Framework for Reduction of Quality Cost

A.B. Murumkar[1], S. N. Teli [2], R . R. Loni [3]

[1]PG Student, Saraswati College of Engineering, Navi Mumbai, amarmurumkar@yahoo.co.in
[2]Professor, Bharati Vidyapeeth College of Engineering, Navi Mumbai, shivanandteli@yahoo.com
[3] Dept. of Automobile Engg., V.P. Dr.P.G.Halakatti College of Engineering and Technology, Vijayapura

ABSTRACT

Presently, the greatest challenges faced by the Indian organizations are global competition, higher focus on quality from the customer side and increasing cost of manufacturing due to inflationary pressures from economy in that order. These challenges are partially overcome by adopting advanced technology and following latest trends in manufacturing management. Quality cost is one tool, among many others, that may facilitate in continuous quality improvement. Cost of Quality (COQ) analysis would help organizations to identify, measure and control the consequences of poor quality.

This paper presents proposed framework for COQ which can be helpful to organizations to identify the various initiatives towards implementation of COQ for manufacturing excellence which are essential to survive in the global competitive market.

Key Words: Cost of Quality, Supplier Quality, Dealer Quality Cost, Six Sigma

1. INTRODUCTION

Quality has become one of the core factors for almost all manufacturing and service companies that aim to win sufficient orders. Therefore, improving quality is considered to be one of the important strategies to attain customer loyalty in today's complex global competitive environment. The studies concluded that any serious endeavor to enhance quality will lead to rise in the cost of the product or service for improving quality has its own costs. As a result, measuring the cost of quality is important because it provides information about the financial consequences of adopting quality improvement programs [1].

In general, the cost of quality (COQ) is the total of the cost incurred for quality control process and the cost of product defect. We should make a competent analysis of the quality cost to find out a better way to minimal the quality cost [2]. Measuring quality costs are an essential step in achieving competitiveness because these costs are strongly related to the company's annual revenue. Several studies indicate that COQ is around 30% of total manufacturing costs. It is a significant cost driver that firms need to control effectively for sustaining competitive advantage [3]. Measuring the quality cost in a small-scale industry is very important and useful. It helps to identify the specific quality levels and ultimately improves the quality [4]. The objectives of having a COQ system in the industry are [5]; (i) Overall quality improvement; (ii) To set cost reduction targets and measure progress; (iii) To have better control of quality activities; (iv) To have better strategic plans; (v) To evaluate the effectiveness of the quality system; (vi) To motivate employees.

2. COST OF QUALITY

The concept of Cost of Quality (COQ) has been around for many years. Dr. Joseph M. Juran in 1951 in his Quality Control Handbook included a section on COQ. The Quality Cost Committee under the Quality Management Division was established by the American Society for Quality (ASQ) in 1961. However, it was Philip B. Crosby, who popularized the use of COQ because of his book Quality is Free at 1979. As Machowski and Dale said "There is no general agreement on a single broad definition of quality costs", however the COQ is the sum of costs incurred to guarantee and sustain acceptable quality level (cost of good quality) plus the loss for failing to achieve that specific quality level (cost of poor quality).

In other words COQ is understood as the sum of non-conformance and conformance costs while Cost of non-conformance is the cost of poor quality affected by service and product failures and cost of conformance is the fee paid for prevention of poor quality. Furthermore, some other researchers identified COQ as a performance measurement tool that provides a measure of cost specifically related to the achievement or non-achievement of services or product quality.

"Cost of Quality" is not the price of manufacturing products of higher level goods or service. It rather represents the dissimilarity between the real cost of a product and the amenities, and what the deduced prices would be if there

 DOI : 10.18231/2454-9150.2018.0231

were no chances of substandard service, failure of products, or faults and shortcomings in their manufacture [6]. Table 1, lists the elements of Poor-quality costs [7].

Table 1. Elements of Poor - Quality Costs

I. Direct poor- Quality Costs
   A. Controllable poor-Quality Cost
      1. Prevention cost
      2. Appraisal cost
   B. Resultant poor-Quality Cost
      3. Internal error cost
      4. External error cost

II. Indirect poor-quality Costs
      1. Customer-incurred cost
      2. Customer-dissatisfaction cost
      3. Loss of reputation cost

Prevention Costs: The costs of all activities specially designed to prevent poor quality of products or services. Examples are the costs of new product review, quality planning, supplier capability surveys, process capability evaluations, quality improvement team meetings, quality improvement projects, quality education and training.

Appraisal Costs: The costs associated with measuring, evaluating or auditing products or services to assure conformance of quality standards and performance requirements. These include the cost of incoming and source inspection/test of purchased material; in process and final inspection or test; product, process, or service audits; calibration of measuring and test equipment; and costs of associated supplies and materials.

Internal Failure Costs: Failure costs occurring prior to delivery of the products or furnishing of a service, to the customer. Examples are the costs of rework, re inspection, retesting, rework, trail review, and down grading.

External Failure Costs: Failure costs occurring after delivery of the product or after the furnishing of a service to the customer. Examples are the cost of processing customer complaints, customer returns, warranty claims, product recalls.

Customer-incurred PQC: Customer incurred COQ come into view when a product fails to meet the requirements of the customers. Some typical customer-incurred PQC are mentioned below.

- Loss of productivity while equipment is down;
- Travel costs and time spent to return defective merchandise; and,
- Repair cost after warranty period is over.

Customer dissatisfaction PQC: Customers now require a much better product to satisfy their expectations and demands. Companies may very well be making parts to specifications, but the specifications may not be good enough to retain old customers, let alone attract new ones. Products that perform at an acceptable level today may not do so tomorrow and probably not the next day. The stress of market share holding is felt by competitors as well and there is no doubt about it as the market today is very competitive. Realizing that customers' expectations may change and continuously resetting standards is the only way to keep the market share.

Loss of Reputation COQ: Loss of reputation and working strategies of COQ are very difficult to quantify. Similar is the case in predicting the reasons for customer dissatisfaction and customer incurred COQ. Expenditure incurred due to loss of reputation may change or develop from customer dissatisfaction costs in that they depend on the customers.

 DOI : 10.18231/2454-9150.2018.0231

Cost of Conformance (COC) and cost of nonconformance (CONC) Quality Cost: BS 6143-1(1992) is a better method for applying quality to the company. The cost of quality has been separated into the cost of conformance (COC) and cost of nonconformance (CONC). COQ = COC + CONC. The cost of conformance (COC) is the process cost of providing products required for quality standards. The cost of nonconformance (CONC) is failure cost associated with the process not being operated to the requirements.

According to researchers, quality related costs represent a considerable proportion up to 40% of a company's sales [8]. It is estimated that quality cost in the manufacturing industry is between 5 and 25% of sales [9]. Service industries, however, expend an estimated 30–40% of operating costs in their quality cost. These figures tell us that the quality costs represent an amount of money too tremendous to be ignored. If the amount of the quality costs can be reduced by 50%, the profit could be increased by 100%. That is why the COQ is called 'gold in the mine'.

Research indicates that 2/3rd of the quality costs may be reduced of their present level, within 3 years, by the commitment of the organization to a process of continuous improvement and company-wide quality Improvement. It helps the organization to evaluate the effectiveness and results of its quality programs in real terms and also helps in cost benefit analysis for future investments in quality programs [10].

Symptoms for need of quality cost measurement

Organizations that have no COQ measurement system often see the following symptoms [11]:

- Slow rate of improvement
- Bureaucracy or complexity in the processes that continues to worsen
- Changes in one area tend to have large, negative effects in one or more other areas
- Management gets personally involved in quality problems only during a major crisis
- Management running out of ideas as to how to cut costs further
- Not all employees are actively and personally involved in driving the organization's mission forward
- Many individuals and departments disagree on what the top priorities should be for the organization.
- Sub-processes and departments function in a manner that is detrimental to the organization's overall best interest.

Goal of Quality Cost

If the manufacturing or service organization's quality program had been geared toward defect prevention and continuous quality improvement, defects and their resulting costs would have been minimized, thus leading the most desirable condition. The goal of any quality cost system thus can help in aiding quality improvement work done that will lead to functioning and management, that can lead to a much more cost reduction opportunities. The strategy for using Quality Cost is simple and is as follows [12].

- Take direct attack on failure costs in an attempt to drive them to zero;
- Invest in the right prevention activities to bring about improvement;
- Reduce the appraisal costs, according to the results achieved;
- Continuously evaluate and redirect prevention efforts to gain further improvement.

3. SUPPLIER QUALITY COST

Today, many products are either copied from the original product of its type, reproduced with poor materials, or both. What makes these products substandard is primarily the poor quality of the materials from which they were made. These products tend to be highly unreliable and once they break or malfunction, they cannot be fixed.

Usually, the quality of a product depends on the practices of the supplier. For this reason, most of the automotive companies carefully select their suppliers. Supplier quality cost is significant and good indicators of problem areas. A system of managing and tracking supplier quality cost are categorized as prevention cost elements such as the cost of the supplier quality survey, appraisal cost elements such as cost of receiving and source inspection; and failure cost elements such as the cost of scrap and rework of supplier caused non-conformances and the cost of site visits to correct supplier service problems [13].

Manufacturing and service companies cannot be thought as independent actors in the market anymore, because their production output is greatly dependent on their supplier's performances. With firms outsourcing their manufacturing to strategic partners across the globe and sell industrial products, they need to preserve their preferred supplier status to continue to be considered for future business. Thus, they are under pressure to ensure that their products continue to meet or exceed acceptable PPM and corrective action thresholds set by their customers. Hence, managing their own supplier's quality is very high on the agenda for these companies.

 DOI : 10.18231/2454-9150.2018.0231

Most organizations do not track and measure the cost of poor supplier quality (COPQ) attributed to their suppliers. Such COPQ may add up to over 10% of the organization's revenue. Some companies only track supplier COPQ by measuring scrap and increase in material review board (MRB) inventory. Results have shown that materials account for fewer than 50% of the total COPQ. The following should be taken into account to calculate the actual COPQ [14].

- Scrap, rework, sorting and processing costs due to poor quality;
- MRB inventory and processing costs due to inspection failure;
- Using equipment that is capacity constrained for rework due to poor quality, reducing the overall utilization of the production line;
- Freight costs due to expedited shipping to customers/downstream plants;
- Warranty expenses due to poor quality
- Recall expenses due to poor quality of products shipped to customers.

Quality Management Systems (QMS) or manufacturing systems can track whenever any of the above costs are incurred due to supplier quality issues. World-class manufacturers are using all the above factors to track the actual supplier-related COPQ.

Use of PPMeq to monitor supplier performance indicate the criticality of supplier related to particular part and also the OEM has evaluated its number of suppliers through part-wise, process-wise, plant-wise to do the business in the future and also to calculate the cost of quality of a particular part related to its supplier [15].

4. DEALER QUALITY COST

Dealership service quality is essential for automaker reputation and profit. A more common customer service issue is failed repair. Many of us blame the organization for dealer problems; either they don't understand that the dealership is individually owned, or they feel the company should not be tolerating bad dealers. The matter goes beyond lost customers. The amount of improper, incorrect or needless repairs, usually caused by not being attentive to customers or by ignoring factory service bulletins, will dramatically inflate warranty costs. Because dealer-caused problems are often blamed on the company by customers and their acquaintances, the company's reputation ultimately takes the blow [16].

Dealerships play an important role in representing the manufacturers in the market place through meaningful customer engagement. Poorly defined and ineffective sales & service processes are often the root cause of substandard dealer performance. While high marketing expense, interest cost, manpower cost and capital expenditure, are identified as major challenges to dealership's growth and sustenance, focus on the primary drivers while improving internal inefficiencies will help improve overall dealership profitability. Dealerships lose at least 60% of service revenue from post warranty therefore it is very essential to handle customer relationship as good as possible to reduce the cost of quality [17].

5. SIX SIGMA AND QUALITY COST

Six Sigma was a way for Motorola (1987) to express its quality goal of 3.4 DPMO where a defect opportunity is a process failure that is critical to the customer. A Six Sigma initiative focuses on reducing the costs of poor quality due to low sigma levels of performance. Designing new features (increasing the sigma levels) will enable management to reap increased customer satisfaction and bottom-line results [18].

Six Sigma is primarily a strategy for rising the capability of business processes by using statistical methods. Its goal is defect reduction (COQ) and it eliminates process variation, poor quality costs by 20 to 30% of a company's revenues. Six Sigma improvement activities should be carried out in project form. In organizations it is built around customer's needs [19]. Six Sigma is classed among initiatives for quality improvement and total quality management. The advantages of quality improvement initiatives argue their potential to increase customer satisfaction by improving product quality, and reduce production costs by lowering costs associated with poor quality [20].

The objective of the Six Sigma initiative is to aggressively attack costs of a quality, e.g. inspection and warranty costs, scrap, rework and reject, can be approximated with only 10-15% of overall costs of quality. Remaining 85 to 90 % of quality Costs is sometimes intangible and, therefore, overlooked and unnoted in the company's quality cost analysis. At three Six Sigma, the cost of quality is 25 to 45 % of sales revenue. It reduces cost of quality from 25 to 40 % of sales revenue. Today, organizations strive for an improved level of process capability and a reduced level of the cost of poor quality (COPQ). Table 2, indicates that the average of industries operates at Sigma level 3 of quality, which costs from 25% to 40% of invoices in wastages with rework, inspections, and other losses [21].

 DOI : 10.18231/2454-9150.2018.0231

Table 2. Quality Scale

Sigma Level	Maximum defects Per million (DPMO)	Quality Level	Cost of the Low quality (% Sales)
6 Sigma	3.4	99.997%	0- 5%
5 Sigma	230	99.98%	5-10%
4 Sigma	6200	99.4%	15-25%
3 Sigma	**67,000**	**93.3%**	**25-40%**
2 Sigma	309,000	69%	>40%
1 Sigma	691,000	31%	

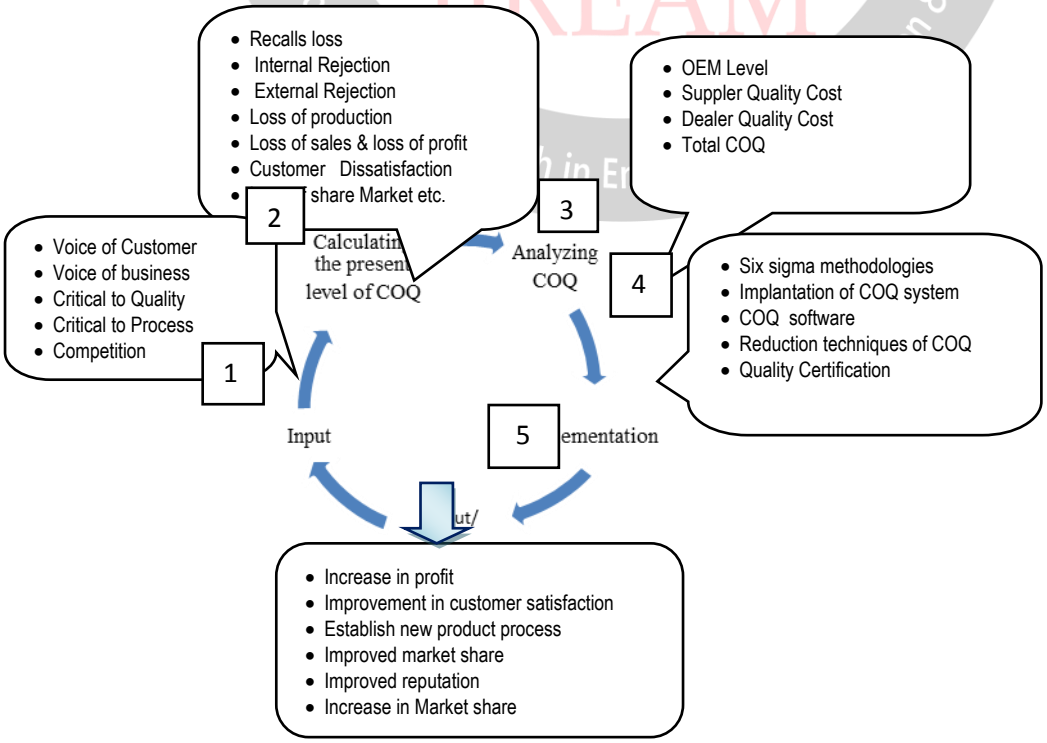
The meaning of bold values implied in the Table 2 indicates that, the average of industries operates at sigma level three quality scales.

6. FRAME WORK ON COST OF QUALITY

The snapshot below figure 1 highlights the use of quality cost and improvement in quality. This framework explains the voice of customers and businesses which the primary inputs are mentioned in Phase 1 and then it captures the secondary input Phase 2. Phase 3 covers the assessment of quality cost and then applies quality improvement programs/methods/tools/techniques to reduce Quality Cost (covered in Phase 4). In the final phase the results can be seen in the form of tangibles and intangibles. It is a dynamic and continuous process; this cycle keeps repeating.

In the initial stage of the assessment and implementation of COQ, the first step is convincing the top management to implement the action plan based on the voice of the customer/business, critical to quality and critical to processes, reflecting how there is a need to reduce cost of quality to sustain in the current global competitive market.

In the next step, the managers should calculate the current level of COQ in their organization in detail plant wise, supplier wise, dealer wise. They should assess and calculate the total recalls loss, internal & external failure costs, and production loss due to rejection, loss of profit, effect on the share market, brand image and finally the overall effect on customer goodwill. After calculating the present level of COQ in the organization, the next step is analysis of the data.



 DOI : 10.18231/2454-9150.2018.0231

Figure 1: Proposed framework for assessment and reduction of Quality Cost

In the analysis stage, managers should analyze the OEM level cost of quality and then analysis should be carried out supplier wise, dealer wise and finally the total Cost of Quality including appraisal cost, prevention cost and internal / external failure cost should be worked out. After stage wise analysis, the next step is suggesting the action plan to reduce such direct – indirect or hidden Quality Cost which hampers the profitability of the organization and the goodwill of the final customer.

In the action plan to reduce such COQ, the first step the practitioner /Managers should be to adopt six sigma methodologies at the design stage (DFSS) and at the process stage for process improvement (DMAIC). This improves the quality of all supply chain processes by reducing costs and increasing levels of customer satisfaction. It is believed that the integration of Six-Sigma into Lean (Lean Six Sigma) will become a standard practice for any business application that seeks advantage in this highly competitive era of globalization. Suppliers are encouraged to become certified as per quality management system standard ISO/TS 16949, to deliver parts/commodities to the OEMs.

OEMs should adopt the tools and techniques to develop supplier quality and reduce COQ such as, Lean Mfg., Six Sigma, QC story, Dealership five star rating program, Corrective action and preventive action (CAPA), Lean principles, DFSS (Design for Six Sigma), Mistake-proof applications, Statistical Process Control (SPC), Quality Management System based on ISO 9001, supplier performance assessment. After implementation of the action plan and the techniques stated above by OEMs at supplier level, dealer level and in their in-house activities, the expected outcomes(Phase 5) would be profit maximization, productivity improvement by reducing rejection rate, improvement in customer satisfaction in terms of quality and reliable product, establishment of new product process and improvement in market share and reputation of the organization, which are essential to survive in the global competitive market.

7. CONCLUSION:

- A COQ system provides a method for monitoring operational performance and identifying an area for improvement with respect to costs.
- Assisting managers and staffs to understand and control processes.
- A properly understood and managed quality cost system can aid organizations in realizing cost savings, whereas avoiding some of the serious pitfalls that can accompany cost cutting; decreases in product or service quality, increased customer dissatisfaction, added rework costs, or simply shifts in costs from one area to another.
- COQ programs offer a better method for identification and measurement of quality costs, and so enables targeted action for reducing COQ.
- At three Six Sigma, the cost of quality is 25 to 45 % of sales revenue. It reduces cost of quality from 25 to 40 % of sales revenue. Thus, if an organization can improve its quality by 1 sigma level, its net income will increase hugely, approximately 10 % net income improvement. Systematic application of Six Sigma DMAIC methodology manufacturing will help to reduce COQ.
- The proposed framework can be helpful to organizations to identify the various initiatives towards implementation of COQ for manufacturing excellence which are essential to survive in the global competitive market.

REFERENCES

[1] Omar, M. and Murgan, S. An improved model for the cost of quality. *International Journal of Quality & Reliability Management*, 31, 4 (2014), 395- 418.

[2] Parker, G. *Achieving cost effieicent quality*. Gower, England,1995.

[3] Srivastava, S. Towards estimating cost of quality in supply chains. *Total Quality management and Business Excellence*, 19, 3 (2008), 193-208.

[4] Chopra A. and Dixit, G. Introducing models for implementing cost of quality system. *The TQM Journal,* 24, 6 (2011), 498-504.

[5] Uyar, A. An exploratory study on quality costs in Turkish manufacturing companies. *International Journal of Quality & Reliability Management*, 25, 6 (2008), 604-620.

 DOI : 10.18231/2454-9150.2018.0231

[6] Wood, D. *The Executive Guide to Understanding and Implementing Quality Cost Programs*. ASQ Quality Management division,2007.

[7] Harrington, H. *Poor Quality Cost*, ASQ Quality Press, New York,1997.

[8] Moyers, D. and Gilmore, H. Product conformance ion the steel foundry jobbing shop. *Quality Progress*, (1979), 17-19.

[9] Bell, D., McBride, P. and Wilson, G. *Managing Quality*, Butterworth-Heinemann, Oxford,1994.

[10] Teli, S., Majali, V., and Bhushi, U. Cost of Quality in the Automotive Industry & Essence of Knowledge Management. *JM International Journal of Management Research*, 2, 3 (2012), 192-199.

[11] Teli, S., Majali, V.., Bhushi, U., and Surange, V. Impact of Poor Quality Cost in Automobile Industry. *Int. Journal of Quality Engineering and Technology,* 4, 1 (2014), 21- 41.

[12] Teli, S., Majali, V., Bhushi, U. and Surange, V. Assessment of Cost of poor quality for Automobile Industry. *Int. Journal of Engineering Research and Applications*, 2, 6 (2012),330-336.

[13] Teli, S., Gaikwad, L., Majali, V., and Bhushi, U. An Application of Six Sigma to Reduce Supplier Quality Cost. *J. of Institution of Engineers (India): Series C*,.97, 1 (2015), 93-107.

[14] Teli, S., and Murumkar, A. Automobile Dealer Quality Cost: A Review*, National Conference on Recent Trends in Engineering & Technology (NCRTET-18),* KBP College of Engineering, Satara, 2018.

[15] Teli, S., Majali, V., Bhushi, U. and Gaikwad, L. Assessment of Supplier Quality Cost in Automobile Industry. *Int. Journal of Quality Engineering and Technology*, 4, 1 (2014), 1-20.

[16] Teli, S., Majali, V., Bhushi, U., Gaikwad, L., and Surange, V. Cost of Poor Quality Analysis for Automobile Industry: A Case Study. *Journal of the Inst. of Engg.: Series C*, 94, 4 (2013), 373-384.

[17] Teli, S., Majali, V. and Bhushi, U. Dealer Quality Management Process. *8th ISDSI International Conference*, Pune, 2015.

[18] DeFeo, J. *The Tip of the Iceberg*, Quality Progress, 29-37, 2001.

[19] Dedhia, N. Six sigma basics. *Total Quality Management & Business Excellence*, 16, 5 (2005), 567-574.

[20] DeMast, J. Six Sigma and Competitive Advantage. *Total Quality Management*, 17, 4 (2006), 455-464

[21] Murumkar, A., Teli, S., Jadhav, S., Dharmadhikari, S. and Nikam, M. Integrated Approach of Cost of Quality and Six Sigma, Global Meet on Advances in Design, Materials & Thermal Engineering, Saraswati College of Engineering, Kharghar, Navi Mumbai, 2018.

 DOI : 10.18231/2454-9150.2018.0231