Cost of Quality

A PROJECT REPORT

Under the guidance of Prof. Srikanta Acharya

Submitted by

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Of

MBA

IN

Total Quality Management

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SMU
Sikkim Manipal University
Directorate of Distance Education

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BONAFIDE CERTIFICATE

Certified that this project report titled " **Cost Of Quality "** is the bonafide work of **" Ajaykumar V. Mehta "** who carried out the project work under my supervision.

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Executive Summary

A Young Engineer Raised at a Meeting, “We have high number of rejections at one of our assembly processes. These are easily detected & segregated. We also know the countermeasure for effective removal of the defect, Should we implement the counter measure or continue with the segregation?”

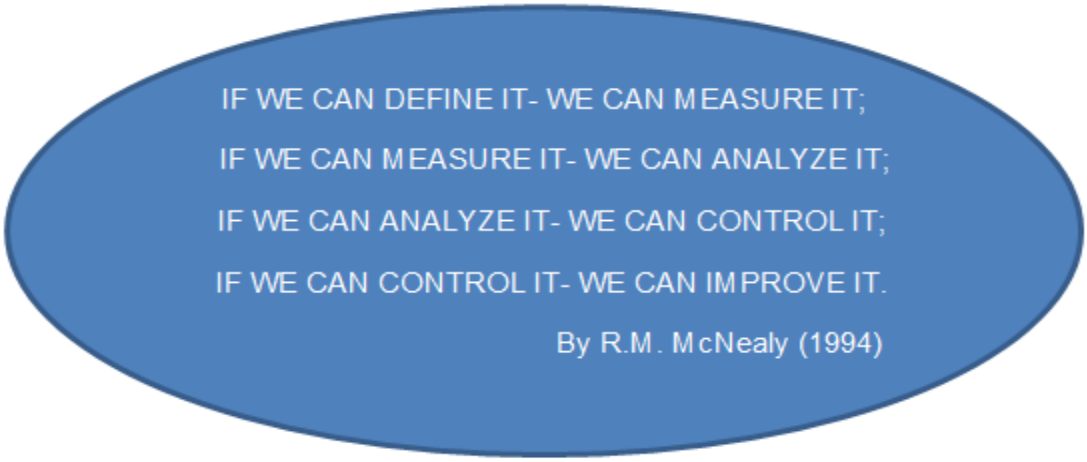
All the Old hands in the meeting found it hard to answer. The Delicate position arose because of insufficient understanding of the cost associated with the Operation & its Quality.

To make it easy, we present this Project to have a more comprehensive understanding Cost associated with Quality.

Cost-of-Quality measurement provides a yardstick for decision-making. It can be used to identify processes that include excessive waste and rework and estimate potential savings that would result with process redesign.

Quality is a make-or-break issue for most businesses. Companies with higher and more consistent quality do better over time. But this performance comes at a cost. While we often hear about the “cost of poor quality,” this only reflects a portion of the total quality costs. This project also lays out four major categories of quality costs and introduces methods to ensure good quality.

The Quality Mantra:



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Chapter 1 INTRODUCTION

1.1 Emergence of Cost of Quality Concept

1.2 Views of Quality Gurus

1.3 5 W's of Cost of Quality

1.4 Summary

1.1 Emergence of Cost of Quality Concept :

Quality is perceived differently by different people. Yet, everyone understands what is meant by “quality.” In a manufactured product, the customer as a user recognizes the quality of fit, finish, appearance, function, and performance. The quality of service may be rated based on the degree of satisfaction by the customer receiving the service. The relevant dictionary meaning of quality is “the degree of excellence.” However, this definition is relative in nature. The ultimate test in this evaluation process lies with the consumer. The customer’s needs must be translated into measurable characteristics in a product or service. Once the specifications are developed, ways to measure and monitor the characteristics need to be found. This provides the basis for continuous improvement in the product or service. The ultimate aim is to ensure that the customer will be satisfied to pay for the product or service. This should result in a reasonable profit for the producer or the service provider. The Relationship with a customer is a lasting one. The reliability of a product plays an important role in developing this relationship.

The general perception was that higher quality requires higher costs, either by buying better materials or machines or by hiring more labor. Furthermore, while cost accounting had evolved to categorize financial transactions into revenues, expenses, and changes in shareholder equity, it had not attempted to categorize costs relevant to quality, which is especially important given that most people involved in manufacturing never set hands on the product. By classifying quality-related entries from a company's general ledger, management and quality practitioners can evaluate investments in quality based on cost improvement and profit enhancement.

1.2 Views of Quality Gurus :

Historically, business managers have assumed that increased quality is accompanied by increased cost; higher quality meant higher cost.

This concept was questioned by quality pioneers like Juran and Feigenbaum. Juran examined economics of quality and concluded the benefits outweighed the costs. Feigenbaum introduced “total quality control” and developed the principles that quality is everyone’s job, thus expending the notion of quality cost beyond the manufacturing function. In 1979 Crosby introduced the new popular concept that “quality is free”.

Three different views held by the management professionals about Cost of Quality

Today view of quality cost among practitioners seems fall into three categories:

Higher quality means higher cost: Quality attributes such as performance and features cost more in terms of labor, material, design, and other costly resources. The additional benefits from improved quality do not compensate for the additional expenses.

The cost of improving quality is less than the resultant savings: Deming promoted this view, which is still widely accepted in Japan. The savings result from less rework, scrap, and other direct expenses related to defects. This paved the way of continuous process improvement among Japanese firms.

Quality costs are those incurred in excess of those that would have been incurred if product were built or service performed exactly right the first time: This view is held by adherents of the TQM philosophy. Costs include not only those that are direct, but also those resulting from lost customers, lost market share, and many hidden costs and foregone opportunities not identified by modern cost accounting systems.

The Quality Guru, Juran has propounded that it is easier to sensitize the top management about the magnitude of the Quality problems if they are translated in monetary terms and linked with financial performance as they are more familiar and concerned with financial performance.

Philip Crosby emphasized meeting customer requirements by focusing on prevention rather than correction. He claimed that poor quality costs about 20 percent of the revenue; a cost that could be avoided by using good quality practices. He pushed for zero defects. His "absolutes" are:

(1) Quality is defined as conformance to requirements, not goodness;
(2) The system for achieving quality is prevention, not appraisal;
(3) The performance standard is zero defects, not that are close enough;
(4) The measure of quality is the price of non-conformance, not indexes.

Feigenbaum was the first to characterize Quality costs as the costs of prevention, appraisal, and internal and external failure.

Dr. Taguchi emphasized on the concept of “Loss function” to the existing body of knowledge of Statistical Quality Control. This “Loss function‟ combines cost, target and variation put together as one matrix and specification of the product as the next.

1.3 5 W's of Cost of Quality :

What : Cost of Quality is a financial measure of the quality performance of an organisation. It is essentially a measure of the lack of quality & can also be termed as cost of Bad quality.

Why : Understanding Cost of Quality helps organisations to develop Quality conformance as a useful strategic business tool that improves their product, services & brand image. This is vital in achieving objectives of a successful organization

When : Cost of Quality is primarily used to understand, analysis & improve the quality performance. Cost of Quality can be used by all shop floor personnel as well as management measure. It can also be used to as a standard measure to study organisation's performance with respect to its competitors & can be used as benchmarking indices.

Where : Cost of Quality is applicable to each & very manufacturing & service industry. It also forms the basis for continuous monitoring & improvement initiatives.

Whom : The concept of Cost of Quality needs to flow from Top

management to the bottom of the organization structure.Everyone needs to be made aware (via Regular Training) to improve quality while reducing cost & works towards all round contribution from All including Management & Workers.

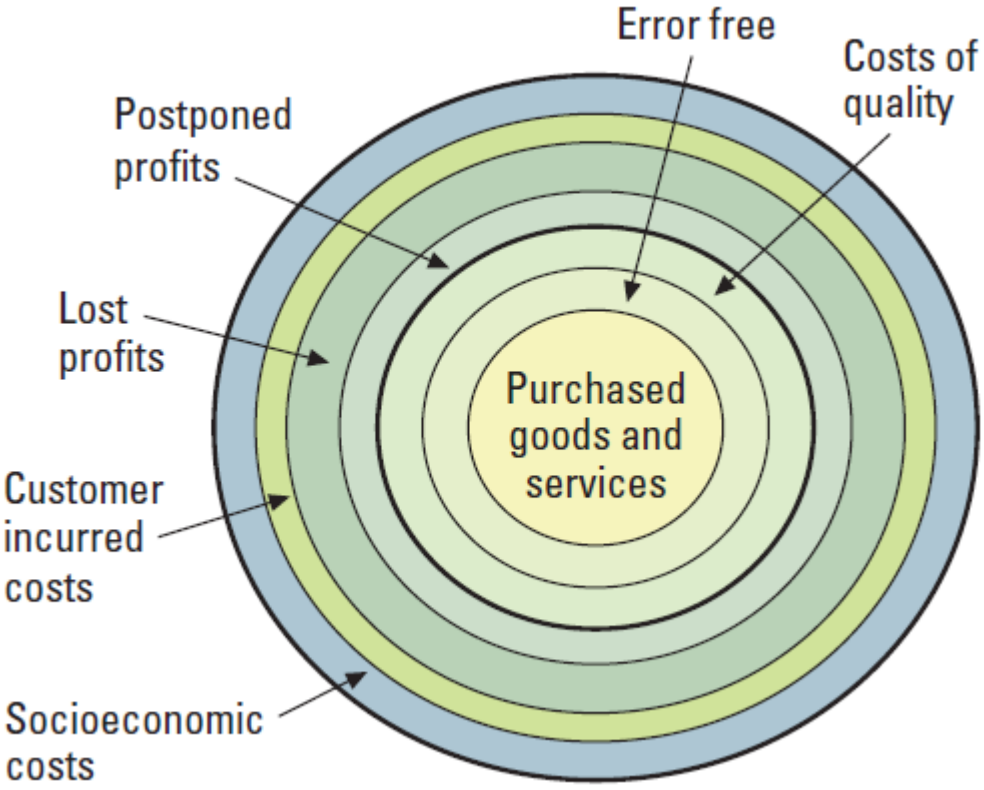
How : The cost associated with quality are divided into 1) Costs due to poor Quality 2) Cost associated with improving quality.

How Much : Cost of Quality ("COQ") is a measurement used for assessing the waste or losses from some defined process (eg. machine, production line, plant, department, company, etc.).

1.4 Summary :

Cost of Quality is an important concept with respect to life cycle of any organization. It helps to achieve Objective of Profit maximization & Goal of Growth & wealth creation.

Figure 1: Levels & Scope of Quality Cost



Chapter 2 Cost of Quality – Quality in the Language of Money

2.1 Concept Introduction

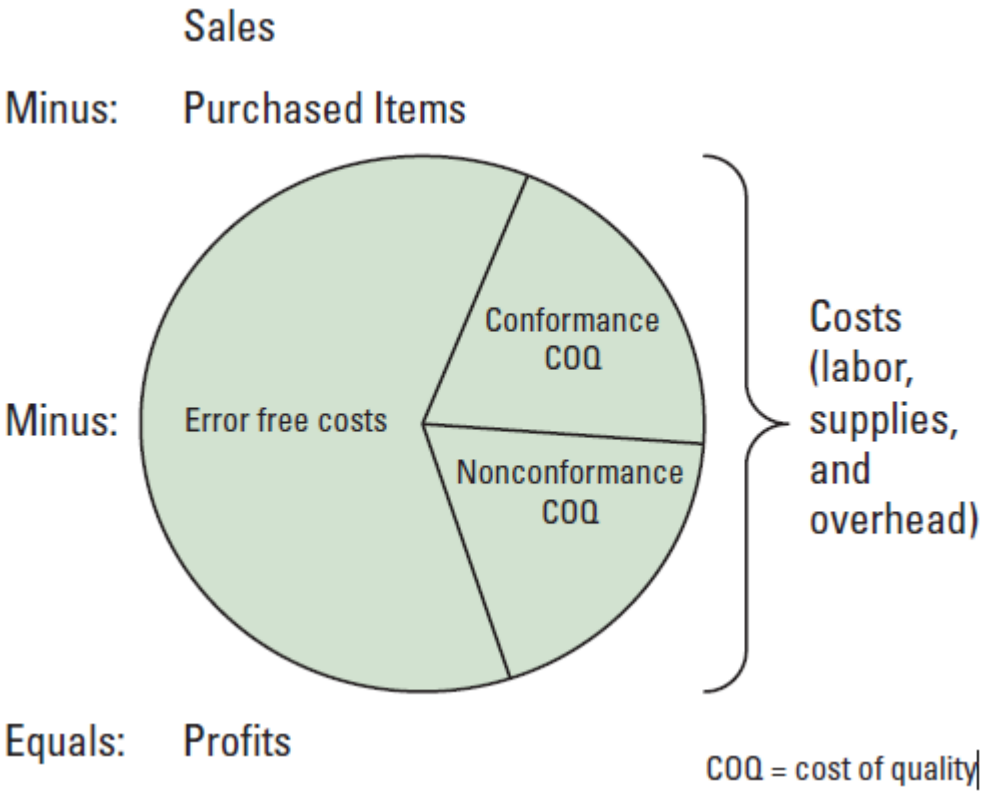
2.2 Model of Cost of Quality

2.3 Quality Loss Function (A Cost oriented concept)

2.1 Concept Introduction :

The concept of Cost of Quality has emerged in 1950s. The concept of Quality Costs is a means to quantify the total cost of Quality related efforts and deficiencies. This was first described by Armand V. Feigenbaum. Various Concepts of Cost of Quality has emerged since.

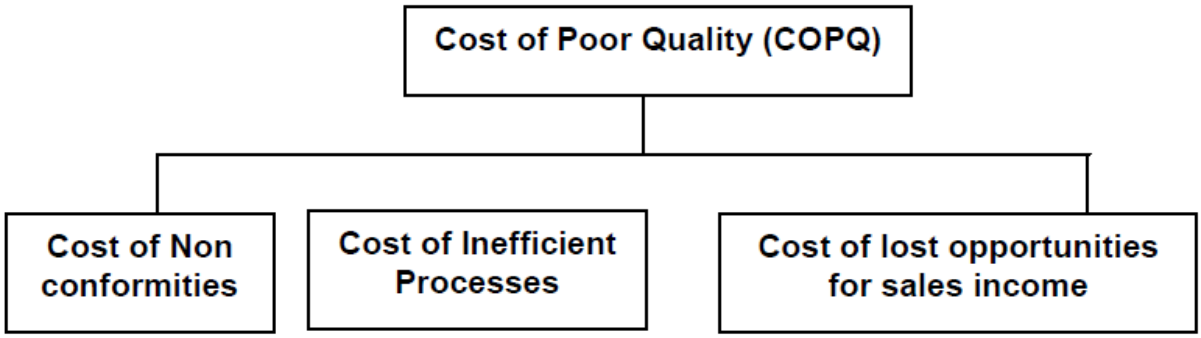
Figure 2: Sales – Cost = Profit



2.2 Model of Cost of Quality :

Juran has defined the Cost of Poor Quality (COPQ) as follows:
"COPQ is the annual monetary loss of products and processes that are not achieving their quality objectives. The COPQ is not limited to quality but is essentially the cost of waste associated with poor performance of processes."

Figure 3: Components of Cost of Quality



(Explained in Detail in Chapter 3)

2.3 Quality Loss Function (A Cost oriented concept)

Taguchi offers a definition of quality in terms of the Loss function: "Quality loss is the financial loss imparted to society after a product is shipped". Societal loss includes failure to meet customer requirements, deviation from ideal performance, etc. The aggregate of all losses namely a) the loss incurred by customers through shorter life cycle, increased maintenance costs, repair costs, etc, b) the loss incurred by the company like increased scrap cost, reworks, warranty costs, damages etc, and c) loss to the society say pollution, safety etc, spent on unusable products or toxic products, will all add to the total loss to society

Loss is measured in monetary units and is related to quantifiable product characteristics. For example, if two products that are designed to perform the same function both meet most specifications, but may impart different type of losses to society. Therefore merely meeting specifications does not mean the better quality, but societal loss indicates poor measure of quality.

Taguchi asserts that the quality of a product is reflected by the key

performance characteristics of a product. The target value for these performance characteristics are prescribed by the designer. It is proved that a high quality product that is performing near the target values throughout its life cycle, continues to satisfy the customer under specified operating conditions.

Taguchi's "Loss Function" shown below is parabolic in nature of the performance characteristics in X axis Vs the Loss to the society in Y axis.

Taguchi's Observations

a) The target value (T) is the value at which the product functions best. Any deviation from that value T on either direction meant an incremental deterioration of performance. This deterioration-"d" is the incurred loss. When evaluated as a cost, it is passed on to the next customer and ultimately both the company and society would incur this loss in some way or the other

b) Close to the target value, the loss is minimal. As the loss curve is Parabolic, the deviation increases to a point where the customer would find it beyond his tolerance band [CTB]

c) Society will always right in rewarding or punishing the firm for its societal savings or the loss respectively. The manufacturing companies should restrict the societal loss to the bare minimum. This can be achieved through sound management decisions on Quality and cost of the product.

Loss from the performance variation (L) is directly related to the square of the deviation (D) of the performance characteristics (X) from its target value (T).
Loss = L = D square x C,
Where, D=deviation from the target and C = Cost constant & is the cost to society due to the deviation. Further, D=X-T, Where X=Actual value of quality characteristics and T= Target value of Quality characteristics.

The above formula represents the financial loss through a quadratic relationship. In industrial engineering, the quality costs are represented by the number of items outside the specification multiplied by the cost of rework or scrap.

Quality Loss Function technique and its analysis of limiting the deviation from the target value should be considered during the early stages of the product design and changes required are incorporated as early as possible to avoid the subsequent losses.. This may also help the designer to detect if the product is over designed.

Taguchi insisted that manufacturers should work to minimize the loss which would certainly enhance their brand reputation, win markets and generate profits.

Example of Loss Function

1) What is loss to society? See the concept with this example:
Farmers use vinyl sheets to protect crops from wind/storms. The industrial standard specified the limits for the product. A manufacturer of vinyl sheet worked to reduce the variations in the production process resulting in a very narrow distribution. The manufacturer has then centered that distribution at the lower end of the specification limit, thus reducing cost.
The above has resulted in three types of losses. First, the product tore because it could not withstand the Wind/storming, the vinyl sheeting itself was the first loss. Second, farmers suffered losses as a result of crop damages. Third, the reduction in the supply of crops caused prices to rise, resulting in loss to society. The result is that the loss to the society is greater than the manufacturer‟s gain. The Japanese call such a manufacturer “worst than a thief”.

2) The loss function is built on a definition that quality as “uniformly built around the target value”.
Think of a car door being assembled. To produce a car with a tight fit and a good appearance the operator must join together many individual parts. But if one part is at the high end of the specification and the adjacent part is at low end of its limit, the two parts may not fit well together. The result is special fitness work to be done by the operator to get everything fit properly. This gives rise to loss due to remake, repair etc.
When all parts are manufactured around the target value, the above said problem will not arise.

Chapter 3 Components of Cost of Quality

3.1 Components of Cost of Quality

3.2 External Failure Costs

3.3 Internal Failure Costs

3.4 Appraisal Costs

3.5 Prevention costs

3.6 Comments on the Cost of Quality

3.7 Things to Consider Before Implementing Cost of Quality

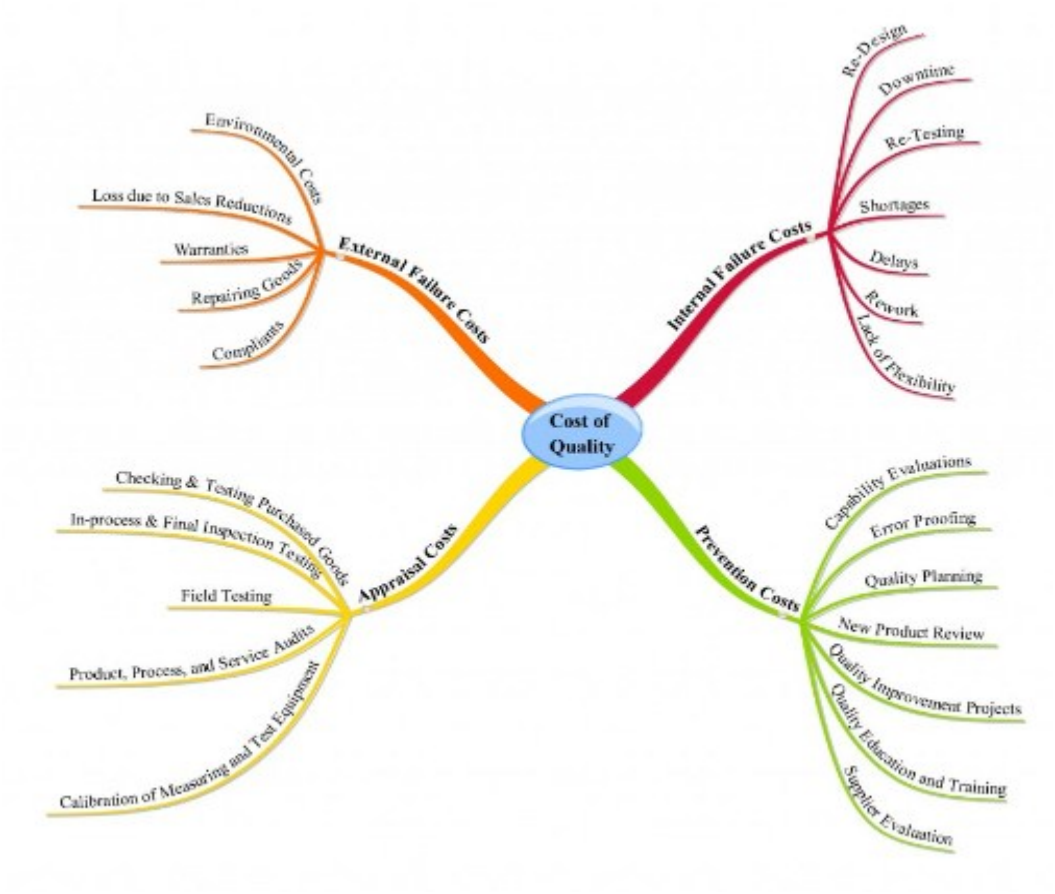
3.1 Components of Cost of Quality :

A) Cost of Non-conformance : It represents the total costs to the organization of failure to ensure conformance to the requirements – which is "Bad Quality ".The cost of Non-conformance is further classified in to: External failure costs and internal failure costs.

B) Cost of conformance : It is the total cost to ensure that a product conforms to the requirements – which it is of "Good Quality". It includes the costs of Quality Assurance and Quality Control activities. It represents an organization's investment in ensuring the quality of its products and services. The cost of conformance is further classified in to: Prevention costs and Appraisal costs.

C) Lost opportunities for sales revenue : Customer lost: profits from the potential customers who have shifted to competitors. Loss of new customers due to inefficient processes: profits lost from the potential customers because of in adequate processes to meet customer needs.

Figure 4: Cost of Quality Tree



3.2 External Failure Costs :

External failure costs are associated with deficiencies that are found after the customer receives the product. External Failure costs represent a category in the total cost of quality where the quality costs are related to defects found after delivery of the product to the customer. External failure costs are generally the highest of the 4 cost of quality categories since the full value of work and processes had to be performed to get the product to the customer. These costs are incurred because the product shipped failed to conform to quality requirements and may include warranties, shipping charges, repairs, recalls, legal actions and lost sales.

External failure costs are notorious for being difficult to measure due to the hidden costs associated with defective products being received by the end user. So how does one measure the cost of lost sales or loss of

potential customers? One method is by using customer survey that ask such questions regarding the behavior of returning product.

Example, Using a customer survey one might determine that 9 out of 10 customers who purchase a defective product are likely to discard it and only 1 of 10 return it to the manufacturer for refund or replacement a multiplier can be applied to estimate customer returns. In this case multiplying actual customer returns by can provide a reasonable estimate of this element of external failure cost. This number can help determine the typical customer's intention to on buying the product again after receiving a defective one and the number of dissatisfied customers that may provide a measure of lost sales.

Main heads: Warranty charges, Complaints, Field returns, Penalties, Lost opportunities for sales revenue etc

3.3 Internal Failure Costs :

These are the costs of deficiencies discovered before delivery. Internal failure costs are costs that are incurred as a result of identifying defective products before they are shipped to customers. The labor,material, and (usually) overhead that created the defective product. The areas / nomenclature are numerous and include; scrap, spoilage, defectives, etc.

The cost to correct the defective material or errors in service products which are found prior to sending to the customer. Some examples of internal costs of quality are:

Lost or missing information: The cost to retrieve this expected information.

The cost analyzing nonconforming goods or services to determine the root causes.

Supplier scrap and rework: Scrap and rework costs due to nonconforming product received from suppliers. This includes the costs to the buyer of resolving the supplier quality problems.

100% Sorting inspection: The cost of completing 100% inspection to sort defective units from good units.

Retest: The cost to retest products after rework or other revision.

Changing processes: The cost of modifying the manufacturing or service processes to correct the deficiencies.

Redesign of hardware: The cost to change designs of hardware to correct the issues.

Redesign of software: The internal cost to changing software designs.

Scrapping of obsolete product: The cost of disposing scrap.

Scrap in support operations: Costs from defective items in indirect operations.

Rework in internal support operations: Costs from correcting defective items in indirect operations.

Downgrading: The cost difference between the normal selling price and the reduced price due to quality reasons.

Variability of product characteristics: Rework losses that occur with conforming product (e.g.,overfill of packages due to variability of filling and measuring equipment).

Unplanned downtime of equipment: Loss of capacity of equipment due to failures.

Inventory shrinkage: Loss costs due to the difference between actual and recorded inventory quantity.

Non-value-added activities: Cost due to redundant operations, sorting inspections, and other non-value added activities. A value-added activity increases the usefulness of a product to the customer; a non-value-added activity does not.

Main heads: Rework, Increased / Re-inspection / re-testing, Scrap, Redesign / Change in processes etc

3.4 Appraisal Costs :

These are the costs incurred to determine the degree of conformance to the quality requirements. Appraisal costs constitute all costs that go testing and inspection of products. The detection of defective parts and products should be caught as early as possible in the manufacturing process. Appraisal costs are sometimes called inspection costs and are incurred to identify defective products before the products are shipped to customers. The problem with appraisal costs is in the fact that they are not true “value added” activities since the generally inspection and testing are not requirements of the customer. The customer just expects the product to function as advertised with no requirement for the product to be tested. The fact that the product is tested and advertised as such may make the customer feel better about the product but the expectation is for the product to, “just work” and if the product was never tested then the customer would not care anyway.

There are exceptions to this rule when customers require product testing as part of their purchase order / contract. So, why do we spend so many resources on testing and inspecting products? The answer is in the failure costs associated with allowing a defect to escape to the next process or customer.

Another unfortunate aspect of performing appraisal activities is that it doesn’t keep defects from happening again. Due to this managers see that maintaining an army of inspectors can be very costly and ineffective approach to quality control.

Today’s quality initiatives are increasingly asking employees and suppliers to be responsible for their own quality control. Further innovations are being put into designing products to be manufactured in ways to eliminate the need for inspections or testing. Engineering reliability into a product is the most efficient process to reduct quality costs.

Main heads: inspection and test of raw materials and other inputs, Final/process inspection and tests, Evaluation of stock in hand etc

3.5 Prevention costs :

These costs are incurred to keep failure and appraisal costs to a minimum. Prevention costs are costs of special planning, review and analysis activities for quality. Prevention Costs are any costs that are incurred in an effort to minimize appraisal and failure costs. This category is where most quality professionals want to live. They say an ounce of prevention is worth a pound of cure and they is what this category is all about. This includes the activities that contribute to creation of the overall quality plan and the numerous specialized plans. Examples include:

Review of new products: The quality planing and inspection planning for new products and design of new products.

Process planning: Inspection planning, Process capability studies, various other work associated with the manufacturing and service processes.

Process control: Evaluation of in-process inspection procedures and and testing to determine the current status of a process

Quality audits: Evaluating adherence and execution of the overall quality plan.

Supplier quality selection and evaluation: Analyzing supplier quality activities prior to supplier selection, perform auditing of processes during the contract, education and training of suppliers.

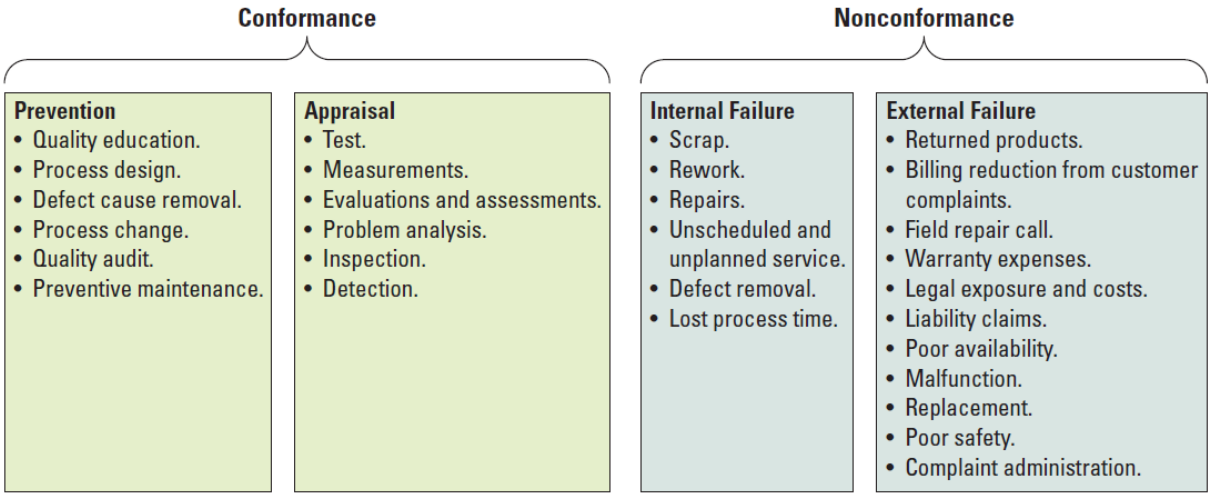
Quality Training: Preparation and implementation of quality training programs. Similar to appraisal costs some of this work may be executed by personell that are not in the quality assurance department. For accounting perposes it's important to separate this by the type of work being performed and not the department of the employees performing the work. Activity based costing accounting lends itself to this.

Main heads: Process planning, Process control, Supplier evaluation, Quality Planning / audit etc

3.6 Comments on the Cost of Quality :

It is estimated that 60 to 70% of the total quality costs are the result of Internal and external failures. These are controllable with concerted efforts by the management. When these figures are thrown up, the initial reaction of most of the managements are to increase inspection activities. This will in turn increase the appraisal costs. This situation may not result in substantial changes either in improved quality or improved profitability.
The following scenario has been observed in most of the companies before they had embarked on formal Quality cost control program.
The external failure costs found to be the highest followed by internal failure costs. The appraisal costs occupy the third position and the prevention costs are at the fourth position.
It has been observed that an increase in prevention costs will result in generating larger reductions in the other cost categories.

Figure 5: Heads of Cost of Quality



3.7 Things to Consider Before Implementing Cost of Quality

- ✓ Is the management team committed to making rapid changes for maximum profitability, within the imposed constraints (eg. Company's Mission, laws & regulations, stakeholder satisfaction, etc.)?

- ✓ Are there "sacred cows", legacy systems, departmental silos, and empire building that are exempt from re-evaluation?

- ✓ Are the hard costs (payroll, raw materials, utilities, etc.) more easily measured (or more important) than the soft costs (morale, employee satisfaction, market share, plant capacity utilization, customer's losses, supplier's losses, societal losses)?

- ✓ Are the current management measurement systems (eg. KPI's, scrap, rework, excess freight charges, stock outages, absenteeism, productivity, profitability, etc.) compatible with Cost of Quality ("COQ")? Can these other systems be adapted to include Cost of Quality ("COQ") without neither duplication nor conflict?

- ✓ Will people be receiving mixed messages and conflicting signals between Cost of Quality ("COQ") and the traditional management measurements?

- ✓ Is there management commitment to do something about the Cost of Quality ("COQ") data on a timely basis?

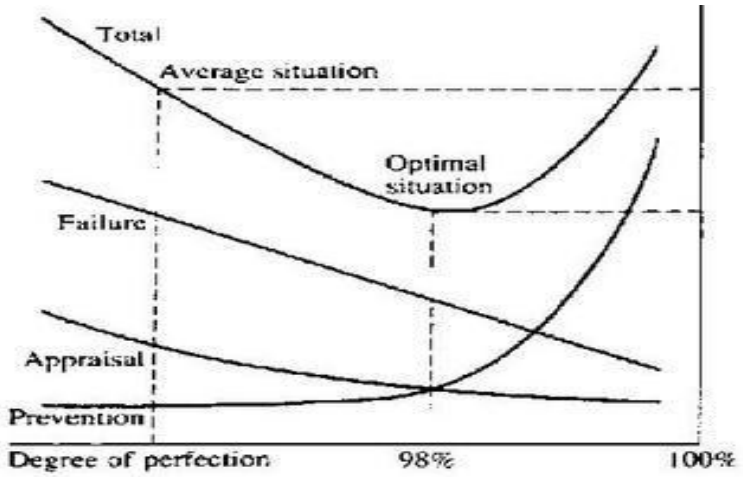
- ✓ Is there COQ Software available that suits your current and future needs for maximum value from data at minimum cost?

Chapter 4 Optimum Total Cost of Quality

To collect quality costs an organization needs to adopt a framework to classify costs. As explained earlier, CoQ is the sum of conformance plus non-conformance costs, where cost of conformance is the price paid for prevention of poor quality (for example, inspection and quality appraisal) and cost of non-conformance is the cost of poor quality caused by product and service failure.

Studies have shown that minimum total cost can be achieved typically at 98% perfection. This percentage is also known as Best Practice. Beyond this, the cost of achieving an improvement outweighs the benefits of that Improvement.

Figure 6: Optimum Cost Structure



As defect level decreases, failure costs decline while appraisal plus prevention costs increase. This apparent tradeoff suggests that an optimum quality level exists and that attempts to further improve quality above this level will increase total cost and decrease financial performance. Proponents of this view therefore argue that striving for zero defects (ZD) through a program of continuous improvement is not in a company's best economic interest. J.M. Juran discusses the concept of optimum quality in his Quality Control Handbook.

Figure 7: Quality Level

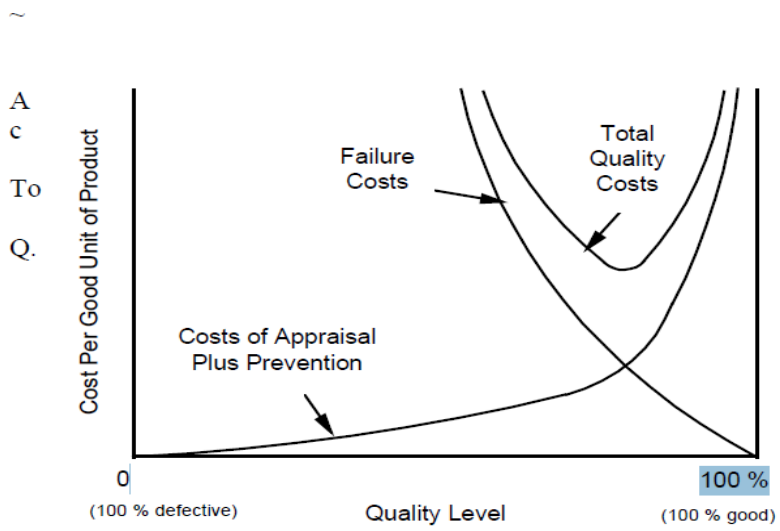


Figure 6 depicts his model for optimum quality costs. Juran also defines three quality zones relative to the point of minimum total quality costs. The “zone of improvement projects” lies below the optimum quality level, while the “zone of perfectionism” lies above it.

Between them, and in the area of the minimum, lies the “zone of indifference.” It is the zone of perfectionism that most troubles proponents of zero defects, for here Juran suggests relaxing prevention efforts and allowing (even encouraging) increased defect rates.

Furthermore, he identifies the boundary of the zone of perfectionism as lying, typically, at a quality level where failure costs amount to 40% of the total quality cost. Applying other rules of thumb, this translates into a defect level only half that which exists in the zone of improvement.

Chapter 5 Six Sigma Philosophy of Cost of Quality

What is the relation between the cost of good quality and the cost of poor quality? The traditional view would be to conclude that if a company wants to reduce defects and thereby reduce the cost of poor quality, the cost of good quality would have to be increased, meaning higher investments in any kind of checking, testing, evaluation, training of operators, etc.

Following the Six Sigma philosophy, however, of building quality into process, service and products and doing things right the first time, the increase of the cost of good quality, while striving for zero defect performance, can be smoothed if processes get better.

As Figure 8 shows, business processes with better process sigma will have significantly lower prevention and appraisal costs. Although you will never fully eliminate appraisal and prevention costs (as opposed to failure costs that in an ideal zero defect world would also be zero), their reduction due to better process performance will be significant.

Figure 8: Traditional Management View vs. Six Sigma Philosophy

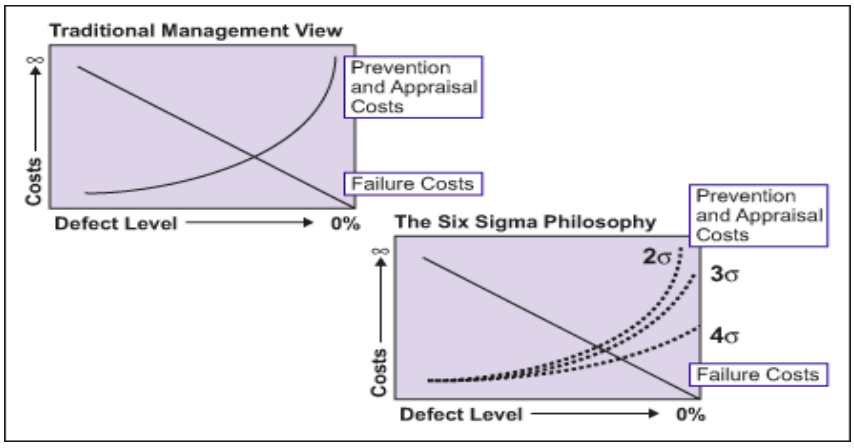


Table 1 shows how dramatically the cost of quality as a percentage of sales decreases if the process sigma improves.

Table 1: Sigma Level and the Cost of Quality

Sigma Level	DPMO	Cost of Quality as Percentage of Sales
2	2,98,000	More than 40%
3	67,000	25-40%
4	6,000	15-25%
5	233	5-15%
6	3.4	Less than 1%

Assuming that the average performance of a company is 3 sigma, 25 percent to 40 percent of its annual revenue gets chewed up by the cost of quality. Thus, if this company can improve its quality by 1 sigma level, its net income will increase hugely.

Chapter 6 Cost of Quality Models

6.1 Introduction

6.2 Model of Cost of Quality

6.3 PAF Model

6.4 Crosby's Model

6.5 Intangible Cost's Model

6.6 Process Cost Model

6.7 Old v/s New CoQ Model

6.1 Introduction

To collect quality costs an organization needs to adopt a framework to classify costs; however, there is no general agreement on a single broad definition of quality costs. CoQ is the sum of conformance plus non-conformance costs, where cost of conformance is the price paid for prevention of poor quality (for example, inspection and quality appraisal) and cost of non-conformance is the cost of poor quality caused by product and service failure (for example, rework and returns). In this section, we will briefly review the approaches to measuring CoQ.

6.2 Model of Cost of Quality

Since Juran discussed the Cost of Quality, many researchers have proposed various approaches to measuring CoQ. Various reviews of CoQ literature can be found. In agreement with the majority of previous researchers present work classifies CoQ models into five discrete generic groups which are:

- P-A-F Model
- Crosby's Model
- Opportunity Cost Model
- Process Cost Model
- ABC Model.

Table 1: Generic CoQ models and cost categories

Generic model	Cost/Activity categories
P-A-F models	Prevention + appraisal + failure
Crosby's model	Prevention + appraisal + failure + opportunity
Opportunity or intangible cost models	Conformance + non-conformance
	Conformance + non-conformance + opportunity
	Tangibles + intangibles
	P-A-F (failure cost includes opportunity cost)
Process cost models	Conformance + non-conformance
ABC models	Value-added + non-value-added

6.3 PAF Model

After Feigenbaum categorized quality costs into prevention-appraisal-failure (PAF), the PAF scheme has been almost universally accepted for quality costing. The failure costs in this scheme can be further classified into two subcategories: internal failure and external failure costs. In general, these costs are described as follows

- Prevention costs: These costs are associated with the design, implementation and maintenance of the total quality management system. Prevention costs are planned and are incurred before actual operation.

- Appraisal costs: These costs are associated with the supplier's and customer's evaluation of purchased materials, processes, intermediates, products and services to assure conformance with the specified requirements.

- Internal failure costs: These costs occur when the results of work fail to reach designed quality standards and are detected before transfer to customer takes place.

- External failure costs: These costs occur when products or services fail to reach design quality standards but are not detected until after transfer to the customer.

The basic suppositions of the P-A-F model are that investment in prevention and appraisal activities will reduce failure costs, and that further investment in prevention activities will reduce appraisal costs. The objective of a CoQ system is to find the level of quality that minimizes total CoQ.

6.4 Crosby's Model

Crosby sees quality as "conformance to requirements" and therefore, defines the CoQ as the sum of price of conformance (PoC) and price of non-conformance (PoNC). The price of conformance is the cost involved in making certain that things are done right the first time, which includes actual prevention and appraisal costs, and the price of non-conformance is the money wasted when work fails to conform to customer requirements, usually calculated by quantifying the cost of correcting, reworking or scrapping, which corresponds to actual failure costs.

6.5 Intangible Cost's Model

This group of models emphasizes the role of intangible cost within the overall quality cost scheme. In general, intangible costs are costs that can be only estimated such as profits not earned because of lost customers and reduction in revenue owing to non-conformance. Actually, in this group of models intangible or opportunity losses cost is incorporated into a typical P-A-F model.

6.6 Process Cost Model

In view of a number of drawbacks of the P-A-F model, the process cost approach, described in the revised BS 6143: Part 1 [13], can be used as an alternative. This approach recognizes the importance of process cost measurement and ownership. The process cost is the total of the cost of conformance (CoC) and the cost of nonconformance (CoNC) for a particular process. The CoC is the actual process cost of providing products or services to the required standards, first time and every time, by a given specified process. The CoNC is the failure cost associated with a process not being operated to the required standard [7]. According to this definition, we know that the content of this categorization (CoC and CoNC) is different from that of Crosby's (PoC and PoNC) mentioned previously.

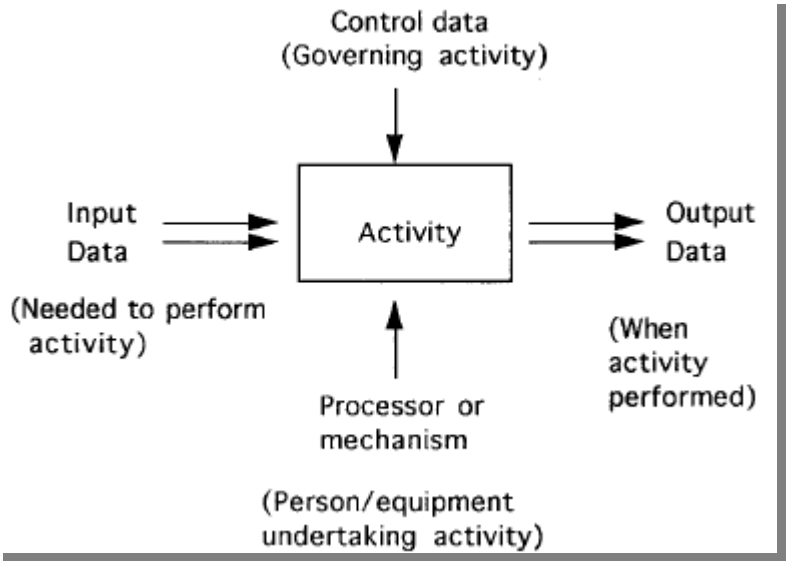
The process cost model can be developed for any process within an organization. It will identify all the activities and parameters within the process to be monitored by flowcharting the process. Then, the flowcharted activities are allocated as CoC or CoNC, and the cost of quality at each stage (i.e. CoC +CoNC) are calculated or estimated.

Finally, key areas for process improvement are identified and improved by investing in prevention activities and process redesign to reduce the CoNC and the excessive CoC respectively. It is believed that this will help to extend the concept of quality costing to all functions of an enterprise and to non-manufacturing organizations, and that it also gets people to consider in more detail the processes being carried out within the organization. The structure of the process cost model is schematically presented in Figure 9.

The use of a process cost model is suggested as a preferred method for quality costing within TQM as it recognizes the importance of process cost measurement and ownership, and presents a more integrated approach to quality than a P-A-F model.

The process cost model pursues a continuous improvement policy on key processes within the organization and innovates where appropriate, which in itself reflects both the kaizen approach and Deming's plan-do-check-act (PDCA) cycle. It can be applied to both service and manufacturing industries, and can be used to improve a process stage with either a high non-conformance cost by increasing preventative costs or with excessive conformance costs. Quality problems and their causes can be determined more quickly than with the PAF model. However, a complete accurate analysis of a company's activities into interlinked processes without duplication may be more time consuming than with the PAF model

Figure 9: The Structure of Process Cost Model

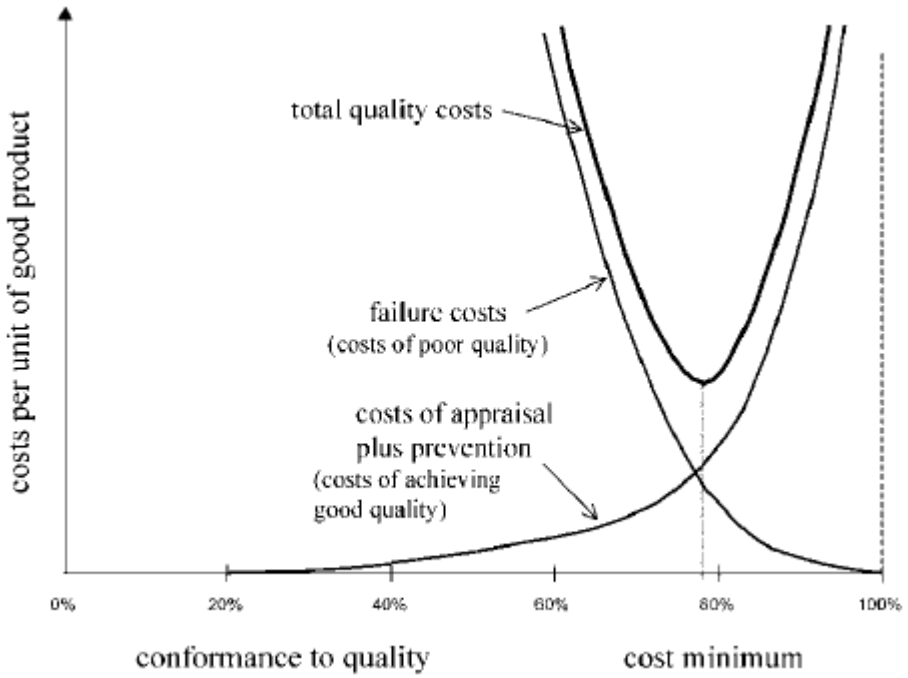


6.7 Old v/s New CoQ Model

Traditionaly, aspects and opinions briefly presented above section are summarized in the so-called old CoQ model. This model was firstly proposed by Juran and had been applied extensively till the 1990. This model which is presented in Figure 10 suggests that the costs of poor quality (internal and external failure costs) decrease with higher quality levels, while the costs of achieving good quality (appraisal and prevention costs) increase. The total cost function, representing the sum of both cost categories, has a parabolic shape. According to Juran's interpretation, the resulting cost minimum represents the economically optimal level of quality. The model's inherent quality–cost trade-off has widely shaped the perception that the optimal level of quality must be somewhere below perfection. Therefore the objective of any quality improvement program should be to find the level of quality (defect rate) that minimizes the total cost of quality.

The old COQ model might have gained its wide acceptance because it coincides with an often observed "inspection mentality" of management. However, the view of old CoQ is in conflict with current trends in industry to strive for best possible quality, as the successful quality concept of six sigma demonstrates

Figure 10: Old CoQ Model



To explain the discrepancy between the old CoQ model and current findings in industry, four points must be considered.

First, The model obviously presupposes a company with a poor quality level, and does not consider that companies might already have a considerable high quality level when they engage into quality improvement.

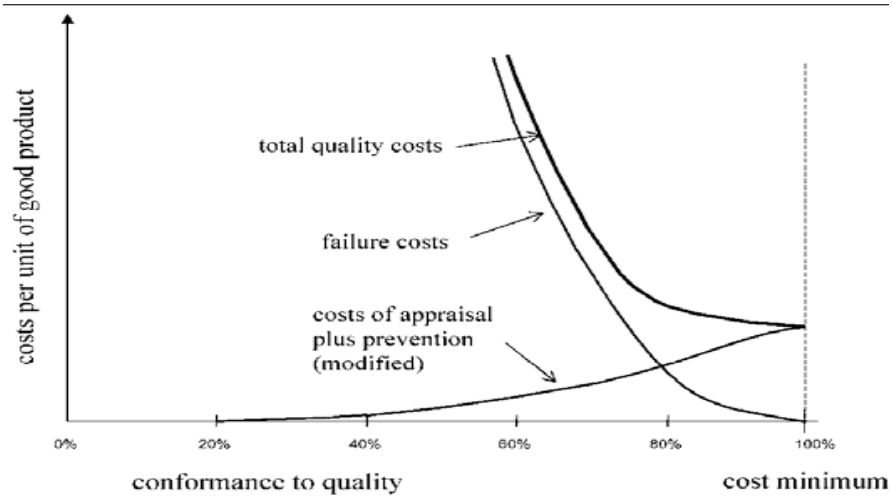
Second, The model is a spotlight on the technological proficiency of the time it was constructed. The prevention of defects has since become more feasible due to technological advances, which benefits both the finding of feasible remedies and the methods of process monitoring.

Third, The model makes no reference to the duration for which a company has been engaged in quality improvement.

Fourth, The unit cost consideration makes a strong point that the exponential shape of the 'costs of achieving good quality' curve is unrealistic. At higher quality levels, more good products are available to bear the costs of both prevention and appraisal.

The so-called new CoQ model which is more in agreement with empirical findings from industry is presented in Figure 3. It exhibits a weaker increase in appraisal and prevention costs, accounting for a higher prioritization of prevention and new technological solutions that reduce the failure rate and make process monitoring feasible. The total cost curve is negatively sloped and the cost optimum shifts to the perfect quality level. In fact, the new COQ model reflects Deming's viewpoint that we do not need a CoQ model to determine an optimal level of quality. Deming asserts that the costs of selling defective products is so high that quality costs will only be minimized when there is 100% conformance, or zero defects. Consequently, he thinks that there is no reason to measure quality costs since the only sensible strategy is to be sure that no defective products are produced at all.

Figure 11: New CoQ Model



In general, it is accepted that the new COQ model presents a much more rounded perspective on quality costs and seems to reflect business reality much closer than the old model, at least for "world-class" organizations. However, there is also a criticism that both models are of a limited value.

ABC Model

Prevention-appraisal-failure (PAF) approach (both old and new) and process cost approach are the two main approaches to measuring CoQ. However, these approaches still cannot provide appropriate methods to include overhead costs in CoQ systems.

These deficiencies could be overcome under activity-based costing (ABC) developed by Cooper and Kaplan of Harvard Business School . ABC uses the two-stage procedure to achieve the accurate costs of various cost objects (such as departments, products, customers, and channels), tracing resource costs (including overhead costs) to activities, and then tracing the costs of activities to cost objects. ABC uses the two-stage procedure to achieve the accurate costs of various cost objects (such as departments, products, customers, and channels), tracing resource costs (including overhead costs) to activities, and then tracing the costs of activities to cost objects.

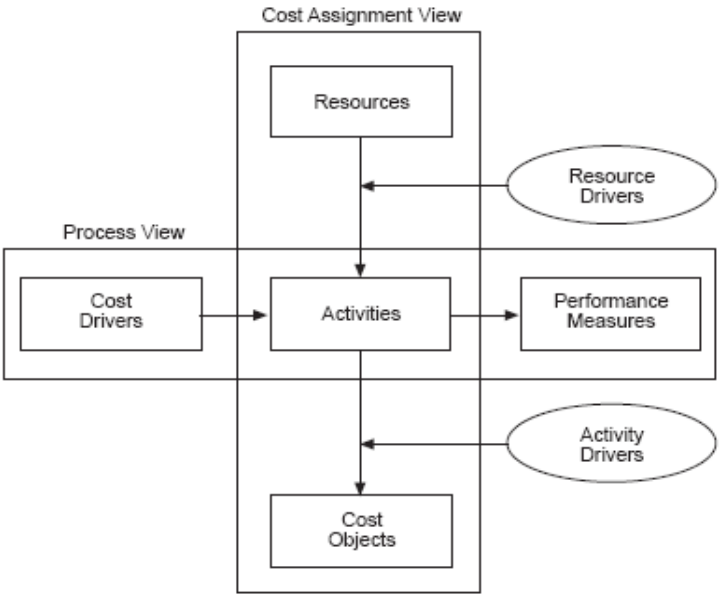
The main shortcoming of traditional cost accounting is to distribute overhead costs over products by using volume-related allocation bases such as direct labor hours, direct labor costs, direct material costs,

machine hours, etc. It will not seriously distort the product cost in the conventional manufacturing environment where overheads are just a small portion of product cost. In the modern manufacturing environment, however, the overheads will grow rapidly as manufacturers increasingly promote the level of automation and computerization, and the cost distortion of traditional cost accounting will be significant. In general, traditional cost accounting overcosts high volume products and undercosts low-volume products.

In view of this, the application of ABC methodology was proposed, in order to improve the accuracy of product costs. Early ABC systems focus on the accurate assignment of overhead costs to products. They do not provide direct information about activities and do not consider the costs outside the plant. Thus, a two-dimensional model of ABC was proposed. This ABC model was characterized by two dimensions: cost assignment view and process view. A detailed analysis of these two sub-systems is not presented due to space restrictions but a schematic overview is given in Figure 4, whilst in Table 2 a comparison between the main CoQ models and the ABC quality costing is presented.

It can be easily concluded that the PAF approach of CoQ is activity-oriented, the process cost approach of CoQ is process-oriented, and ABC is activity-oriented for the cost assignment view and process-oriented for the process view.

Figure 12: Two-dimensional model of ABC



An integrated CoQ - ABC framework was proposed in 1998 and it was stated that "The cost and non-financial information achieved from the integrated CoQ - ABC system can be used to identify the magnitude of the quality improvement opportunities, to identify where the quality improvement opportunities exist, and to continuously plan the quality improvement programs and control quality costs".

Table 2: Comparison between main COQ approaches and ABC

Aspect of comparison	Cost Of Quality		ABC
	PAF approach	Process cost model	
Orientation	Activity-oriented	Process-oriented	Activity-oriented (cost assignment view) Process-oriented (process view)
Activity/cost categories	Prevention Appraisal Internal failure External failure	Conformance Non-conformance	Value-added Non-value-added
Treatment of overhead	No consensus method to allocate overhead to CoQ elements under current CoQ measurement systems and traditional cost accounting		Assigning overhead to activities by using resource drivers in the first stage of ABC cost assignment view
Tracing costs to their sources?	No adequate method to trace quality costs to their sources		Tracing activity costs to cost objects by using activity drivers in the second stage of ABC cost assignment view
Improvement objects	CoQ-related activities	Processes activities	Processes/activities
Tools for improvement	Quality circle Brainstorming Nominal group technique Cause and effect analysis Force-field analysis		Process/activity value analysis Performance measurement Benchmarking Cost driver analysis

In general, one serious limitation of the ABC approach is the need to conduct a full-blown activity-based costing analysis to identify and rank each activity. However, a wide variety of service and manufacturing firms have found that simplified activity-based costing concepts can be used to identify non-value-added activities and quality improvement opportunities, without the time and expense required to implement a full ABC system .

The goal of the simplified activity analysis is to identify the activities and costs associated with preventing, identifying, and correcting quality problems. To do so, each activity is broken out into four categories:

(1) Essential work, which encompasses value-added activities required to produce a product or service right the first time

(2) Prevention activities such as quality-related training and preventive maintenance that are carried out to avoid defects, rework, or delays
(3) Appraisal activities such as inspections and data verification that are conducted to measure or test whether a product or service meets customer requirements

(4) Rework and Failure activities such as problem resolution and defect correction that arise because products or services did not meet customer requirements.

The three activity analysis levels offer various degrees of detail and accuracy, allowing the firm to adapt the analysis to the quality improvement team's requirements and the available time frame and resources.

Chapter 7 How to start a Quality Cost Program?

The following are the steps for Starting a Quality Cost Program.

Step 1: Awareness Creation – Top Management needs to be aware of Cost of Quality concept. Objective of Cost of Quality Program needs to be identified. Cost of Quality Program should be implemented. Results needs to be analysed & Improvements needs suggested.

Step 2: Identifying Project Team – Top Management needs to be identified. The following important members needs to be identified a) Finance coordinator b) Quality in-charge and c) Departmental Representative

Step 3: Identification of Quality Cost Elements – A Checklist of Quality Cost Elements needs to be prepared. Quality Cost Elements needs to be identified for each Function / Process.

Step 4: Designing Quality Cost Procedure – The step involves a) Defining each element of Quality cost b) Data needs to be collected as per guideline c) Sources & Frequency of Data needs to be identified d) Comparison bases for Cost of Quality analysis needs to be identified e) Reports & Formats for Cost of Quality needs to be identified.

Step 5: Data Collection: Data needs to be collected from all the Sources in coordination from Functions / Processes. Data needs to be collected at each Level of Functions / Processes. Data needs to be accurate & validated.

Step 6: Reporting of Quality Costs – Important steps involves a) Compilation of Quality Cost Data b) Function / Process wise Quality Cost Reporting c) Company-wide Reporting needs to be complied & analysed.

Step 7: Trend Analysis – All Functions / Processes needs to be appended to Overheads classified under External / Internal / Appraisal / preventive costs. Post allocation Total Cost needs to be derived & Improvement strategy needs to be identified. Strategy to be implemented by Function / Process.

Step 8: Evaluation & Continuous Improvement – Strategy plan needs to

be evaluated & continuously improved.

Figure 13: Steps for Starting a Quality Cost Program

Chapter 8 Reporting Quality Costs

A Quality cost report details the prevention costs, appraisal costs, and internal failure cost and external failure cost that arise from company's current level of defective products or services. Companies often construct a quality cost report that provides an estimate of the financial consequences of the company's current level of defects. A simple quality cost report is shown in the following example:

Example of Quality Cost Report

Ventura Company Quality Cost Report For the Year 1 & 2

Particulars	Year 2		Year 1	
	Amount	Percent	Amount	Percent
Prevention Cost	10,00,000	2.00%	6,50,000	1.30%
Appraisal Costs	15,00,000	3.00%	12,00,000	2.40%
Internal Failure Costs	30,00,000	6.00%	20,00,000	4.00%
External Failure Costs	20,00,000	4.00%	51,50,000	10.30%
	---------	---------	----------	---------
Total Quality Cost	75,00,000	15.00%	90,00,000	18.00%
	======	=====	======	=====

Workings & Observations :

1) Prevention cost increased by (1,000,000 – 650,000) = 350,000
2) Appraisal cost increased by (1,500,000 – 1,200,000) = 300,000
3) Internal Failure cost (3,000,000 – 2,000,000) = 1,000,000
4) Total Increase = 1,650,000

Several things should be noted from the data in the quality cost report. First, note that the quality costs are poorly distributed in both years, with most of costs being traceable to either internal or external failure. The external failure costs are particularly high in year 1 in comparison to other costs.

Second note that the company increased its spending on prevention and appraisal activities in year 2. As a result, internal failure costs went up in that year (from 2 million in first year to 3 million in year 2), but external failure costs dropped sharply (from 5.15 million in year 1 to 3 million in year 2). Because of the increase in appraisal activates in year 2, more defects were caught inside the company before they were shipped to the customers. This resulted in more cost for scrap, rework, and so forth, but saved huge amounts in warranty repairs, warranty replacements, and external failure costs. Third, note that as a result of greater emphasis on prevention and appraisal, total quality cost decreased inyear2.As continued emphasis is placed on prevention and appraisal in future years, total quality cost should continue to decrease. That is, future increases in prevention and appraisal costs should be more than offset by decreases in failure costs. Moreover, appraisal costs should also decrease as more effort is placed into prevention

Chapter 9 Quality Costs in Service Organizations

9.1 Dimensions of Service Quality

9.2 Brief on Quality Costs in Service Sector

9.1 Dimensions of Service Quality

The Three basic Dimensions in Quality

1) Aspects of Product / Service (Basic Quality)

2) Dependability (Continued availability of Quality)

3) Exceeding Expectations (Extending the first two Dimensions and adding depth to service quality)

9.2 Brief on Quality Costs in Service Sector

Usually the management is aware of actual expenses of prevention, appraisal, repairs and corrective actions, and even downgrade of a product as a result of errors, faults and improper treatment.

But management does not consider additional and sometimes heavy intangible losses such as those mistakes that give the supplier a poor reputation resulting in loss of customers.

These intangible losses are very important to service organizations such as transportation, hotels, communication services, post office services, repair shops, educational facilities, banking and others, which depend on continuous and wide contact with their client.

When the customer is not satisfied by the requested service he will most likely not contact the same supplier again, particularly if there are others around, which is usually the case

The model includes parameters which relate to word-of-mouth advertising; this advertising causes transitions between unaware, positively aware, and negatively aware states of consumers and thus affects service demand. Model simulations reveal some generally useful guidelines for

service providers:

1) it is unwise to expand service operations excessively during the early phases of the service offering in order to handle strong demand. The model shows that the demand typically peaks at this early stage before settling down to an equilibrium rate.

2) Because of customer sensitivity to service quality, cost reductions that deteriorate service quality are likely to be a poor policy.

3) It is a good strategy to adopt a high service quality from the beginning, rather than to improve it later; this is because the impact of good service on the customer base is more rapid in the startup phase than in the long-term equilibrium phase.

In Manufacturing, Quality costs are primarily product – oriented, where as in service industry it is personnel (labour) oriented. Personnel costs account for up to 60 to 75% of the total costs.

The nature of Quality costs differs from services and manufacturing organizations. In services, the external failure costs like warranty and field support are less relevant compared to manufacturing. Process related costs like customer service and complaints handling are critical in addition to lost customers.

The service organizations must spend a lot of money in prevention activities (prevention costs) such as employee training, quality planning, work flow planning and work automation in order to be successful in reducing cost

Chapter 10 Implementation Strategy

10.1 Introduction

10.2 Model for implementing cost of quality program

10.1 Introduction:

It is not proper to apply the Quality cost system to every project until it is applied successfully on a pilot project. Initially it may not be possible to measure all the costs. Hence, consider only the costs that are obvious initially.

It is most important to have consensus in the organization among the costs and their classification. Avoid the pit fall – inclusion of all types of costs to show up dramatic results. But at the same time, underplaying the costs also does not help as it may hide the customer dissatisfaction.

10.2 Model for implementing cost of quality program:

An integrated simple model is proposed to implement cost of quality program in any industry. The model is named as integrated as it integrates various inputs like resources, organizational objectives, quality objectives etc and various steps required for its implementation. The different steps of proposed model were explained as under:

Step-1 First of all, in order to implement a Quality Cost program, an organisation should constitute a Quality Cost Team for its successful implementation. The quality cost implementing team may have members from only quality assurance department or it may be multidiscipline team. The team should be well versed with various quality cost concepts. The various inputs for starting a quality cost program are:

- Top Management Support
- Organizational resources
- Quality Objectives
- Organizational Objectives

Step-2 The next step should be to decide about quality cost base. Total Quality cost compared to an applicable base results in index which may

be periodically analyzed in relation to past indices and peer industries. The base used should be representative of, and sensitive to, fluctuations in business activity.

Generally any one out of following bases is used:

• A labor base - such as total labor, direct labor etc.
• A cost base - such as shop cost, operating cost, or total material and labor
• A sale base - such as net sales billed or sales value of finished goods and services
• A unit base - such as number of units produced, the number of services performed, or the volume of output. However, Sales base is most commonly used, as this base is quite helpful in making presentations to top management.

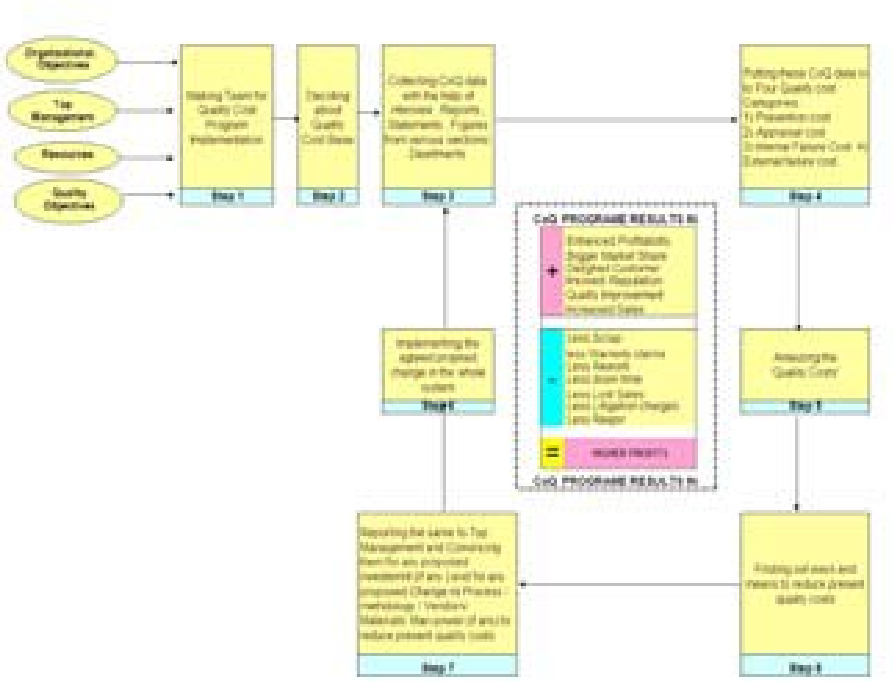


Fig.1: Integrated Simple Model for Implementing Cost of Quality program

Step-3 The next step shall be collection of data related to various cost of quality elements. These data might not be readily available. As many appraisal and internal failure costs are considered a normal part of operations. For that, these costs could be calculated with the help of various cost sheets , files, statements and interviews of different persons

associated in different departments, In some cases, one may also estimate these costs (if needed).

Step-4 The next step in this regard shall be of putting these quality cost elements in following four types of quality cost categories:

- Prevention costs
- Appraisal costs
- Internal failure costs
- External failure costs

Step-5 In this step, the different quality costs collected in Step-4 should be analyzed. The data can be put in Excel spread sheet and different tools can be applied. Further, the presence of any trend (if any) can also be verified. The help of Pareto analysis can also be taken so as to find out those few quality costs which are responsible for majority of total quality costs. The quality costs should be calculated as percentage of pre defined base.

Step-6 In this step, different ways and means should be decided so as to reduce the present level of quality cost. Here, resources/investment required for reducing quality costs and thereafter its impact on reduction of targeted quality costs should also be estimated. This is an important activity as any proposed investment / activity should be justified to management.

Step-7 Here present level of quality costs in terms of money terms like costs of quality in percentage of total sales, costs of quality in percentage of profits etc should be communicated to top management. Further, to reduce the present level of quality costs, all the proposed quality efforts along with their likely financial burden and proposed estimated savings in quality costs over a period of time should also be essentially mentioned. Top management should be convinced to give their acceptance for proposed changes/ investments so that in the long run net savings in quality costs will overshadow proposed changes/investments."

Step-8 In this step, changes approved by top management should be implemented in the whole system.

Chapter 11 Cost of Quality As Tool For Strategic Cost Management

11.1 Cost Management Information

11.2 Quality tools to implement and influence the Cost Management

11.3 Significance of Quality in SCM

11.4 Activity Based Costing

11.5 Value Analysis & Value Engineering

11.6 Waste Management

11.7 Time & Motion Study

11.8 Cost Benefit Analysis

11.9 Budgetary Control

11.1 Cost Management Information

It is the information the manager needs to effectively manage the firm and includes both financial information about costs and revenues as well as relevant non-financial information about productivity, quality, and other key success factors for the firm.

Financial information (earnings made, costs incurred etc.) tends to have a short term focus while the non financial factors like productivity, quality, customer loyalty have a long term focus.

'Strategic Cost Management' is the development of cost management information to facilitate the principal management function, strategic management.

Strategic Management in essence is the development of a sustainable competitive position in which the firm's competitive advantage provides continued success.

Because strategic issues are increasing in importance to management, cost management has moved from a traditional role of product costing and operational control to a broader, strategic focus: strategic cost management.

11.2 Quality tools to implement and influence the Cost Management.

• BENCHMARKING :- Benchmarking is a process by which a firm identifies it's critical success factors, studies the best practices of other firms (or other units within a firm) and then implements improvements in the firm's processes to match or beat the performance of those competitors.

• TOTAL QUALITY MANAGEMENT :- TQM is a technique by which management develops policies & practices to ensure that the firm's products and services exceed customers' expectations. This approach includes increased product functionality, reliability, durability and serviceability. Cost management is used to analyze the cost consequences of different design choices for TQM and to measure and report the many aspects of quality including production breakdowns and defects, wasted labour or raw materials, the number of service calls, and the nature of complaints, warranty costs, and product recalls. TQM efforts can build brand loyalty and help company improve product quality and competitiveness quickly.

• CONTIUOUS IMPROVEMENT :- It is a Japanese management technique Kaizen by which managers & workers commit to a program of continuous improvement in quality and other critical success factors. It is often associated with Benchmarking & TQM.

• ACTIVITY BASED COSTING :- Many firms have found that they can improve planning, product costing, operational control and management control by using activity analysis to develop a detailed description of the specific activities performed in the firm's operations. The activity analysis provides the basis for Activity Based Costing and Activity Based Management. ABC is used to improve the accuracy of cost analysis by improving the tracing of costs to products or to individual customers. ABM uses activity analysis to improve operational control and management control. ABC & ABM are the key strategic tools for many firms, especially those with complex operations, or great diversity of products.

• RE-ENGINEERING :- Reengineering is a process for creating competitive advantage in which firm reorganises it's operating & management functions. It is defined as the ' fundamental rethinking and radical redesign of business processes to achieve dramatic improvements in critical, contemporary measures of performance, such as cost, quality,

service and speed.' Strategic Cost Management supports the reengineering effort by providing the relevant information

• JUST-IN-TIME SYSTEM :- It is a comprehensive production and inventory management system that purchases or produces materials and parts only as needed and just in time to be used at each stage of the production process. JIT can be applied to all aspects of business, including purchasing, production and delivery. JIT focuses on eliminating waste, reducing inventories and developing strong supplier relationships.

• KANBAN is used with JIT to greatly reduce lead times, decrease inventory, and improve productivity by linking all production operations in a smooth, uninterrupted flow. It is essentially a communication system; mostly in the form of card, a label, a box or bin, a series of trays, or a number of squares painted or taped on the factory floor or work surface.

• CAD & CAM :- CAD is the use of computers in product development, analysis and design modification to improve the quality and performance of the product. CAM is the use of computers to plan, implement, and control production. It helps to bring in flexibility & innovation in products.

• FMS & CIM :- FMS is a computerized network of automated equipment that produces one or more groups of parts or variations of a product in a flexible manner. It uses robots and computer controlled materials handling equipment to link several stand-alone, computer-controlled machines in switching from one production run to another. CIM is a manufacturing system that totally integrates all office and factory functions within a company via a computer-based information network to allow hour by hour manufacturing management. Advantages of FMS & CIM include production of high quality products & services, low inventories, high degrees of automation, quick cycle time, increased flexibility and advanced information technology.

• TARGET COSTING :- Target costing is a tool that determines the desired cost for a product on the basis of a given competitive price, such that the product will earn a desired profit. Cost is thus determined by price. The firm using target costing must often adopt strict cost reduction measures or redesign the product or manufacturing process to meet the market price and remain profitable.

Target Cost = Market determined price less desired profit

• LIFE CYCLE COSTING :- It is a management technique to identify and monitor the costs of a product throughout it's life cycle. The life cycle consists of all steps from product design and purchase of raw materials to delivery and service of the finished product. The steps include research & development, product design including prototyping & testing, manufacturing, inspecting, packaging and warehousing, marketing, promotion and distribution, sales & service. LCC includes both upstream & downstream costs prior to and post – manufacturing as well.

• THE VALUE CHAIN ANALYSIS :- Value chain analysis helps management discover those activities which are non-productive and where costs can be reduced by either outsourcing them or eliminating them altogether. The key idea of value chain analysis is that firm does thorough analysis of it's operations, to determine how each activity contributes to the firm's profits and competitiveness.

• THE BALANCED SCORECARD :- Strategic information using critical success factors provides a road map for the firm to use to chart it's competitive course and serves as a benchmark for competitive success. These factors have both financial & non financial dimensions. CSFs in the areas of financial performance, customer satisfaction, internal business processes and innovation & learning. The accounting report based on these four dimensions is called a 'Balanced Scorecard'.

11.3 Significance of Quality in SCM

• Strategic Cost Management system develops strategic information, including both financial and non financial information.
• Strategic use of financial performance measures like – growth in sales and earnings, cash flow and stock price are made to evaluate nonfinancial measures such as market share, product quality, customer satisfaction and growth opportunities.
• Availability of strategic information helps in preparation of balanced scorecard based on factors like – Customer Measures, Internal Business Processes, Innovation & learning, Community & Social Impact, government relations and ethical or professional management behavior.
• Sound decision making possible and decisions are not based on guesses and intuition.
• Clarity about direction and goals.
• Clear and favorable perception of the firm by all the stakeholders.

• Learned decisions in respect of investments decisions, choice of products & markets, manufacturing processes etc.
• Developing capabilities to effectively benchmark competitors.

11.4 ACTIVITY BASED COSTING

ABC is a costing approach that assigns resource costs to cost objects such as products, services, or customers based on activities performed for the cost objects. The premise of this costing approach is that a firm's products or services are the results of activities and activities use resources which incur costs. Costs of resources are assigned to activities based on the activities that use or consume resources (resource consumption drivers), and costs of activities are assigned to cost objects based on the activities performed for the cost objects (activity consumption drivers). ABC recognizes the causal or direct relationships between resource costs, cost drivers, activities, and cost objects in assigning costs to activities and then to cost objects.

Definition :- Activity- An activity is a specific deed, action, or work performed. -An activity can be a single action or an aggregation of several actions. Resource- It is an economic element needed or consumed in performing activities. Cost Driver- It is a factor that causes or relates to a change in the cost of an activity.

11.4 VALUE ANALYSIS & VALUE ENGINEERING

Definition :- A systematic analysis and evaluation of the techniques and functions in the various spheres of an organisation with a view to exploring channels of performance improvement so that the value in a particular product can be bettered

The important objective of Value Analysis and engineering is to reduce costs without loss of quality or function. It is a team work involving designers, engineers, purchase managers and accountants.
The economic value of a product is the combination of Use value, Cost value, Esteem value and Exchange value.

• Use Value : It refers to the characteristics and features which make the product useful for which it is intended.

• Esteem Value :- It makes an ownership of an objective desirable and make it attractive which would induce customer to buy.

• Cost Value:- It is the total cost i.e. material, labour and overheads required to produce an item in case of manufactured items and the cost of purchase in case if obtained from outside.

• Exchange Value :- It refers to properties of an object that makes it possible to procure other items by trading.

11.5 WASTE MANAGEMENT

Following aspects are covered under waste management.

• Waste Control
• Scrap Control
• Spoilage Control
• Control of Defectives

Waste Control :- Waste is a material loss during production or storage due to evaporation, chemical reaction, unrecoverable residue, shrinkage etc.

Wastage may be visible at times or invisible. It may be a normal waste incidental to manufacturing activities or abnormal waste which is in excess over the normal and invites a corrective action. Control on waste can be exercised achieved in the following aspects.

• Quantity Control :- It involves maintenance of detailed records of quantities with an object to detect shrinkage, breakage, loss etc. Establishment of output ratios are much helpful in framing strategies for waste control. Normal allowances of waste can be fixed with technical assessment and past experience along with due consideration to the special features of material and processes. A systematic procedure for feedback of achievements against standards laid down for wastage will improve the quality control aspect of the production. Study of the causes of abnormal wastage helps in fixing the responsibility. Better material handling systems will also help control of waste.

• Quality Control:- Wastage may also occur from loss of control on process or poor quality of material. Fixing the responsibilities for purchase,

stores, production and maintenance departments to ensure achievement on standards will provide a strategic advantage.

Scrap Control :- Scrap control is the residue material that has a recovery value. It is incidental residue from the materials used in manufacturing operations
which is recoverable and measurable without processing. For control purpose scrap may be classified into the following:

Legitimate Scrap:- Predetermined or anticipated in advance due to experience in manufacturing operations.

Administrative Scrap:- Results from administrative decision e.g. change in design or withdrawal from saleable lots or for some other reasons.

Defective Scrap:- Resulting from poor quality of raw material, negligient handling of material etc.

Scrap can be controlled in the following ways:

- Material specification at the product design stage.
- Selection of right material and equipment.
- Selection of right type of personnel with proper training and experience.
- Determination of acceptable limits of scrap.
- Reporting the source of waste, quantum of waste.
- Specific areas of responsibility.

Spoilage Control:- Spoilage is the production that fails to meet quality or dimensional requirements and these are so damaged in manufacturing operations that they are not capable of rectification economically and hence taken out of the process and disposed off without further processing. If spoilage is well within the limits, it is regarded as normal spoilage. The limits of spoilage are laid down after thorough study of material, men, processing and operating conditions. If spoilage exceeds the normal limits, it is required to take prompt action.

Control of spoilage can be achieved in the following ways.
- Control through predetermined standards.
- Control through fixation of individual responsibility.
- Prompt & systematic reporting of spoilage.

Defectives Control :- Defectives represent the part of production that does not meet dimensional or quality specifications of a product but which can be reworked by additional application of material , labour and processing and made into saleable condition either on first or seconds depending on characteristics of the product.

11.7 TIME & MOTION STUDY

TIME STUDY - Time study is a technique designed to establish the time for a qualified worker to carry out specified elements under specified conditions at a defined rate of working recorded by direct observation of the times using a time measuring device and the ratings for individual elements.

The main objective of the study is the development of standard time which is normally defined as the time required by an 'average worker' working at 'normal pace' to complete a specified task using a 'specific method'. The possession of exact knowledge through time study helps to eliminate waste and minimise costs.

METHOD STUDY - Method study is aimed at finding better ways of doing jobs. There are five ways that methods can be improved.

- Eliminate unnecessary tasks
- Simplify the process
- Combine tasks
- Rearrange tasks
- Reduce number of operations

Method study is usually undertaken in the following stages:

- The area of study is defined based on cost/benefit considerations.
- Information is gathered by close observations and interviewing employees.
- Flow charts & management reports are analysed.
- Alternative methods of performing job are considered. This involves analysing current methods which will be subject to following questions

1. Is the job & all it's aspects necessary?
2. Is the best equipment used?
3. Are controls adequate?

4. Do bottlenecks and idle time occur?
5. Is the standard set for the job acceptable?

• The best alternative is developed and installed
• Feedback is obtained and progress is monitored.

Method study is the critical study of existing and proposed ways of doing work as a means of developing and applying easier and more effective methods are reducing costs

WORK STUDY - Work study is the application of systematic analysis to the work of men and machines so as to improve methods and to establish proper time values for that work.

The objectives of work study are:
- The most effective use of plant
- The most effective use of human effort
- A reasonable workload for those employed

Work study investigates every aspect of existing or proposed work in order to find the best way of performing tasks. It involves setting standards and solving problems which include bottlenecks, low morale, large amounts of defective work and low productivity. Work study is comprised of method study and work measurement. Work study is a general term for those techniques (especially method study & work measurement) that are used in the examination of human work and which lead systematically to the investigation of all factors affecting the efficiency of the situation being reviewed as a basis for making the improvements.

ACTIVITY SAMPLING - In activity sampling, a number of successive observations are made over a period of time of one or a group of machines, processes or workers. Each observation records what is happening at that instant and the percentage of observations recorded for a particular activity or delay is a measure of the percentage of time during which that activity or delay occurs. Activity sampling is a technique in which a large number of instantaneous observations are made over a period of time, of a group of machines, processes or workers

WORK SIMPLIFICATION - Work simplification is a technique for analysing operations and procedures with a view to finding easier ways of performing the work invoved.

11.8 COST BENEFIT ANALYSIS

In the cost reduction program the differentiation between necessary costs & unnecessary costs is essential. If necessary costs are reduced, the benefits created by the resources consumed are reduced. Such cost reduction leads lower than required quality, extended delivery periods, increased rejections.Therefore the effective way of cost reduction is to search for unnecessary costs and eliminate them entirely.

Following steps are involved in establishing the benefits created by resources consumed in the business. The steps are analytical, concerned with separating resources into the appropriate activities and establishing the reasons for their consumption.

STEP I Cost Analysis - It involves an analysis of all costs and activities. This can usually be done from any reasonably designed accounting system.

STEP II Contribution Analysis - Analysing the value of what each activity contributes in terms of income or benefits is important in establishing the real wealth-creating activities of the business.

STEP III Benefit Analysis - Costs are broken down on the basis of the reasons why they are incurred and then to assess the benefits. Following queries are raised.

• Would the contribution of the activity or group of activities be reduced if the reason for spending be eliminated? If answer is no, elimination of the reason for spending should be carefully considered.
• Are adequate benefits received from those reasons for spending which are considered necessary? If the answer is no, either the degree of spending should be reduced or benefits increased.

STEP IV Cost Reduction - Develop a cost reduction programme by establishing those reasons for incurring cost which:

• Do not contribute to an activity's earning potential.
• Do not create benefits
• Do not create adequate benefits for the level of cost.

The analyst's role at this point is two fold:

• To present the facts & figures objectively.
• To set an example by reducing unnecessary costs in his own area of responsibility.

STEP V Profit Improvement - Develop a profit improvement programme by determining those areas which can create additional income from existing and new resources, based on rationalisation and reduced costs of existing activities.

11.9 BUDGETARY CONTROL

Budget :- Budget is a financial and quantitative statement, prepared and approved prior to a defined period of time, of the policy to be pursued during that period for the purpose of attaining a given objective.

Budget is a plan quantified in monetary terms, prepared & approved prior to a defined period of time, usually showing planned income to be generated and expenditure to be incurred during that period and the capital to be employed to attain a given objective. It is a plan of future activities for an organisation. It is expressed mainly in financial terms, but also usually incorporates many non-financial quantitative measures as well.

Budgeting :- Budgeting is the whole process of designing, implementing and operating budgets. The main emphasis in this is short-term budgeting process involving the provision of resources to support plans which are being implemented.

Budgetary Control :- Budgetary control is the establishment of budgets relating the responsibilities of executives to the requirements of a policy and the continuous comparison of actual with budgeted results, either to secure by individual action the objective of that policy or to provide a basis for it's revision.

Chapter 12 Benefits of Cost of Quality Information

12.1 Benefits of Quality

12.2 Typical Uses

12.3 Typical Results Achieved

12.4 Summary

12.1 Benefits of Quality

Quality Cost information serves a variety of purposes. It helps management to evaluate relative importance of quality problems and thus identify opportunities for cost / waste reduction. The Quality cost information can aid in budgeting and cost control activities. It can also serve as a benchmark for evaluating organization's performance in achieving quality objectives.

Cost of Quality ("COQ") can be used to identify the global optimum for a process, and monitor that process' progress towards its global optimum. "Global optimum" is defined as the best possible outcome from all physically possible operating modes, combinations, and permutations of the current process.

As Organisations strive to increase the Bottom Line performance in this highly competitive environment there are two important ingredients Quality & strategic Planning

Cost of Quality is associated with preventing, finding and correcting defective work. Key benefits are listed below:

1) It assists in strengthening the project activities/tasks which are well in supplier's control before it is shipped to the customer. The training programs or awareness programs can be strengthened to have a control on the preventive costs. More emphasis can be given to the preventive measures and activities.

2) Code inspections and testing can be strengthened to have a control on the Appraisal costs. A focussed approach in these two directions helps

minimize the cost of fixing bugs at a later stage of the Project life cycle as well as dealing with the customer complaints.

3) Cost of Quality is thus a tool to measure the losses from defined processes.

4) Tracking measurement over a period of time can be used as 'benchmark'

Any organization whether it is micro, small, medium or large one can easily implement this model. It is closed model and favors continuous improvement. It does not need too much investment to implement this Model It emphasizes importance of top management for successful implementation of cost of quality program Making team for cost of quality program will ensure its success.

This model will result in

1) Enhanced Profitability
2) Bigger market share
3) Increased sales
4) Improved organization reputation
5) Delighted customer

By implementing this model, organizations will have

1) Less rework
2) Less repair
3) Less down time
4) Less lost sales
5) Less warranty claims
6) Less litigation charges

12.2 Typical Uses

Cost of Quality ("COQ") is used to collect cost data on a sampling basis (eg. all data occurring during a 24 hr period, calculated once each quarter), or on a continuous basis (eg. Cost of Quality ("COQ") is calculated with all data occurring in the month, and reported monthly) .

After confirming that the data is accurate and comprehensive, and

consistent with previous definitions and implementations, it is analyzed for opportunities and trends. Based upon statistical analysis (eg. regression analysis, indexes, correlations, Pareto analysis, factor analysis, etc.), conclusions and recommendations are presented to managers of the process being analyzed.

In some cases (supported by process modeling, heuristics, prior experience, or intuition) the optimum Cost of Quality ("COQ") can be predicted, and the process design necessary for achieving this global optimum Cost of Quality ("COQ") can be defined. A plan can then be defined to modify the current process, phase by phase, so as to move towards this global optimum process.

Management responsible for the process can decide on if, how, and when they will run the current process, or modify the process for even better results.

All projects are analyzed for their impact on Cost of Quality ("COQ"), and projects that show high ROQ are implemented on a priority basis (ROQ%= Cost of Quality ("COQ") savings/Implementation cost*100%).

12.3. Typical Results Achieved

When all costs are included, Cost of Quality ("COQ") as a % of gross sales will probably be around 30% to 35% for a profit orientated organization, 40% to 60% for a not-for-profit organization (ie. hospitals, charities, government, etc.). Many organizations take only a sub-set of the costs, including only those that tend to fluctuate, or that often need management intervention. The others are assumed to be constant.

When manufacturing companies often earn only 5% NPBT (Net Profit Before Tax), a 35% Cost of Quality ("COQ") indicates that 40% of gross revenue is generated by the company as profit, but only 5% of that gets trapped as NPBT. Therefore, the profit yield is only 12.5% (87.5% of the available profit is lost before it gets to the bank).

For improvements in Cost of Quality ("COQ"), some manufacturers have been able to reduce manufacturing costs by as much as 7.65% per year, every year, for more than 10 years.

For Six Sigma processes, Cost of Quality ("COQ") is usually reduced to less than 1% of gross sales. (Refer to Six Sigma Philosophy of Cost of Quality) This indicates that, as large and unbelievable as Cost of Quality ("COQ") seems to most managers, it is a real number that can be eliminated through hard work and dedication.

Obviously, as more and more improvements are made, it becomes more difficult to find the next saving. This is when an excellent Cost of Quality ("COQ") system can help point out the remaining opportunities.

12.4 Summary

Identifying COQ can have Several Benefits

- ✓ It Provides a standard measure across the organization & also inter-organization
- ✓ It build awareness of the importance of Quality
- ✓ It Identifies improvement opportunity
- ✓ Being a cost measure, it is useful at all levels across organization from shop floor to top management

Chapter 13 Case Study

Profile of the organization: A case study was carried out in a textile industry located in Punjab (India). The organization was under process to acquire ISO 9000 certification. The industry was making various textile products. The turnover of the company was approximately 348 Lacs INR. Quality costing system was implemented in that organization by following the proposed model and the same was explained step-by step as under:

Step-1 In this regard, a cross functional team was constituted for implementation of cost of quality programme. The team had taken inputs from Top management, organizational objectives and quality objectives.

Step-2 The team decided Sale Base as indicator for determining the performance of Cost of quality programme.

Step-3 The team gathered expense data related to quality related actions of financial year 2009-2010 from different records / files/ statements / reports .Help of interviews of different personnel in the organization was also taken in estimation of certain quality costs.

Step-4 Later the cost of quality data was put under four different quality cost categories i.e. Prevention, Appraisal, Internal Failure and External Failure costs.

The different quality cost data under categories of Prevention costs, Appraisal costs, Internal Failure costs and External Failure costs were shown as per Table-1, Table-2, Table-3 and Table-4.

Table1:	Prevention Costs		Table 2:	Appraisal Costs
Quality Cost Category Amount	(Rs.)		Quality Cost Category Amount	(Rs.)
Salaries	384000		Expense on in-process inspection	531000
Quality Training	12500		Calibration & Maintenance Costs	8000
Quality Administration	8500		ISO 9000 certification charges	20000
Quality Planning	0		Total	559000
Total	405000			
Table 3:	Internal Failure Costs		Table 4:	External Failure Costs
Quality Cost Category Amount	(Rs.)		Quality Cost Category Amount	(Rs.)
Wastage	1628411		Discount	271800
Rejection	410062		Traveling Expenses	25000
Extra Operations	132000		Total	296800
Total	2170473			

Step-5 The cost of quality data was analyzed. It was found that the annual sales turnover of the organization in the financial year 2009-2010 was 348.11 Lacs INR. Further the profit of the organization was 3.61 Lacs INR. The ratio of cost of quality / Annual sales was calculated and found to be 9.85%.

Step-6 By observing cost of quality data and ratio of cost of quality / Annual sales, it was found that the present level of cost of quality was very high. The percentage wise break up of different Fig. 2: Break up of quality costs

A pareto analysis was conducted on all the quality costs to help to point out quality cost categories which were responsible for major proportion of total quality costs and it was found that following types of quality costs were responsible for most of Total Quality Costs

1. Wastage
2. Expense on in process inspection
3. Salaries
4. Discounts
5. Rejection

Hence, instead of concentrating equally on all quality costs, the team proposed to concentrate more on these five quality costs as the scope of reduction was maximum in these five quality costs as compared to other

costs. Hence by using less energy and resources the results can be much better.

Step-7 The quality cost implementation team proposed following actions:

To increase efforts on quality training,

• Quality Planning and Vendor Evaluation, Development and ratings program

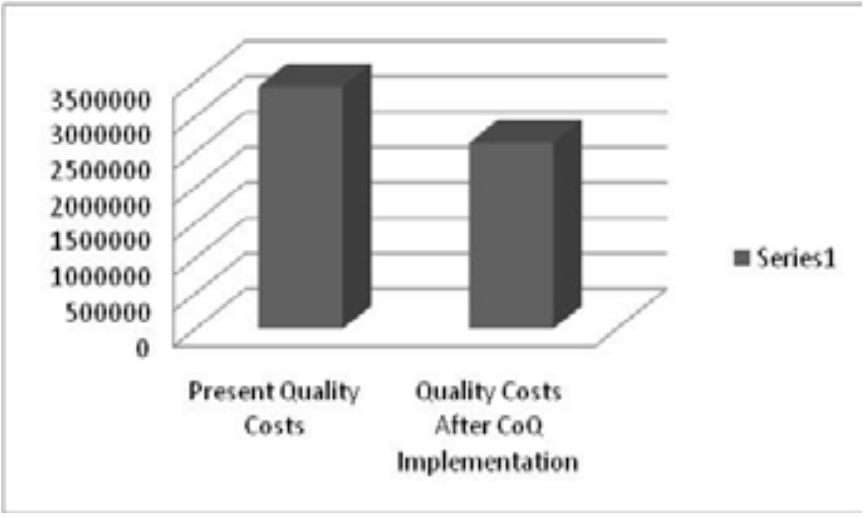
• To increase efforts to acquire ISO certification

Report of present level of cost of quality along with proposed changes to reduce the level of present quality costs was submitted to top management.

Step-8 After getting acceptance/clearance from top management , the team Implemented the proposed changes in the whole organization.

Conclusion : This study proposes an integrated simple model for implementation of cost of quality programme in an organisation.
It was shown that with the implementation of proposed model, the total quality costs would decrease significantly. The calculated quality costs and proposed quality costs were shown as under.

Figure 14: Calculated & Proposed Quality Costs



Chapter 14 Summary

The said project brings to light the various concepts related to Cost of Quality. It is only an effort to highlight the Realms of Cost of Quality.

There is always cost to errors and mistakes, especially in the business and industry. The quality costs require a practical understanding as they impact both the financial performance as well as customer satisfaction. As explained in this unit, there are several types of costs associated with quality such as external failure costs, internal failure costs, appraisal costs, prevention costs etc. Further, we also understood how quality costs could be treated in financial accounting and their mode of reporting to the management and other authorities.

Hence it is concluded that this integrated simple model can be very useful to organizations attempting to implement cost of quality program and to identify those characteristics that may provide an opportunity to improve customer satisfaction.

Many Gurus has helped to bring this Concept of Cost of Quality to Fore. Many Components of Cost of Quality are yet to be researched & A Day in reckoning when the Dimensions of Bottom Line will make The Upper Line Appear Much Brighter & a world a Better Place to Live In.

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