

Impacts of the Cost of Quality Components on Business Execution and the Strategies to Minimize the Cost of Poor Quality

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ABSTRACT

This research paper discusses and analyzes the components of the cost of quality (namely the cost of good quality and the cost of poor quality), their impacts on business execution and the company's bottom line (i.e. profits) and suggests strategies to minimize the cost of poor quality.

Keywords — The cost of quality, The cost of good quality, The cost of conformance, The cost of poor quality, The cost of bad quality, The cost of non-conformance, Prevention costs, Appraisal costs, The cost of internal failures, The cost of external failures, Continuous Improvement, Quality Management System (QMS), Quality Assurance (QA), Quality Control (QC), Risk Management and Change Management.

I. INTRODUCTION

The cost of quality is a term extensively used across industries (Oil and Gas, Manufacturing and Automobile etc.), however, often misunderstood. It is not the cost associated with creating a quality product or service, but it is the cost incurred if the product or service is not created as per the company and/or industry quality standards [1]. Each time a product/service is not as per quality standards, the corrective actions must be taken to bring the product/service up to the quality standards. Each corrective action requires time, money and labor. Therefore, with every poor quality/non-conforming product/service, the cost of quality increases. This is a bit opposite to historical thinking of business managers who presumed that higher quality meant higher costs [1]. In fact, lower quality subsequently results into higher costs.

The purpose of this research paper is to:

- Discuss and analyze components of the cost of quality
- Impacts of the cost of good quality and the cost of poor quality on the business execution and the company's bottom line (i.e. profits)
- Strategies to minimize the cost of poor quality

II. THE COST OF QUALITY

The cost of quality typically constitutes of two components i.e. *the cost of good quality and the cost of poor (bad) quality* [2], [3]. Often, the cost of good quality is called the cost of conformance and the cost of poor (bad) quality is called the cost of non-conformance [4]. In simplistic terms, the cost of quality can be represented with the following equation:

$$\text{CoQ} = \text{CoGQ} + \text{CoPQ}$$

where

CoQ = Cost of quality

CoGQ = Cost of good quality

CoPQ = Cost of poor quality

Let us now dive into the nuances of the cost of good (or conformance) quality and the cost of poor (or non-conformance) quality.

The Cost of Good (or Conformance) Quality

The cost of good quality is the cost incurred by the company in making sure that essential activities to create products or provide services (as per the quality standards) are performed right, the first time and always [4]. Costs associated with good or conformance quality include *Prevention costs and Appraisal costs*. The cost of good quality can be represented with following equation:

$$\text{CoGQ} = \text{PC} + \text{AC}$$

where

CoGQ = Cost of good quality

PC = Prevention costs

AC = Appraisal costs

Prevention costs are typically expenses a company incurs for all the activities that are formulated/designed to prevent poor quality products or quality failures [2, 3]. Prevention costs can be incurred in various activities including following but not limited to:

- Development and implementation of a robust Quality Management System that is designed to prevent quality failures
- Process Improvement initiatives
- Corrective and Preventive action processes and their implementation
- Knowledge Management and Lessons learned programs

- Preventive Maintenance processes
- Technical Design Reviews
- Risk Management program
- Personnel training
- Supply Chain Management processes

Appraisal costs are the costs that a company experiences in measuring, inspecting and controlling activities to ensure compliance and conformance to the quality requirements and standards [4]. In other words, appraisal costs are the costs involved in controlling the quality of products/ services. Following are few examples of activities where appraisal costs are incurred:

- Quality Audits
- Inspections
- Testing (in process, factory acceptance, system acceptance)
- Sampling
- Equipment calibrations

The Cost of Poor (or Non-conformance) Quality

The cost of poor (or non-conformance) quality is typically the cost a company expenses due to internal and external failures [2, 3, 4]. Mathematically, the cost of poor quality can be expressed as below:

$$CoPQ = CoIF + CoEF$$

where

CoPQ = Cost of poor quality

CoIF = Cost of internal failures

CoEF = Cost of external failures

The boundary line between internal and external failures is the *delivery*. If the product/service is non-conforming to the quality requirements/standards and the non-conformance is determined before delivering the product/service to the customer, the costs associated with the non-conformances or failures are called **the Cost of Internal failures**. However, if the non-conformance or failure is determined after delivering the product or service to the customer, the costs incurred are called **the Cost of External failures**.

There are numerous examples of the cost of internal failures including:

- Rework and repairs to correct the non-conforming or poor-quality products/services
- Investigation costs to determine root causes and corrective/preventive actions for internal failures
- Scraps due to bad quality
- Internal wastes because of poor design and manufacturing/fabrication processes
- Loss/down time
- Unplanned maintenance
- Equipment breakdowns
- Design failures
- Re-testing due to inadequate testing performed the first time

In the similar vein, examples of the cost of external failures include:

- Customer returns
- Customer dis-satisfaction and/or complaints
- Damages during shipping due to inadequate packing and protection measures
- Field non-conformances and repair costs
- Warranty claims
- Lost goodwill due to poor products/services delivery

III. IMPACTS OF THE COST OF QUALITY ON BUSINESS EXECUTION AND COMPANY’S BOTTOM LINE (PROFITS)

As discussed above, the cost of quality consists of two components, the cost of good quality and the cost of poor quality. Each of these components play key roles in business execution and the company’s bottom line (profits). Detailed analysis of how these components impact the companies is illustrated below.

Let us first dive into the impacts of the cost of good quality on business execution and the company’s bottom line. If we look back to 1970s, a general consensus among business managers was that superior quality means higher costs [1]. However, as the concepts of Quality Assurance (QA) and Quality Control (QC) grew and got more streamlined, quality gurus such as Juran questioned this notion. Juran’s economic conformance level model depicted in Fig. 1 [5] illustrates that the appraisal and prevention costs which are the costs to attain higher quality are traded off with the failure costs (typically much higher than appraisal and prevention costs), the costs of having poor quality products or services.

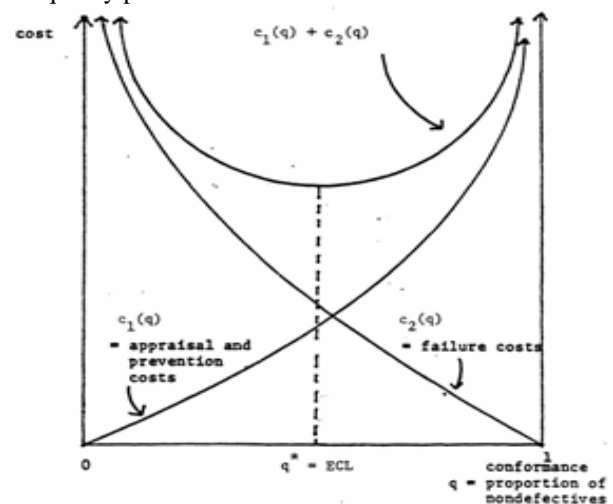


Figure 1: Economic Conformance Level

In addition, investments in development and implementation of appraisal and prevention activities also bring other tangible, intangible and learning benefits to the companies including but not limited to:

- Discovery of bugs or inefficiencies in the processes and systems which shall be eliminated to reduce operational costs
- Learnings about relationship between quality decisions *and* operational and pricing decisions
- Rapid/instant feedback from quality control personnel to operations personnel about non-conformances and quality failures
- Higher customer satisfaction because defects/non-conformances are detected before delivery of the products or services to the customer
- Increased Goodwill due to higher quality and increase in market share due to superior quality products/services

Let us now analyze impacts of the cost of poor (or non-conformance) quality on the business execution and the company's profits and performance. Philip Crosby in his interview with Industry Week [6] mentioned that *Quality is viewed as an expense, a trade-off, something that you must spend money on. However, the actual expense of Quality is non-conformance. In other words, Quality is conformance to specified requirements. So, if a company's products/services are conforming to the specified requirement, quality is already built in and is free. It is the non-conformances and corrective actions needed to rectify non-conformances and bring the products/services to the required quality levels cost more and more.* According to ASQ (American Society for Quality), many organizations have true quality related costs as high as 15% to 20% of sales revenue. In some cases, it may be as high as 40% of total operational costs [7]. Another research [8] also suggests that the typical cost of poor quality can range from 15% to 40% of total business costs. It can be argued that all these costs because of poor quality, non-conformances or failures negatively impact business execution and eat into the company's bottom-line (profits). Even worse, when the non-conformances or failures are not identified at the right time and in the right step of the processes (but at the later stages/phases). Later identification of non-conformances or failures creates a bull whip effect [9] on rectification costs, efforts and time. Fig. 2 represents this bull whip effect for a typical Oil and Gas project phases i.e. Engineering, Procurement, Construction, Installation and Commissioning.

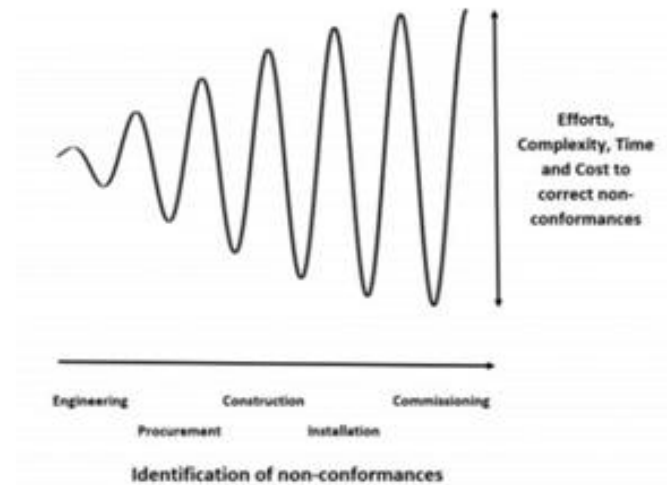


Figure 2: Bull Whip effect of later identification of non-conformances

It is evident from above discussion and analysis that the cost of poor quality impacts company's bottom line and performance negatively. Additionally, there are other negative impacts (as listed below) to the company because of its poor-quality products/services:

- Decline in customer satisfaction levels
- Sales decline and potential loss of market share
- Decreased company goodwill
- Low employee motivation and subsequently a decline in company's operational performance

IV. STRATEGIES TO MINIMIZE THE COST OF POOR QUALITY

Time and again, data [7, 8] illustrates that the cost of poor quality is a significant % (around 15% - 40%) of overall operational costs for many organizations. Therefore, to improve business execution, to increase company's overall bottom line, *and* to increase customer satisfaction and goodwill, it is critical that the companies invest in and implement strategies that create a quality culture, improve operational performance and reduce the cost of poor quality. A list of suggested strategies [10] is illustrated below:

A. Robust and effective quality management system (QMS)

A robust and effective quality management system helps in reducing expensive mistakes, increases operational efficiency, continuously improves products, services, processes and systems along with reduction in the cost of poor quality [11]. Therefore, top management of companies should invest in the development and implementation of

robust and effective quality management system as per their business needs.

B. Invest in internal (employees) and external (customer and supply chain personnel) training

Training employees about the company's processes is not a choice but is a *must*. The more an employee/worker knows about his/her job, responsibilities, accountabilities, processes, systems and equipment, the level of employee confidence and performance increases. Enhanced employee performance and confidence subsequently improves company's overall performance and decreases the probability of non-conforming/poor quality products/services [12].

Similarly, it is equally important that the company trains its suppliers on material/product requirements to avoid delivery of inappropriate or defective material/products. Companies should also invest in making their customers well verse about the operational instructions and features for supplied products/services to avoid operator errors (which can be very costly at times).

C. Digitization of the document and record management system

Among other benefits of a digitized document and record management system is the ease of information sharing and collaboration [13]. In this age where companies have offices and operations globally, information sharing and collaboration among employees are essential to ensure that latest and greatest versions of procedures, drawings, guidelines, process maps and checklists are made available to them; failing which can result in producing defective products and will subsequently increase the cost of poor quality. A digitized document and record management system also have an edge over traditional systems in terms of better version control and allowing different stakeholders to work on the same documents and records in real time.

D. Customer complaints and feedback management

Key benefit of customer complaints and feedback management process is that the customer feedback can be utilized to make a company's products/services better [14]. Customer feedback equips the company with useful information such as what is working well and what needs to be improved about its products/services. The later part of feedback (i.e. improvement opportunities) will help in reduction of the cost of poor quality for the company in the long run.

E. Efficient and effective risk management program

According to an article [15] in Becker's ASC Review, "*An effective risk management program is an organization's first line of defense in identifying a weakness or system failure before it occurs and in mitigating or reducing any loss after it occurs*". Anticipation and early identification of process, operational and product/service related risks allow companies to come up with necessary risk mitigation measures and actions to avoid quality

failures. Effective implementation of risk mitigation actions not only reduces the probability of quality failures but also reduces the cost of poor quality for the company.

F. Invest in an effective change management process

Change Management shall be a well thought, planned and managed process [16]. An effective change management process permits companies to add/modify/delete specific tasks, and activities at the right time and the right stages in the change process. Change Management, if not addressed effectively with enough due diligence, can result in costly errors and poor-quality products/services. An effective change management process also ensures minimum disruption in the operations and productivity. Therefore, it is a critical component of successful business execution and a key factor in reducing the cost of poor quality.

G. Business excellence and continuous improvement programs

Among many other benefits, one of the key benefits of the business excellence and continuous improvement programs is that these programs play as a catalyst in improving company's processes, systems, and products/services [17]. These improvements lead to minimize internal failure costs and increase customer satisfaction.

H. Lessons learned process

Research has shown time and again that the companies that learn from their past mistakes/failures and implement effective lessons learned process perform better than the ones who don't. According to Project Management Institute (PMI) article [18] and Parnell et al. [19], project managers can reduce costs by learning from past projects and implementing past successes while avoiding past failures. Aiyer et al. in their research [20] found that many developmental projects fail because the lessons learned were never performed. Chan and Kumaraswamy in their research [21] suggested that there are many lessons learned which are applicable and can be applied to new projects to prevent making same/similar mistakes over and over. Mining and implementation of lessons learned is the key to avoid past same/similar mistakes and non-conformances. Effective and efficient lessons learned process can reduce the cost of poor quality and can save millions of dollars for the companies.

I. Preventive maintenance program to minimize equipment breakdowns

Avoiding preventive maintenance and lingering till the issues become major is not only costlier in the long run but this postponing can also cause additional damages and internal failures [22]. A sound preventive maintenance program typically results in fewer major repairs. Preventive maintenance allows companies to address maintenance issues less overwhelming, easier to handle, less time consuming and less expensive.

J. Implementation of processes to minimize down time/loss time

The more the employees/workers know about the company's processes, systems and equipment, the less will be breakdowns and down time/loss time. Therefore, a sound training program is critical to minimize breakdowns and faster troubleshooting/repairs and thus results in minimizing down time/loss time.

K. Processes to identify non-conforming or poor-quality products/services at the right time/phase to minimize bull whip effect of non-conformances on cost, time and efforts

If the non-conformances are identified early and at the right time/phase, the corrective actions cost less. However, if the non-conformances go undetected and passed from one phase to another, the corrective actions to rectify the non-conformances can be costly and time consuming and at times may cause customer dissatisfaction. Therefore, it is important that companies invest adequately in Quality Assurance and Quality Control programs that have processes, systems and tools to identify non-conformances early and at the right phase/time. Quality Assurance and Quality Control programs that are proactive (rather than reactive) in non-conformance/poor quality identification and correction can save millions of dollars and minimize the cost of poor (non-conformance) quality.

V. SCOPE OF FUTURE RESEARCH

Author would like to identify and analyze causes/factors causing the cost of poor quality on the oil and gas projects. Further, author would like to suggest recommendations how the cost of poor quality can be minimized on the oil and gas projects.

VI. CONCLUSION

In this research paper, two main components of the cost of quality i.e. the cost of good quality and the cost of poor quality are discussed. It is evident from the research that though the cost of good quality requires investment from companies in prevention and appraisal activities, the return of investment (ROI) outweighs the expenses a company will incur because of poor quality and/or non-conforming products. In fact, investment in the appraisal and prevention activities brings down the cost of poor quality significantly.

This research paper also analyzes the impacts of the cost of good quality and the cost of poor quality on company's business execution and profits. Since the cost of poor quality impacts businesses negatively, this research paper suggested strategies to minimize the cost of poor quality, to enhance operational performance and to increase the company's bottom line (i.e. profits).

Disclaimer: This paper does not represent any TechnipFMC position, and it is in no way related to TechnipFMC.

REFERENCES

- [1] *Cost of Quality*. (2008). Available at: <https://totalqualitymanagement.wordpress.com/2008/09/12/cost-of-quality/>
- [2] Arne Buthmann. (2014). *Cost of quality: Not only failure costs*. Available at: <https://www.isixsigma.com/implementation/financial-analysis/cost-quality-not-only-failure-costs/>
- [3] Cost of Quality. (2019). *Quality-one International*. Available at: <https://quality-one.com/coq/>
- [4] Cost of Quality. (2018). *White paper – Altran*. Available at: https://www.altran.com/as-content/uploads/sites/4/2018/02/altran_cost-of-quality-whitepaper.pdf
- [5] Charles Fine. (1983, 84). Quality control and learning in productive systems. *Sloan School of Management*. Available at: <https://dspace.mit.edu/bitstream/handle/1721.1/2062/SWP-1494-15478413.pdf>
- [6] Philips Crosby. (1995). Quality is still free. *Interview with Industry Week*. Available at: <https://www.industryweek.com/quality/philip-crosby-quality-still-free>
- [7] Cost of Quality. (2019). *American society for quality (ASQ)*. Available at: <https://asq.org/quality-resources/cost-of-quality>
- [8] Vishal Waje & Vishal Patil. (2009). Cost of poor quality in construction. *IOSR Journal of Mechanical and Civil Engineering*. Available at: [http://www.iosrjournals.org/iosr-jmce/papers/sicete\(civil\)-volume3/28.pdf](http://www.iosrjournals.org/iosr-jmce/papers/sicete(civil)-volume3/28.pdf)
- [9] Shobhendu Prabhakar. (2018). Benchmarking quality management system (QMS) audit process on oil and gas projects. *International Journal of Engineering and Management Research*, 8(2), 103-109.
- [10] *9 key strategies to minimize the cost of poor quality*. (2019). Available at: https://www.metricstream.com/insights/costofPoorQuality_home.htm
- [11] *Benefits of QMS*. (2019). Available at: <https://fqmltd.com/services/management-systems/benefits-of-qms-2/>
- [12] *The importance of training and development in the workplace*. (2019). Available at: <https://2020projectmanagement.com/index.cfm?topNav=resources&subNav=project-management-training-and-qualifications&subsubNav=the-importance-of-training-and-development-in-the-workplace>

- [13] Chris Pursaba. (2015). *The top 7 benefits of document management systems*. Available at: <http://www.whymeridian.com/blog/the-top-7-Benefits-of-Document-Management-Systems>
- [14] *7 reasons why customer feedback is important to your business*. (2016). Available at: <https://blog.startquestion.com/7-reasons-why-customer-feedback-is-important-to-your-business-28e99c00eba7>
- [15] *5 tangible benefits of an effective risk management program*. (2011). Available at: <https://www.beckersasc.com/asc-accreditation-and-patient-safety/5-tangible-benefits-of-an-effective-risk-management-program.html>
- [16] *Benefits of change management*. (2019). Available at: <https://www.change-management-coach.com/benefits-of-change-management.html>
- [17] Nawras Skhmot. (2017). *5 benefits of continuous improvement*. Available at: <https://theleanway.net/5-Benefits-of-Continuous-Improvement>
- [18] Trevino, S. A. & Anantmula, V. S. (2008). Capitalizing from past projects: the value of lessons learned. Paper presented at PMI® Research Conference: *Defining the Future of Project Management*, Warsaw, Poland. Newtown Square, PA: Project Management Institute. Available at: <https://www.pmi.org/learning/library/business-benefits-value-lessons-learned-7116>
- [19] Parnell, J. A., Von Bergen, C. W., & Soper, B. (2005). Profiting from past triumphs and failures: Harnessing history for future success. *SAM Advanced Management Journal*, 70(2), 36–59.
- [20] Aiyer, J., Rajkumar, T. M., & Haveleka, D. (2005). A staged framework for the recovery and rehabilitation of troubles is development projects. *Project Management Journal*, 36(4), 32-43.
- [21] Chan, D. W. M., & Kumaraswamy, M. M. (2002). Compressing construction durations: Lessons learned from Hong Kong building projects. *International Journal of Project Management*, 20(2002), 23–25.
- [22] Seth Lessack. (2016). *The top 3 benefits of preventive maintenance programs*. Available at: <https://www.smsassist.com/blog/the-top-3-benefits-of-preventative-maintenance-programs>