

CHAPTER 2

LITERATURE SURVEY

Introduction

Traditional measures of quality within industry using the percentage scrap, rework hours, number of warranty claims etc. It can be measured, but they have not been proved to be an effective report to management. Quality cost principle provides the manufacturing business with a management philosophy of “the economics of quality”. This includes the use of quality costs, typical quality cost profile, the goal of a quality cost system and setting up a quality costing system. They also give the advises on how to improve the quality and achieve the quality cost reduction based on the quality cost analysis and effective quality cost program implementing. All these are included in these literature surveys to be applied on performing the research.

2.1 Quality cost principle

According to Singapore productivity and standard board , “The concept of Cost of Quality (COQ) was first initiated by Dr. A.V. Feigenbaum in the 1950s. It was made popular by Philip Crosby in the early 1980s and further refined by Dr. H. James Harrington over the years. Today, the concept is still relevant to a successful organization.

Cost of quality is the total cost of ensuring product and service quality. It comparison two major components, namely, the cost of non-conformance (CONC) and the cost of conformance (COC).

Cost of non-conformance (CONC) refers to the total cost of not doing things right the first time (e.g. rework, scrap, customer complains). In the PAF model, this comprise the internal and external failure cost.

Basically, they are the waste or no-value-added cost. They are also referred to as the cost of poor quality or COPQ.

Cost of conformance (COC) refers to the total cost of ensuring that things are done right the first time (e.g. planned inspections and tests, quality related education and training) in the PAF model, this comprise the prevention and appraisal cost.

Jack Campanella [1999] described very details on the principles of quality cost. He defined total quality costs represents the difference between the actual costs of product or service and what the reduced cost would be if there are no possibilities of substandard service, failure of products, or defects in their manufacture.

Basically, he separated quality cost into three categories, Prevention costs, Appraisal costs and Failure costs, which can be further, divided into internal failure cost and external failure cost.

(1) Prevention costs. The costs of all activities specifically designed to prevent poor quality in products or services.

(2) Appraisal costs. The costs associated with measuring, evaluating or auditing products or services to assure conformance requirements.

(3) Failure costs. The costs resulting from products or services not conforming to requirements or customer / user needs. It includes internal failure costs which occurring prior to the customer and external failure costs which occurring in customer side.

He used figure 2.1 to identify the hidden costs of quality and the multiplier effect.

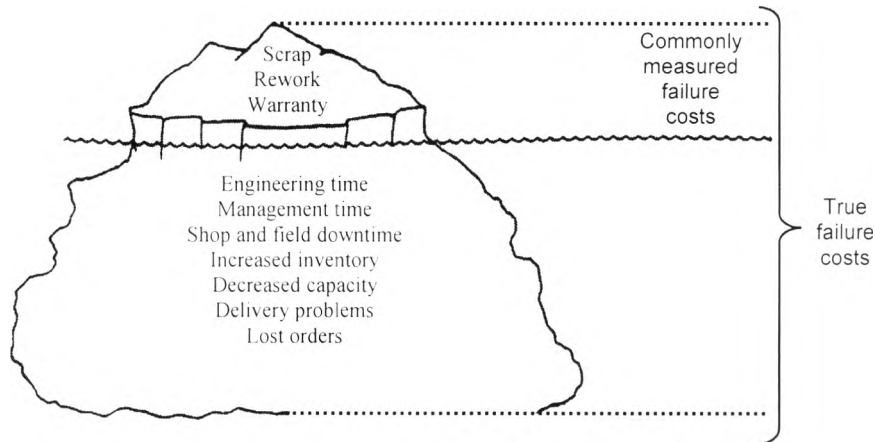


Figure 2.1 Hidden costs of quality and the multiplier effect

The use of quality costs

(1) Via the effective analysis methods to the quality cost and apply the appropriate problem solving techniques to improve the quality performance and achieve the quality cost reductions.

(2) Quality cost analysis is substantial on developing the cost-oriented strategic business plan.

(3) Supplier quality cost identification and analysis can control and improve the supplier quality performance.

(4) Cost of software quality (CoSQ) developing

Effective quality costs program is recommended to consists of the following step:

- Establish a quality cost measurement system.
- Develop a suitable long-range trend analysis.
- Establish annual improvement goals for total quality cost.
- Develop short-range trend analysis with individual targets that collectively add up to the incremental demands of the annual improvement goal.
- Monitor progress against each short-range target and take appropriate corrective action when targets are not being achieved.

He developed three approaches to collect and report quality costs, namely, quality costing approach, process cost approach and quality loss approach.

A Pareto analysis is a good tool analyzed the data then come out counter-measure. Then a trend analysis can be performed.

The good point for his book are systematic approach for quality cost program. Also, it explains the quality cost and basic approach on implementation. However, it also has disadvantages.

Firstly, this book explains only the principle of quality cost, lack details on how to apply. Also it does not have case study to refer.

Secondly, the book advocates ABC costing approach that is not popularly used in manufacturing companies in Asian countries. Therefore, it won't give us more useful references

Quality costs principle can contribute many benefits. Feigenbaum [1983] summarized the benefits of quality costs as below,

(1) Quality costs serve as a measurement tool to provide comparative measurement of improvements in given area and as an on going measure of quality performance.

(2) Quality costs serve as a process quality analysis tools. It can be used to pinpoint major problem areas, prioritize the areas for action.

(3) Serve as a programming tool. Quality costs can be used as a mean to identify the actions which provide the highest potential payoff, hence priority to time sequence.

(4) Serve as a budgeting tool. Quality costs are a guide to budget the necessary expenditure for accomplishing the desired quality-control programs.

(5) Serve as a predictive tool. Quality cost data provide the controls to evaluate and assure performance in relation to the goal and objectives of the company.

They are effective in producing valid cost estimates in obtaining new business in service or products and in meeting competition in the marketplace.

Many researchers and scholars performed studies on how to optimized the quality cost.

Besterfield [1992] gives detailed explanation on quality cost program and PAF model. In PAF model, each item are explained in details and attach some examples.

In this model, it is recommended to increase prevention and appraisal cost, and to reduce failure cost but the overall quality cost should be reduced.

The final goal of quality cost program is to optimize the quality cost, the optimum quality cost can be shown as figure 2.2

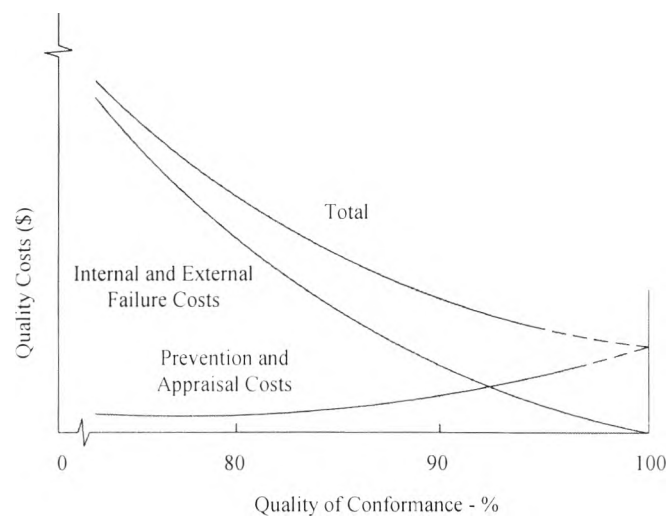


Figure 2.2 Optimum quality costs concept

Gong [1999] further developed a curve to divided quality status into three areas, each area has its proportion of failure cost, prevention cost or appraisal cost. If the failure cost is more than 70%, the quality needs big improvement. If the failure cost is about 50% and prevention cost is about 10%, the quality is in control area. If the failure cost is less than 40% and the appraisal cost is more than 50%, the quality is in excessive area.

He summarized the proportion of each quality categories into three areas that can be shown as figure 2.3

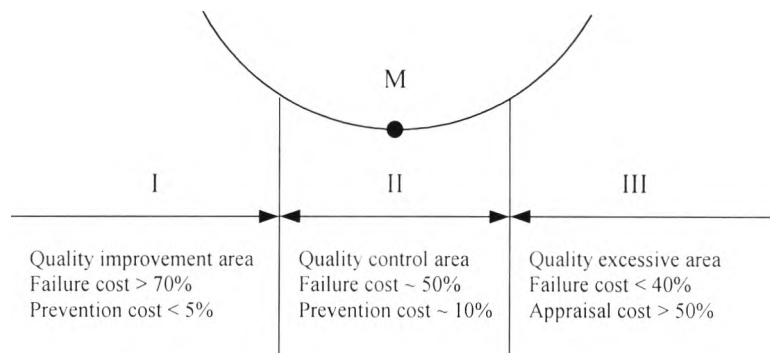


Figure 2.3 Quality cost analysis model

This discussion is based on the quality cost curve. In practice, most of manufacturers, which prepare to analyze the optimum point of quality cost, don't have this analysis model. Therefore it is very difficult to find out the optimum quality cost for them.

2.2 Quality cost program approach

British standard developed two models on quality cost program approach.

BS6143: part 2 (1990) is a quality cost PAF model, namely prevention cost, appraisal cost and failure cost was introduce to how implement to reduce the costs of quality. To reduce the increasing of the failure costs, first can increase in appraisal of product quality. then, spend more on prevention as appraisal together with

investigation points to elements where improvement can be made to product design / process / systems. Finally prevention action takes effect the prevention, appraisal and failure proportions of the costs realign and all costs reduce. It gives a schematic representations of trends to illustrate the total quality related cost reduction after quality improvement activity, which can be shown as the figure 2.4

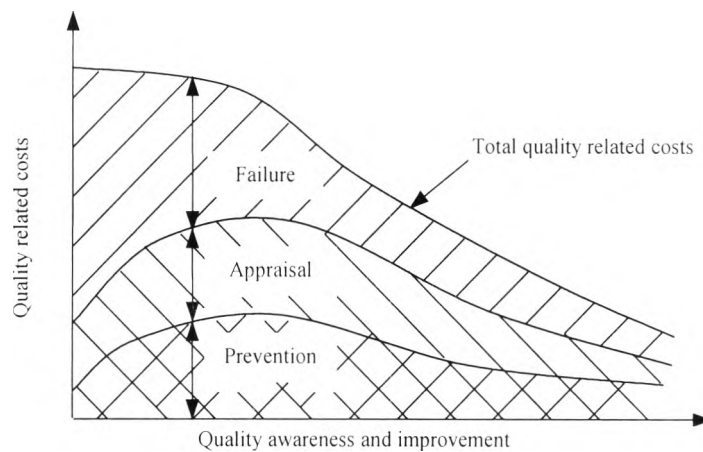


Figure 2.4 Increasing quality awareness and improvement activities

This standard defines very detailed quality cost categories and set up how to perform the quality cost program.

Besides PAF model, BSI also developed “process cost model” namely BS6143 part 1 (1992). The process cost approach is a stepwise analysis emphasizing on the process. The process cost element consists of people, equipment, material and environment. This model is shown as figure 2.5

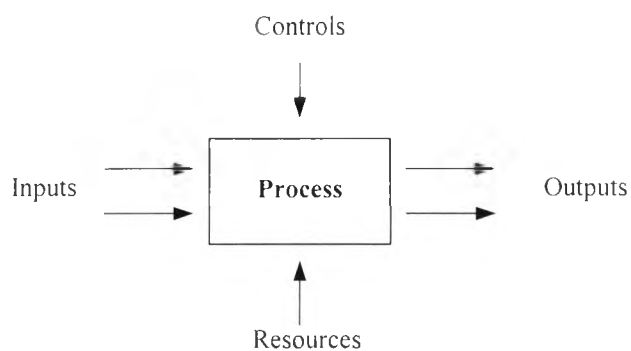


Figure 2.5 Basic process model

This standard identified the quality-related costs in the process element based on cost of conformance (COC) and cost of nonconformance (CONC).

Cost of conformance (COC) is the cost that spent to operator the process as specified in a 100% manner. However, the cost of conformance merely indicates the cost of satisfying the standards declared. It does not indicate an efficient or even a necessary process. It may not be the lowest cost. Therefore, it can be improved.

Cost of nonconformance (CONC) is the cost that spent on non-essential process such as wrong output (therefore requires rework), or various modes of waste. This also has room to improve.

Both areas of cost offer opportunities for improvement CONC should be prioritized for improvement.

To adapt this model, firstly a team should be set up, then the team will identify the process and cost. Afterwards, a cost report will be raised which contains both COC and CONC, and process improvement activities will be performed.

Advantages and disadvantages for PAF cost model and process cost model can be summarized as below,

PAF cost model

Advantages:

- 1). It is a revised version of the traditional method of product quality costing in manufacturing industries. Improvement had been made in the light of experience.
- 2). It can identify the hidden and buried costs that are not part of operations. Quality costs in marketing purchasing and design are brought to the forefront by the system.

Disadvantages:

- 1). Difficult to identify and collect the data. Some costs such as prevention costs associated with marketing, design and purchasing are more difficult to identify and allocate. There are some costs associated with lost sales and customer goodwill, which may be impossible to measure and must be estimated.
- 2). Much more time need to expending in identifying and categorizing cost of PAF

Process cost model

Advantages:

- 1). It can thoroughly review the whole system so that some hidden cost will be digging out.
- 2). It is compatible within the concept of TQM.
- 3). It serves a simple classification of quality costs to the cost of conformance and the cost of non-conformance. The cost of conformance is raised and reviewed.

Disadvantages:

- 1). This method depends on the use of process modeling.
- 2). Requires Activity-Based-Costing to be the costing system. However in most manufacturing firms in Asia, ABC method is not widely applied.

Besides PAF model and process model, Godfrey [1999] argued that during his days at Bell labs, they developed an approach call “golden line”. The approach is to walk the line, make estimate of true production costs using rough estimates of labour costs, materials and finished goods inventories, rework, inspection and so forth. Afterwards, they will review the process and make “what-if”, then major opportunities for improvement will be identified and performed.

2.3 Cost data collection and reporting

The objective of quality cost collection is to identify those “hidden cost”, “indirect cost” or “un-budgeted costs” from various departmental budget and overheads.

Dale and Plunkett [1995] developed three approaches to quality cost collection in organization are introduced,

(1) Prevention-Appraisal-Failure cost element method (PAF).

The first step is to identify the elements of cost; the second step is to measure and quantify the elements and the final step is to cost the elements. This method is mainly used in case where the organization is engaged in the mechanical and electrical products.

(2) Time-based cost element methods

Cost of making mistakes is the collecting and measuring elements of quality costs. The objective is to focus on areas where mistakes / errors occur and use a planned approach to improvement to put matters right for non-manufacturing situations.

(3) Semi-structured cost element identification and measurement methods.

There are three semi-structured methods using in helping to develop the quality cost elements.

- a. Department based quality cost analysis method.
- b. Team-based quality cost analysis method.
- c. Process cost model. This is based on the computer-aided-manufacturing integrated program.

Who should collect the cost data?

Besterfield D. [1992] suggest that the cost collection requires the close interaction of the quality and accounting departments.

For subsequent quality cost analysis, it should be collected by product line, projects, departments, operators, non-conforming classification and works centres.

In some cases, work-sampling techniques will be used with estimates.

For the insignificant costs may be overlooked but for the significant ones must be captured even if they are only estimated.

When analyse the quality cost, some typical bases can be used for comparison index, e.g. labor, cost, sales, and units.

2.4 Quality cost improvement strategy

Like other improvement, a strategy needs to be developed before the implementation. Campanella [1999] developed a strategy to improve quality cost.,

It is based on the premise that

- (1) For each failure there is a root cause.
- (2) Causes are preventable.
- (3) Prevention is always cheaper.

The strategy for using quality cost can be:

- a. Directly drive the failure costs to zero using “zero defect” concept.
- b. Invest in the “right” prevention activities to improve quality.
- c. Reduce appraisal costs according to results achieved.
- d. Continuously evaluate and re-direct prevention efforts to gain further improvement

In order to achieve quality cost reduction, quality cost control is required.

According to Gong [1999], Quality cost control is defined as control the quality related costs by properly using control tools to achieve the target that set up first. Effectively control quality cost needs a systematic quality management approach.

There are three control approach introduced.

(1) Re-action: As named, which is an approach that after failure happens, then find out the root cause and raise the corrective action to prevent lost in

next time to achieve the objective. Though this method can't control the problem on time, it is still useful since it is simply to perform.

(2) In-process control: This method is developed on the basis of reaction. Using proper methods to control quality while there is evidence of problem to avoid the quality lost. This approach obviously is more effective than re-action. It can reduce even if avoid lost. It is popular to be applied in industry. Quality control chart is an practice of this approach. However, this "effective approach" is not suitable for all quality cost elements.

(3) Pro-action: This requires the prevention concept to control the quality before the problem occurs. It is proved that the best control in the stage of product design can control 60% of quality problems and product costs. This is the best control approach. However, it is not easy to forecast all failure factors.

Oakland & Porter [1995] pointed out some other tools on quality improvement. Specially, he recommended two items, FMEA and SPC.

- FMEA is a technique to prevent failure can be applied to any stage of design, development, production / operation or use.
- SPC is a technique to assist to prevent failure in any transformation process. It is a prevention strategy using the collection of data to predict and control process to avoid waste by not producing unusable output in the first place.

2.5 Quality cost program implementation

In terms of quality cost program implementation, Campanella [1999] recommends firstly a champion should be assigned inside the organization, then the champion have to perform a presentation which will draw attention from management for the acknowledge and make them convince such a program is worthwhile. Afterwards, a pilot program will be recommended and a quality cost education will be performed.

Next, an internal quality cost procedure will be established. Based on the established procedure, the quality cost will be collected and analyzed.

The advantages of the pilot quality cost program are as below.

- Prove the ability of the system to produce cost-saving results.
- Resell management on the continued need for the program.

Limit the initial scope of implementation - both people and area allow system debugging prior to full implementation.

Juran & Gryna [1993] Developed a project - by - project approach which is an effective approach using a sequence of steps associated with some quality tools to solve quality related problems. The main steps are:

- (1) Proving the need. Study on the cost of quality is one of the convincing method to collect information quality costs relating to financial measures can measure the performance and show the benefits.
- (2) Identifying projects. Pareto principle is a powerful data analysis tool can identify the major problem areas; cause and effect diagram can be helpful identifying the root cause of the problem.
- (3) Organize project teams. Set up task force.

Carrying out each project involves:

- a. Verifying the project need and mission.
- b. Diagnosing the causes.
- c. Providing a remedy and proving its effectiveness.
- d. Dealing with resistance to change.
- e. Instituting controls to hold the gains.

There are some risks on implementation.

Kaner [1996] identified two major implementation risks

(1) It's unwise to try to achieve too much, too fast. As resource limitation, we can not probably try to measure all of the costs.

(2) Beware of insisting on controversial cost. Cost should be probably identified / classified. Therefore, some costs will not be overlooked, also will not be underestimated.

He takes two examples as the case, Ford Pinto litigation and GM PROM controlled the fuel injector in a pickup truck. As the result, both companies underestimate the external failure and got big penalty and intangible company image loss. Below is the Ford Pinto case,

First, it's unwise to try to achieve too much, every project until you've applied it successfully to one project.

Second, this is usually wise advice, but it can lead you to underestimate your customer's probable dissatisfaction with your product.

The Ford Pinto litigation provided the most famous example of a quality cost analysis that evaluated company costs without considering customers' costs from the customers' viewpoint. Among the documents produced in these cases was the Grush-Saunby report, which looked at costs associated with fuel tank integrity. The key calculations appeared in table 2.1

Table 2.1 Ford Pinto key calculation

Benefits and Cost Relating to Fuel Leakage Associated with the Static Rollover Test Portion of FMVSS 208
<u>Benefits</u>
Savings – 180 burn deaths, 180 serious burn injuries, 2100 burned vehicles Unit Cost -- \$200,000 per death, \$67,000 per injury, \$700 per vehicle Total benefit – $180 \times (\$200,000) + 180 \times (\$67,000) + 2100 \times (\$700) = \49.5 million
<u>Costs</u>
Sales – 11 million cars, 1.5 million light trucks Unit Cost -- \$11 per car, \$11 per truck Total Cost – $11,000,000 \times (\$11) + 1,500,000 \times (\$11) = \$137 \text{ million}$

In other words, it looked cheaper to pay an average of \$200,000 per death in lawsuit costs than to pay \$11 per car to prevent fuel tank explosions. Ultimately, the lawsuit losses were much higher. [Grimshaw V. Ford Motor Co. (1981). (California court of appeal), California reporter, volume 174, page 348].

2.6 Good practice on the implementation

Many articles and paper can be found. Some of them are good practices. while some of them listed other practices.

Keogh, Dalrymple and Atkins [2000] performed researches in 6 organizations. 2 of them are chemicals. 1 is refractory materials, 1 is ink. 1 is rubber. 1 is petrochem / hydrocarbons. Five out of six organizations are large.

Three out of six organizations applied PFA model (BSI, 1990), two of six used process model (BSI, 1991), while rest one applied a combination of process model and PFA model without acknowledging that.

The result shows that quality cost program can lead to performance improvement.

Keogh and Dalrymple [1998] performed researches in a part of major multi-national and employees over 80 people on the site. The research took three years.

The result is that a number of major organizational changes occurred during the study. And a number of improvements occurred in processes and quality. As a result, this leads to profitability.