

10) Goal Setting
Purpose: To turn pledges and commitments into action by encouraging individuals to establish improvement goals for themselves and their groups.

11) Error Cause Removal
Purpose: To give the individual employee a method of communicating to management the situations that make it difficult for the employee to meet the pledge to improve.

12) Recognition
Purpose: To appreciate those who participate.

13) Quality Council Participation
Purpose: To bring together the appropriate people to share quality management information on a regular basis.

14) Do It All Over Again
Purpose: To emphasize that the quality improvement process never ends.

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