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COST OF QUALITY MANAGEMENT IN INDIAN INDUSTRIES: A PRACTICAL INSIGHT

Abstract: *In India, quality cost management system is becoming an important area within the purview of quality engineering; where in upper management can get true reflection of status of quality department in monetary terms for all types of organizations. Cost of Quality (COQ) practices; have well defined standards and lot of research backing, still lacks in large scale adoption at industry level practically. Reason could be, the sustainability and usefulness of these practices has normally not been elaborated or tracked once primary research objective is over. At the same time, it is observed that COQ initiatives taken by industry people are not published. This work intends to study the COQ practices followed by reputed and successful industries of different types. Eight industries shortlisted are classified into two groups and detailed analysis of COQ practices adopted was done for each industry. The analysis provides useful input for design of quality cost management system (QCMS) for the industries where COQ practices are not implemented.*

Keywords: *Quality Costs, Indian Industries, COQ practices, QCMS*

1. Introduction

To survive and excel in today's competitive world, every organization has to work on different fronts simultaneously. Indian industries are no exception to this (Mahadevappa, B., & Kotreshwar, G., 2004). As the national boundaries are diminishing in market place, the competence level required is higher and higher. Industries are adopting modern technologies to improve productivity and operational efficiency. Customer satisfaction and beyond is a key initiative on the agenda of strategy makers of

organizations across the globe. To meet these challenges it is imperative to go for a better quality product/ service at lower cost.

In modern management science, utmost importance is given to total quality management (Jha, V. S., & Joshi, H., 2007) and hence almost all organizations go for different quality certifications irrespective of size, sector, location and other differentiating parameters. In doing so, they undertake systematic changes leading to continuous improvement. Numerous tools and techniques are developed by researchers/academicians in the field of quality engineering/management and many of them have been successfully implemented by industries, reaping the benefits, becoming part of quality management system of

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organization.

One such program, quality costing, also shares the same goals. "Quality costing" or "Cost of Quality" has well established theory, national and international standards. Lot of research work is being done in the area of quality costing in last seven decades. The important issue is the practical implementation of the technique for industry to fulfill intended purpose. To understand this it may be of interest and use to have inside in actual industry practices. One of the studies done with this aspect as a focus evaluated the adoption of formal COQ practices in successful multinational manufacturing companies (Schiffauerova, A. and Thomson, V., 2006). The present work intends to extend the work on similar line in context with the Indian manufacturing organizations working in advanced manufacturing environment.

2. Literature review

Many researchers worked to find out COQ status across globe/nation/region for different industrial sectors, through surveys, reviewed the literature (Vaxevanidis, N. M. et al, 2009; Schiffauerova, A. and Thomson, V., 2006; Hwang, G. H. & Aspinwall, E. M., 1996; Plunkett, J.J. and Dale, B.G., 1987) to compile the information about industry penetration, usage, benefits and limitations from reported case studies. The few of surveys conducted to know the COQ practices followed are: (Oliver, J.,1999) for Australian manufacturers certified to AS/NZS ISO 9000, (Rapley, C.W. et al. ,1999) designed a study aiming investigation of COQ practices in small and medium sized manufacturing enterprises located in North east of England region, (Uyar, A. ,2008), to investigate the extent to which Turkish manufacturing companies implement a COQ system, (Kajiwara, Takehisa ,2009) for Japanese firms working in TQM environment, (Pires, A. R. et al. ,2013) for management of quality related costs in Portuguese firms and (Chopra, A. and Garg, D. ,2011) for

industries located in north India.

The case study conducted for small and medium sized aerospace precision component industry highlights the difficulty in understanding language of quality costing at different levels of organization and various perceptions observed (Roden, S., & Dale, B. G. ,2000). Another research (Superville, C. R., & Gupta, S., 2001) emphasized on study and development of COQ models for different types of industries considering firms maturity and strategic direction. Although the COQ practices are prescribed by all the quality experts, but the question remains that, why more organizations are not utilizing this technique efficiently? (Sower, V. & R. Quarles, 2003) studied this aspect using a survey with a sample of 3200 members from over 22000 members of quality management division of ASQ. The survey came out with important reasons for which authors have suggested suitable solutions for respective reason. Still it is observed that the penetration of COQ methodology or its adoption is not wide spread as compared to some of the other quality engineering tools and techniques. This is also evident from the fact that, many quality standards are revised and updated regularly, whereas no such developments are seen on COQ front. For motivating more and more organizations to get into COQ practices the identification of factors and measures contributing to a successful quality cost program implementation is essential. Rodchua S. (2006) identified these for manufacturing environment. The work reported by Vukcevic, M. (2008), proposes an index for COQ measurement and presses a need to simplify the implementation process.

The literature published on COQ practices in India can be broadly classified in three categories. 1. Survey papers (Kaur, P., 2009; Chopra, A., and Garg, D., 2012), 2.Review Papers (Trehan, R., et al, 2015; Mantri, S. G., and Jaju, S. B., 2015), 3. Case studies; Survey finding give very broad directional information, which may not be useful for

COQ implementation for a particular industry. Review papers help to understand the state of art of techniques under study, wherein more emphasis is on summarizing underlying theory. Case studies published on Indian industries can be classified in two categories:

- 1) Based on the literature and guidelines available with standards, designed by researchers, implemented in trial period and data generated was used to draw inferences (Desai, D. A., 2008; Jaju, S. B. et al, 2009; Sharma, R. K. et al, 2007).
- 2) Used existing data in industry, fitted them in COQ structure and collected additional data if not available as per structure and calculated COQ (De, R. N., 2009; Chopra, A., and Garg, D., 2011, Sailaja, A. et al, 2014).

It is observed that, the sustainability and usefulness of the process has not been elaborated and tracked after the primary research objective is over. On the other hand, detailed insight of the COQ practices actually undertaken by organizations on their own initiative is not normally reported outside the organization. This information is usually not available to academicians and researchers. On this account, the necessity is felt that, before undertaking any such research work, it is desirable to get deep insight into the industry practices of successful industries. This work intends to contribute towards understanding of how industries go for cost of quality management, what practical difficulties are faced by organization, such that this information will be useful for academicians as well as industry practioners.

3. Basics of cost of quality

Quality costs or economics of quality was described (Juran, J.M., 1951) as all necessary activities to attain merchantability or, in terms of Juran's definition of quality:

“fitness for use.” He described tangible costs, which could include inspections, testing, and losses caused by errors and intangible costs which might include opportunity costs such as damaged reputation or loss of business. A cost-of-quality model that differentiated it from quality costs described in earlier scholarly work, made a paradigm shift, which incorporated classifications Prevention, Appraisal, and Failure (PAF) that were made to describe even the nuances of the cost behavior related to quality (Fiegenbaum, A.V., 1956). The basic thought process of quality costing has been extended to include the effects of customer satisfaction on profits, to use it as a feedback tool for quality improvement teams and to accommodate quality costing for advanced manufacturing, service and software industries.

The definition of quality costs is as important as that of quality. After comparing different definitions of quality costs it can be found that most of them are similar. Mainly two different groups of terms exist (Mantri, S. G., & Jaju, S. B., 2013):

- 1) Cost of Quality – either abbreviated COQ or CoQ
- 2) Cost of Poor Quality – abbreviated COPQ.

Critical issues for effective COQ implementations are: To categorize various quality costs and make sure that all costs are captured; to collect and analyze data and quantify all quality costs accurately; to identify areas of poor performance on basis of the data analysis; to allocate responsibility for the overall cost.

Each of the below categories should be identified as a cost driver and quantified.

- 1) Prevention Costs: The costs of all activities specifically designed to prevent poor quality in products or services.
- 2) Appraisal Costs: The cost associated to assure conformance to quality and performance standards.

- 3) Internal Failure Costs: All costs resulting from products or services not conforming to requirements which occur before product or the service is delivered to customer.
- 4) External Failure Costs: Cost incurred when customer finds failure
- 5) Opportunity or Hidden Costs

4. Methodology followed for study

Several organizations with good performance and brand presence indicating successful working in their domain were contacted and few of the organizations willing to share information and data about quality costs practices are part of this study. Purpose of the study is to get insight into actual industry practices and compare with the reported information in published literature to come out with a proposal for implementation of COQ methodology where those are nonexistent.

Eight companies, divided into two groups are considered for this study. The first group consists of three large-sized companies with well-established quality programs and working in different industrial sectors. The names of companies are A, B, C for description in the paper to keep confidentiality. Further, the second group of companies, which are medium-sized, mostly OEM suppliers, similar to the working of company C are selected and named as company 1, 2, 3, 4 and 5. The companies catering to the same market are avoided as those will be reluctant to share data.

The study started with the description of the company's quality policies and practices briefed by the respective company representative. Then the author has explained the intent and details of the study, and based on a mutually agreed schedule, visits to each company, open-ended interviews with concerned persons, information and data gathering was done. During these sessions, a lot of new information was exchanged regarding the practices mentioned in

literature and followed by different companies. All the information thus collected was analyzed and a comparative analysis was performed for the second group of companies. The study concluded with sharing the appropriate outcomes to individual companies as recommendations.

5. Company wise analysis and summary

As outlined above, the following section covers the brief description of company, quality and COQ practices followed, usage of the data, use of tools and techniques used. The detailing of each company is concluded with the company-specific features and findings with respect to cost of quality practices. The comparison is done within the defined group of companies to draw the conclusions.

5.1. First Group (Companies A, B, C)

The organization considered for study, company A, is a leading energy and environment solutions provider, is one of the few companies in the world that offers integrated innovative solutions in heating, cooling, captive power, water & waste management, air pollution control and chemicals.

A cost of poor quality measurement system was developed for the EPC (Engineering Procurement and Construction) business of power division of this organization. A formal COQ/COPQ system or standards were not followed, as for project type of work no specific standard exists. Instead, keeping broad theme of minimization of waste, establishment of a suitable system for measuring COPQ and understanding of areas of improvements was undertaken. The project comprised of the following steps in phase-I:

- 1) Mapping Process Flow for the Business with potential for COPQ
- 2) Identifying and prioritizing the factors affecting COPQ

- 3) Developing a system to capture COPQ.
- 4) Designing and implementing process for COPQ measurement system
- 5) Designing and Setting up periodic MIS Report

The flow of business processes was mapped and the possible costs due to poor quality in the process step were documented. This list was discussed with the senior team for their view and experience for the prioritization of the criterion. The process flow for capturing the COPQ and deriving the corrective actions thereof, is also documented. Following was the list of COPQ areas considered for the company:

- 1) Cost incurred on the extra time & resources spent to complete a given task which was not completed on schedule due to overrun
- 2) Cost incurred on time & resources spent due to miss outs, errors, rectification, replacement, leading to rework
- 3) Underutilization of capacity, capability due inefficient planning and work distribution/ loading
- 4) Value of Excess stock (left over materials at the end of the project)

- 5) Cost incurred in transfer of Excess stock from site to the other (including re-inspection, packaging, loading, unloading and re-compliances to statutory & regulatory requirements)
- 6) Loss due to scrap of materials
- 7) Cost incurred for resolution of Customer complaint
- 8) Loss of Goodwill resulting in potential loss of business/ repeat orders
- 9) Penalties, liquidity damages.

Based on the areas indentified, a list of twenty COPQ criteria was prepared by considering process flow and the input from the system. The information source for the decided criterion and the responsibility for the information sharing were fixed in the form of responsibility matrix (consisting of 22 criteria). The responsibility matrix included for each COPQ criteria, the source of information, the personnel responsible and reporting frequency in unambiguous way. This helped in the formalizing a monthly MIS template, which was made part of regular MIS from the division. Sample responsibility matrix is shown in Table 1.

Table 1. Sample Responsibility Matrix for Company ‘A’

Responsibility Matrix (Sample)				
Sr. No.	Criterion	Source of Information	Responsibility	Frequency of reporting
1	Premium freight paid	1) Values of CCN raised- In case of Budget overrun 2) Amended Purchase order	Buyer, Project Engineer	Monthly
2	Excess quantity of material supplied at site.	1) Values of Excess Buffer qty (>5%) in indents 2) Value of additional indents raised for the project after Engineering completion	Site In charge	At the end of the project
3	Increase in man days and number of visits for inspection of the material / equipment due to reasons attributed to supplier.	1) Invoices raised for extra visits made to the vendor	Group Head QC	Monthly

Following Key Performance Indices were decided for the Monthly MIS report, which will be circulated to top management of the division.

- 1) COPQ in Rs Lakhs: It is imperative to know how much money is getting drained out due to the various parameters. COPQ, in Rs Lakhs to be reported every month. At the end of the Qtr, the sum of the three month's COPQ is to be reported.
- 2) COPQ % of Revenue Recognition: The percentage of RR is to compare the cost of poor quality amount with the sales. For project division, such as POWER, RR is considered as sale. on the volume of the amount in relation with the total
- 3) COPQ Project wise (trend): To understand the individual project's trend in the COPQ.
- 4) COPQ Project Contribution: Impact of individual project on the total COPQ. Which project is to be focused for COPQ reduction? From Figure 1, it can be seen that project 2 needs more attention.
- 5) Reason for negative / positive trend: Documentation of the causes why there is increase in COPQ, what process went wrong and what is to be improved in due course of time
- 6) COPQ % of PBT (Profit before Tax): This will directly give the % of reduction in PBT due to cost of poor quality.

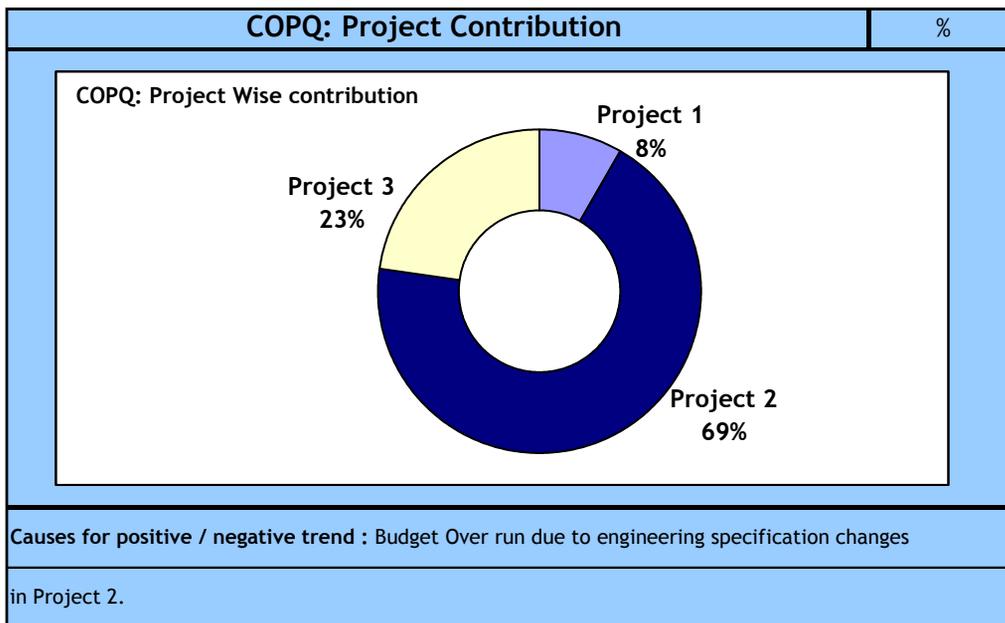


Figure 1. Project wise COPQ contribution (% of total COPQ)

In second phase, highlighting and taking corrective actions will be targeted. Although formal COQ method is not used in this industry, most of the elements of costs are covered. The method can also be used for tracking COQ in manufacturing units where continuous expansion and up gradation of

facilities is going on. This example highlights the need based customization approach.

Company B is leading global and one of the largest Automotive manufacturing MNC based in India. It caters to a wide market all over the globe with a broad portfolio of

automotive vehicles covering passenger cars, buses, trucks etc. The company has a focus on automation and use of state of art technology for manufacturing. As the operations of company are spread over multiple locations, it was decided to focus on the activities followed by a manufacturing shop in one of the plant, as it was found that company doesn't have a uniform procedure for implementation of quality costs practices. For the present study company has shared the information about the quality policy and practices followed in the body shop of passenger car manufacturing plant. The plant under study is certified for world class manufacturing and quality standards.

The manufacturing process employed consists of various welding techniques implemented through use of semi-automatic and automatic set ups. The whole of the quality emphasis is on defect prevention at various levels right from plant, shop, line to work station. For this various quality

improvement techniques are employed with generation of new initiative, leading to continuous improvement. However formal cost of quality program is not implemented. Instead they have identified an area of cost of poor quality (COPQ) namely rework manpower.

The rework manpower is one of the cost elements in the internal failure cost category of PAF methodology or part of cost of non conformance (CONC) as per the quality cost literature. Based on the process flow, the existing manpower used for rework per shift was listed section wise. A target was decided to reduce this manpower by 20% in one financial year. Out of the section identified, Pareto Analysis is performed and potential sections for reduction in rework manpower are highlighted. It can be seen from Figure 2 that, the rework men at the beginning of study, target and proposed reduction and actual reduction.

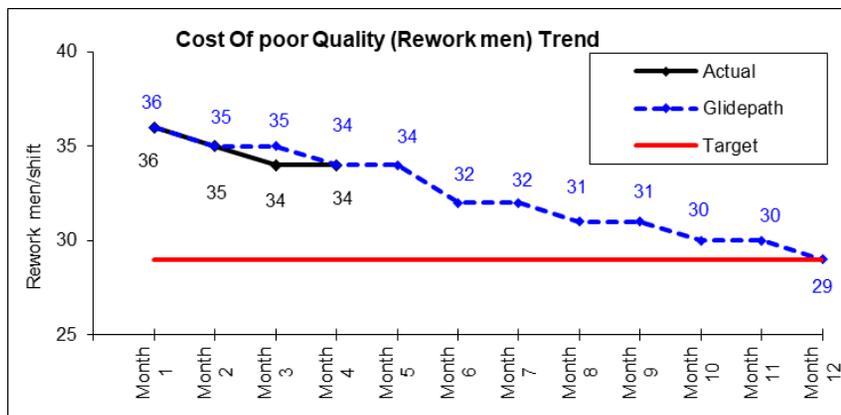


Figure 2: Rework Manpower Trend for Body Shop of Company 'B'

Although, this company has not adopted quality cost practices as depicted in the literature, but implemented the theme after customization to their needs. The overall approach followed was, started shop level activity by defining the rework manpower reduction as the target, devised methodology considering the levels of implementation as production line to individual work station.

After successful implementation the methodology can be extended to plant level.

Company C is one of the world's largest forging companies. The manufacturing facilities of the company are established at many places in India, China and European countries such as Germany and Sweden. The company is in the business of manufacturing, high performance, critical & safety

components for the automotive & non-automotive sector. It is largest Indian manufacturer and exporter of automotive components. Company's customer base includes almost all global automotive OEM and Tier 1 supplier. Company works through various divisions having their own expertise which performs allotted operation.

At company C, quality and customer focus is of utmost importance. Their quality systems have been designed to comply with the latest automotive quality system standard, TS 16949. Plant considered for present study is named as closed die forging unit, which has design, engineering and manufacturing facilities. In design and engineering facility, activities undertaken consist of new product development and yield improvement. The manufacturing facilities consist of die making shop, forge shop, heat treatment section and final processing. The plant has an advanced in-house Tool & Die manufacturing facility comprising of 3 axis, 4 axis, next generation high speed CNC milling machines, high precision EDM, wire cut machines for machining of Tool and Dies. Over the years Company C has created world-class capacities and capabilities for varied customer base and specific industry requirements. At Company C, quality and customer focus was found to be of utmost importance. The organization works to provide total customer satisfaction by implementing continuous improvement using 6-sigma methodology, Robust manufacturing system in line with the best-in-class. The quality is assured by adhering to different quality standards relevant to

industry. The company follows a formal cost of quality procedure, although it doesn't refer to the standards for same. The cost elements calculated are: Appraisal cost (Pay-roll cost of quality control staff), Internal failures cost (Scrap, rework and associated transportation), External failure cost (Line rejection, visit and rework cost at customer end, Debit note cost). The costs are calculated and reported on monthly basis. The variation of COQ and percentage scarp is found to be nearly similar as seen in Figure 3. As the major portion of IFC is scrap cost and IFC is the largest component in total cost of quality calculated, the company gives maximum emphasis on reduction in scrap. The EFC consists mainly of the scrap cost due to line rejection at customer end. It can be concluded that the COQ figures reported are mere reflection of scrap cost and just static representation of pay-roll cost in case of appraisal cost calculation. It is felt that, although the company has got resources, good quality culture, advanced manufacturing environment, the cost of quality system used was at very primitive level. The main component of quality costs namely prevention cost calculation was found to be completely missing. The conclusions for COQ components for company C are clearly visible in Figure 4. This may be the reason why the TCOQ figures reported are much lower than normally found in literature. Where-as the scrap values are near to the expected in forging industries which is usually taken as 3 percent of production quantity.

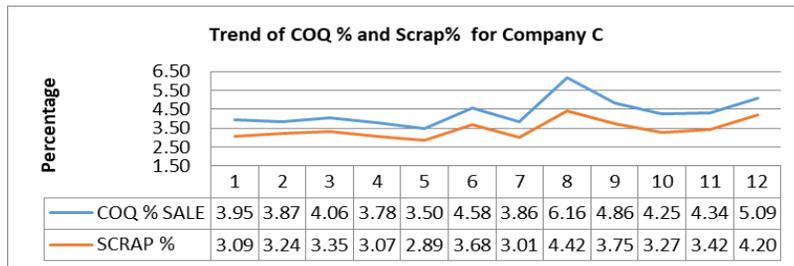


Figure 3. COQ Trends for company 'C'

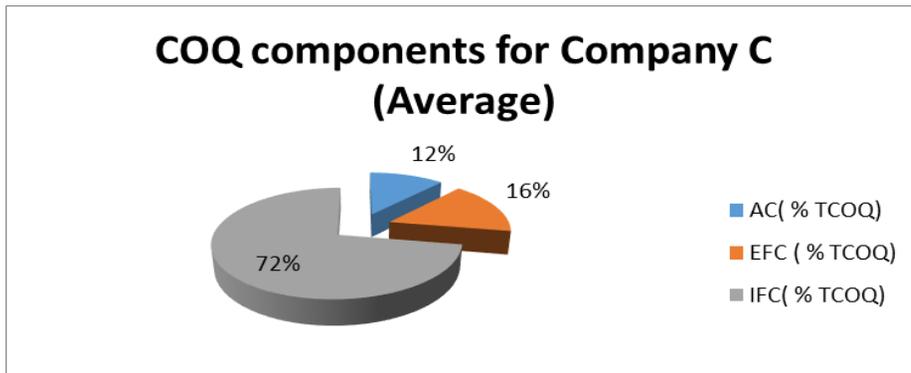


Figure 4. Components of COQ for company 'C' (Average values of 12 months)

Out the three companies described, the nature of business was found to be altogether different, i.e. company A works in EPC domain which undertakes projects, Company B, OEM manufacturer and company C, OEM supplier. It is obvious and found after having insight in the working of quality departments of these companies that, the quality system requirements of these differ considerably. It may not be appropriate to compare the quality cost practices followed in these companies. The company C, which works as OEM supplier has to withstand the stringent quality norms of the OEM's and also to bear the effects of quality problems of its suppliers. It is found that, usually the Tier-I or Tier-II OEM supplier has to maintain the balance in supply chain on the aspects such as quality, productivity to remain competent enough to survive the competition. In this space in addition to large corporations, mid sized enterprises or independent sections of large industrial houses which can be considered as a separate mid-sized business are working. Owing to these factors it was decided to extend this study focus on mid-sized enterprises working as Tier-I or Tier II suppliers and having all the features of successful enterprises broadly.

5.2. Second Group (Companies 1-5)

For this part of study, five companies working as Tier-I or Tier-II supplier to

different automotive OEM's were selected which have shown willingness to participate in the study and share the required data. The methodology used for the study consist of two stages viz. collection of information on actual Cost of Quality practices followed by analysis of information collected to draw useful conclusions.

In the first stage, the collection of basic information of company and quality department is done. Further, with the help of provided documents, archival records, direct observation and interviews with different persons, the detailed information about the quality cost practices followed by the company was obtained in the structured way. The focus of information collection was on, whether the COQ standards were used, which components of COQ used, methodology of collection, calculation, reporting formats, use of quality cost data and company specific features and observations. In second stage, the comparison and analysis of the information is done. It was found that all companies used quality standards in general but no company has referred the standard meant for quality costs. The level of implementation was different for all these companies. As all the companies have shared data on the conditions that its use should be only for study purpose and should not be shared or published with names of the companies such that their business interest should not be hampered. Hence these companies will be

referred as company 1 to company 5 for the description and conclusion purpose.

Company 1, a tier-II, small and medium sized enterprise, consists of four manufacturing units. One of the unit, deals in manufacture of precision pressed sheet metal components, tubular components and assemblies for automotive industries, was considered for present study. The said unit is ISO 9001:2000 certified and gives utmost importance to customer satisfaction. Being vendors of OEM, the management came across cost of poor quality procedure followed by one of their customer. They have adopted it partially by calculating internal failure cost (IFC) only. The procedure followed can be briefly described in following steps.

- 1) Component wise defects Identified and costs assigned to each defect type,
- 2) Calculation: Component wise- (Cost of defect x Quantity) at the end of day,
- 3) Monthly report of component wise and total COPQ,
- 4) Components with highest COPQ analyzed.

Due lack of resources and willingness company could not extend the practice to accommodate other cost elements as specified in literature. It can be considered to be most elementary level COPQ system out of all the studied industries.

Company 2, a tier-I, automotive OEM supplier, is in manufacture of electrical components, sub-assemblies and assemblies for automobiles. As far as, quality cost practices are concerned, they were found to calculate COPQ with two cost components viz. IFC and EFC. For calculation of IFC, component wise rejection cost and rework cost is considered. For EFC the elements used were, rework/ rejection cost at

customer end and warranty cost. From the monthly report created, the component with highest COPQ is analyzed. Trend analysis is not done.

Next medium sized enterprise taken up for study, company 3, a precision components and gears manufacturing set up, is tier I supplier for automotive OEMs, an ISO/TS 16949:2009 certified organization and presently has been awarded as TPM organization. The company supplies fully finished gear shaft sub-assemblies with zero ppm (parts per million) at customer end. The unit is capable of producing 15 million components annually. The company has in- house die making, forging (Hot, warm and cold), precision machining and heat treatment facilities. The company has elaborate quality policy with well defined objectives. For achieving customer satisfaction, company tries to provide value for money with a target of zero defects at customer end.

The COPQ system is implemented with major emphasis on IFC only. The data is separately taken for vendor, forging shop, machining and heat treatment shop. Method can be described as:

- Finish and work in progress Rejection for Vendor, Forgings , Machining and HT quantity collected, PPM calculated
- Cost of component rejection allocated and based on quantity total cost per component calculated
- Reporting: Individual section wise and total COPQ in Rs terms as well as percentage of sales terms and PPM trend plotted and discussed on monthly basis, compared with sales figure. The consolidated sample values from one year COPQ data are shown in the Table 2.

Table 2. Department wise COPQ for company ‘3’

Department	Forging	Vendor	Machining & HT	Total
COPQ (% of Sales) Maximum	0.66	0.63	1.27	2.54
COPQ (% of Sales) Minimum	0.5	0.23	0.78	1.84
PPM Maximum	13919	2453	8157	23304
PPM Minimum	11251	1269	6130	20669

The process used is reliable and accurate as the data is directly taken from central data base. The limitation is only IFC is traced with very few cost elements. The process can be extended for all the elements of quality costs if management desires. Another important thing to be noted is, as number of components manufactured presently, are near to two hundred and COPQ data is to be collected at component level, the number of

cost categories (under different heads such as PC, AC, IFC and EFC) need to be restricted to very few as compared to given in the standards or literature.

Company 4 is one of the largest Tier-I supplier of sheet metal component sub-assemblies to many automobile OEMs operating in India. The cost elements considered are shown in Table 3.

Table 3: Elements of COQ considered at Company ‘4’

COPQ External Failure	COPQ Internal Failure	COGQ Inspection(Appraisal)	COGQ Prevention
<ul style="list-style-type: none"> - Processing customer complaints - Customer Returns - rework cost - Freight - Short supply - Dispatch - Scrap at Customer end 	<ul style="list-style-type: none"> - Scrap - Rework Material - Rework persons - Re-inspection - Re-testing - Internal failure analysis - Material downgrades 	<ul style="list-style-type: none"> - Inspection Cost - Testing - Product, Process or service audits - Calibration of measuring & test equipments 	<ul style="list-style-type: none"> - New Product review - Quality planning / TUV Audits - Supplier surveys/evaluation - Error proofing - Quality improvement teams Purchases - Quality Education & training

It is public limited company with manufacturing facilities at ten locations. Quality policy of company put emphasis on providing right quality products as per customer’s specified requirements, at competitive prices. This is being visible from the growth of company from small partnership firm to a stock exchange listed company with a customer base of reputed automotive multinational OEMs and number of awards for best supplier, excellence in quality and performance from different organizations. Company has detailed COQ

policy, which classifies costs as cost of poor quality (COPQ) and cost of good quality (COGQ).

It is evident from the table that so many cost elements are considered for calculation of COQ. It is also seen that this exercise is done from last few years with monthly reporting of total COQ and COQ as percentage of sales. The values reported were less than one percent of sales during the whole period, which are very much less as compared to reported values of similar companies and published values in literature. Data is not

convincing as reported values of COQ are very low ranging from a minimum of 0.12 to maximum 0.35 percent of sales for year 2011 to a minimum of 0.03 to maximum of 0.27 percent of sales for year 2015. After careful examination of the data collected, it was found that the data related with pay roll cost of employees was totally missing and under many other heads only partial data was reported. This state of affair leads to the conclusion that, template selected for data collection was good, but all the data was not captured, major expenses were found to be excluded. When reason for this was tried to be traced by author, it was found that, to escape the responsibility of COQ analysis and to avoid blame game the values were intentionally not reported or suppressed whenever possible such that the, final total COQ values appear to be very less indicating excellent performance on COQ front to top management. Hence exercise is not useful for company and it is recommended that the company should encourage the people involved to report factual data irrespective of the outcome. This can be done by assuring concerned people about the use of data that, it will be done to initiate quality improvement programs instead of being used to fix or blame people for poor performance.

The final company for the present study is company 5, which is a part of group, head quartered in India, working as an emerging global automotive component manufacturer and supplier of exterior lighting systems, power-trains, electrical assemblies , body and chassis parts to leading passenger car and motorcycle segments worldwide. The

group has presence in ten countries with thirty five manufacturing facilities, catering to almost all the global automobile OEMs. The company 5 is an exclusive division of the group, engaged in manufacture of engine valves for two wheelers, three wheelers and passenger cars, commercial and off road vehicles. The revenue contribution of the company 5 to the group is in the range of three percent of the total group revenue of Rs. 7800 crores approximately. This company is most preferred supplier of engine valves in India. The group is structured in such a way that the general policies are implemented by top management through individual plant heads. At the same time, based on the need of individual plant or manufacturing facility there is ample flexibility in working. Hence although the company 5 is a part of large industrial enterprise, it can be treated as a medium sized independent entity.

The organization has a well designed quality system under which a properly devised quality cost calculation and reporting process is executed. The COQ system uses cost categories in line with the standards and literature. The P-A-F methodology of COQ is devised and a data capture mechanism is implemented, in which nearly eighty percent of the data is available from centralized database of ERP system. Remaining data is manually collected from different departments by quality department. The classification and the calculation of COQ in company 5 are explained in Table 4.

Table 4: Classification of COQ components at Company ‘5’

Prevention Cost (PC)	Appraisal Cost (AC)	Internal Failure Cost (IFC)	External Failure Cost(EFC)
-Salary of QA staff and operator -Half of Std. room and engineering staff salary	-Calibration staff salary -External calibration and service cost -Half of Std. room and engineering staff salary	-Scrap cost (Quantity X Cost) -Rework cost (Quantity X Cost)	-Warranty Debit Cost - Customer complaint cost -Travelling expenses

The total cost of quality is calculated as sum of all the costs; (COQ = PC + AC + IFC + EFC).The cost of quality is calculated and reported on monthly basis. The trend COQ is plotted. The values obtained during one

complete year are used to get the average monthly values. These values of quality cost as percentage of sales and percentage contribution of each cost head in total cost of quality are shown in Table 5.

Table 5. COQ breakup for Company ‘5’

Cost	PC	AC	IFC	EFC	Total
COQ as % of Sales	0.7	2.42	2.76	0.21	6.10
% of total COQ	11.55	39.96	45.07	3.43	100

Out of all the companies that are studied, company 5 used the COQ methodology as given in the standards or available in some of published literature. The important point to be noted here is, the values reported indicate that sum of prevention and appraisal costs is nearly equal to failure costs.

6. Conclusions

The study confirms the usage of COQ practices across broad spectrum of industries but simultaneously highlights variation in implementation methodologies. In first group of companies which are large sized organizations, the concept was implemented, which does not follow the methodology detailed in literature in case of company A and B. However company C and five companies in second group follow the structure as depicted in literature to different extent. One common striking feature observed was, data collection for COQ was still done manually mostly, although advanced technologies are implemented for different manufacturing activities. With exception of company 5 of second group, all companies have more emphasis only on reducing failure costs. It is observed that, the company 5 followed COQ practices as

expected, which is visible from the fact that the sum of failure costs is less than the sum of prevention and appraisal costs. The study also found that the use of COQ practices was limited to collection of data and preparation of monthly reports for presentation purpose. The detailed analysis of data and generation of quality improvement initiative was found to be missing.

For the generalization of above key findings, more detailed studies are required to be performed across industry types such as public sector organizations , sizes such as large, medium and small enterprises, with more cases, which can be termed as limitation of this study.

The present study can be used as one of the vital inputs for development and implementation of a formal quality cost management system for a medium sized manufacturing organization working in advanced manufacturing environment. The input for design of framework for quality cost management system (QCMS) for an enterprise where it is not in use is illustrated by the Figure 5. The diagram highlights the importance of due considerations to be given to study of actual COQ practices followed by industries.

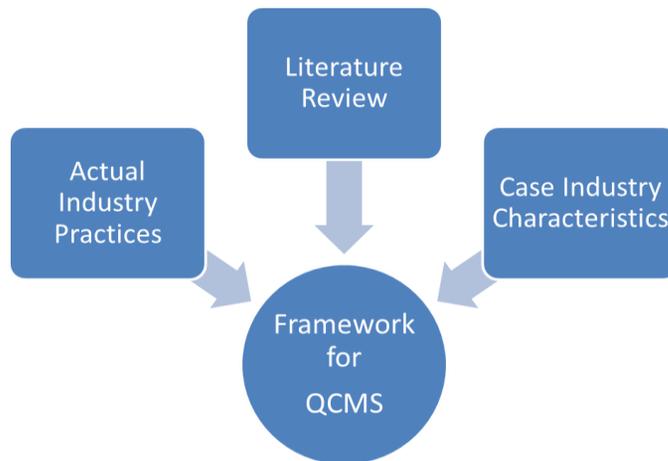


Figure 5. Inputs for design of QCMS framework

References:

- Chopra, A., & Garg, D. (2012). Cost of Quality Practices among Indian Industries. *International Journal for Quality Research*, 6(2), 109-112.
- Chopra, A., & Garg, D. (2011). Behavior patterns of quality cost categories. *The TQM Journal*, 23(5), 510-515.
- De, R. N. (2009, October). Quality costing: An efficient tool for quality improvement measurement. In *Industrial Engineering and Engineering Management, 2009. IE&EM'09. 16th International Conference on* (pp. 1117-1123). IEEE.
- Desai, D. A. (2008). Cost of quality in small-and medium-sized enterprises: case of an Indian engineering company. *Production planning and control*, 19(1), 25-34.
- Feigenbaum, A. V. (1956). Total quality control. *Harvard Business Review*, 34(6), 93-101.
- Hwang, G. H., & Aspinwall, E. M. (1996). Quality cost models and their application: a review. *Total Quality Management*, 7(3), 267-282.
- Jaju, S. B., Mohanty, R. P., & Lakhe, R. R. (2009). Towards managing quality cost: A case study. *Total Quality Management*, 20(10), 1075-1094.
- Jha, V. S., & Joshi, H. (2007). Relevance of Total Quality Management (TQM) or business Excellence Strategy Implementation for Enterprise Resource Planning (ERP)-A Conceptual Study. In *Proceedings of the 12th International Conference on Information Quality*.
- Juran, J. M. (1951). *Quality Control Handbook, 1st edition*. McGraw-Hill, New York.
- Kajiwara, T. (2010, December). Factors influencing the use of quality costs in TQM environments: Evidence from Japan. *AAA 2010 Management Accounting Section (MAS) Meeting Paper*.
- Kaur, P. (2009). Current Cost of Quality Management Practices in India in the Era of Globalization: An Empirical Study of Selected Companies. *Decision (0304-0941)*, 36(1).
- Mahadevappa, B., & Kotreshwar, G. (2004). Quality management practices in Indian ISO 9000 certified companies: an empirical evaluation. *Total quality management & business excellence*, 15(3), 295-305.

- Mantri, S. G., & Jaju, S. B. (2013, December). Modeling Cost of Quality in Advanced Manufacturing Environment. In *2013 6th International Conference on Emerging Trends in Engineering and Technology* (pp. 130-131). IEEE.
- Mantri, S. G., & Jaju, S. B. (2015). Emerging trends in cost of quality practices: an overview. *International Journal of Productivity and Quality Management*, 15(4), 469-485.
- Mohapatra, S. (2002). Improving Cost of Quality through bench marking exercise. In *International conference on principles of software evolution*.
- Oliver, J., & Qu, W. (1999). Cost of quality reporting: some Australian evidence. *International Journal of Applied Quality Management*, 2(2), 233-250.
- Pires, A. R., Cociorva, A., Saraiva, M., Novas, J. C., & Rosa, Á. (2013). Management of quality-related costs. The case of Portuguese companies. *Total Quality Management & Business Excellence*, 24(7-8), 782-796.
- Plunkett, J. J., & Dale, B. G. (1987). A review of the literature on quality-related costs. *International Journal of Quality & Reliability Management*, 4(1), 40-52.
- Ramos Pires, A., Novas, J., Saraiva, M., & Coelho, A. (2015). How companies use the information about quality-related costs. *Total Quality Management & Business Excellence*, 1-21.
- Rapley, C. W. (1999). Quality costing: A study of manufacturing organizations. Part 1: Case studies and survey. *Total Quality Management*, 10(1), 85-93.
- Rodchua, S. (2006). Factors, measures, and problems of quality costs program implementation in the manufacturing environment. *Journal of Industrial Technology*, 22(4), 1-6.
- Roden, S., & Dale, B. G. (2000). Understanding the language of quality costing. *The TQM Magazine*, 12(3), 179-185.
- Sailaja, A., Viswanadhan, K. G., & Basak, P. C. (2014). Analysis of Economics of Quality in Manufacturing Industries. *International Journal for Quality Research*, 8(1), 121-138.
- Schiffauerova, A., & Thomson, V. (2006). A Review of Research on Cost of Quality Models and Best practices. *International Journal of Quality & Reliability Management*, 23(6), 647-669.
- Schiffauerova, A., & Thomson, V. (2006). Managing cost of quality: insight into industry practice. *The TQM Magazine*, 18(5), 542-550.
- Sharma, R. K., Kumar, D., & Kumar, P. (2007). Quality costing in process industries through QCAS: a practical case. *International journal of production research*, 45(15), 3381-3403.
- Sower, V. E., & Quarles, R. (2003, January). Cost of quality: why more organizations do not use it effectively. In *ASQ World Conference on Quality and Improvement Proceedings* (Vol. 57, p. 625). American Society for Quality.
- Superville, C. R., & Gupta, S. (2001). Issues in modeling, monitoring and managing quality costs. *The TQM magazine*, 13(6), 419-424.
- Trehan, R., Sachdeva, A., & Garg, R. K. (2015). A Comprehensive Review of Cost of Quality. *VIVECHAN International Journal of Research*, 6(1), 70-88.
- Tsai, W. H. (1998). Quality Cost Measurement under Activity-Based Costing. *International Journal of Quality and Reliability Management*, 15(6), 719.
- Uyar, A. (2008). An exploratory study on quality costs in Turkish manufacturing companies. *International Journal of Quality & Reliability Management*, 25(6), 604-620

Vaxevanidis, N. M., Petropoulos, G., Avakumovic, J., & Mourlas, A. (2009). Cost of quality models and their implementation in manufacturing firms. *International Journal for Quality Research*, 3(1), 27-36.

Vukcevic, M. (2008). Cost of Quality Management. *International Journal for Quality research*, 2(4), 297-303.

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