Spending Behavior on Components of Cost of Quality: A Case Study

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***Abstract*—**High cost identified by the quality cost is an opportunity for profit improvement. To establish quality improvement efforts it is required to identify and organize quality related costs to assess their magnitude and elements, analyze quality performance, measure productivity and identify problem areas, take corrective action, evaluate the effect of action against the expected results. This paper provides insight into the behavior of spending on the various components of cost of quality of a company engaged in providing turnkey solutions in India.

***Keywords*—** EPC, cost of quality, conformance cost, non-conformance cost

I. Introduction

QUALITY costing can help companies to reduce manufacturing cost by identifying any excess cost and non-value added activities [1]. The organization must evaluate their process and figure out what constitute the quality cost. There is not perfect model or prototype that can fit the industry. The model has to be designed by the industry. The CoQ is means of identifying problems and then finding a solution. CoQ should be designed by involving employees at all the levels and thus making them a part of system. The main purpose of implementing CoQ measurement system is to determine the level of quality that minimizes the total cost [2]

PAF approach of measuring CoQ has been used successfully by various organization [3]. It has been discussed that the focus of P-A-F is cost reduction. The PAF model needs to be complemented by other approaches quality costing like JIT and SPC [5] .A case study was conducted in a footwear company. The cost of quality per pair of shoe was calculated. The COQ data was used to reduce major cause of footwear failure [6].

Reference [2] discussed about the quality cost practices of different industries belonging to different sectors. A telecommunication company uses activity based costing to determine cost categories, multinational microelectronic company does not measure COQ, an aerospace company tracks all non-quality events, finds its root cause and takes corrective action.

It has been found that all the companies strive for very high quality but a few apply formal COQ method. Company using COQ methodology successfully has achieved 40% reduction in the failure cut over 18 months.

Reference [7] conducted a study involving 500 companies in Turkey and found that 75% of the respondents had a perception that cost of quality is around 5% of turnover while [8] found it 5 to 25 percent. Reference [9] has used system dynamics approach with the help simulation software to predict the future cost of quality. Results of an empirical study show that an increase in the prevention cum appraisal cost will decrease the total cost of quality. With the increase in prevention cost the failure cost decreases which will result in the improved level of customer satisfaction. Reference [11] discussed the identification and analysis of hidden poor quality cost in a continuous process manufacturing company and in a case study found that the hidden cost of quality is most double (1.6 times) than the CoQ normally calculated. A survey in small scale industries [10] for measurement of cost of quality using Pearson Correlation Coefficient found there is strong negative correlation between prevention cost and internal failure cost.

In this article, a case study was conducted in an Indian industry. The company had a quality cost system where PAF approach was being used. It was studied and improvements were suggested. The pattern of the various costs of quality was studied. The team suggested increase in efforts regarding prevention and appraisal activities. After that, costs of quality were calculated for the next two years. Based on costs of quality data of three years, the behavior patterns of all quality cost elements with respect to each other were found out.

The quality costs are defined in BS: 6143 part 2 as:

1) Prevention cost: The cost of any action taken to investigate, prevent or reduce the risk of non-conformity or defect.

2) Appraisal cost: The cost of evaluating the achievement of quality requirements including e.g. cost of verification & control performed at any stage of quality loop.

3) Internal failure cost: The costs arising within an organization due to nonconformities or defects at any stage of the quality loop such as cost of scrap, rework, retest, re-inspection and redesign.

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4) External failure cost: the cost arising after delivery to a customer/user due to nonconformities or defects which may

include cost of claims against warranty, replacement and consequential losses and evaluation of penalties incurred.

II. Methodology

The cost of quality (COQ) was calculated at established Engineering, Procurement, Construction (EPC) company in India, engaged in providing turnkey solutions in solutions in the areas of:

- Bulk Material Handling Systems for cement, power, steel sectors etc
- Ash Handling Systems for thermal power plants,
- Balance of Thermal Power Plant ,
- Captive Power Plants,
- Captive Power Plants on Waste Heat Recovery Boiler based technology and
- Pollution Control systems.

Data was collected by direct observation during plant operation visits, through personal interviews with the personnel from quality assurance, accounts and production.
Conformance and non-conformance costs were calculated. Conformance costs were categorized into prevention and appraisal cost. Non-conformance costs were categorized into internal and external failure. The BS6143-2:1990 was used to define various cost elements.

III. Findings

Distribution of costs amongst the various quality cost categories:

Table I
Percentage Of Various Elements Of Quality Costs

	Prevention Cost (%)	Appraisal Cost (%)	Internal failure Cost (%)	External Failure Cost (%)
Quarter -1	27	17	31	25
Quarter -2	31	15	30	24
Quarter -3	26	23	30	21
Quarter -4	21	27	28	25

As indicated in the Table I, the proportion of Internal failure cost is maximum at around 30%, followed by Prevention Cost around 25%, External Failure Cost around 25% and lastly appraisal costs around 20%.
Company should increase the investment in prevention activities to reduce internal failure Cost and External Failure Cost.

The various elements of Prevention Cost, Appraisal Cost, Internal failure Cost, External Failure Cost are shown in the Table II (as provided by the organization)

Table II
Elements Of Quality Costs

Prevention	Appraisal	Internal failure	External failure
Types of Costs	Types of Costs	Types of Costs	Types of Costs
Laboratory	Inspection	In house Rejects	Customer service (quality reasons)
Quality admin.	Supplier quality	Rework – remake	Customer rejects
Patrol inspection	In process & finished products	Rework – reinspection	Onsite inspection
Quality engineering	100% inspection	Material Wastage	Warranty expense
Quality training	Appraisal equipment	Extra operations	Other ext. Failure expenditure
Q & R programme	Quality Assurance	Total downtime	Complaints
Design of Equipment	Production test	Internal failure costs	product service
Administration, Improvement	Laboratory acceptance testing	Substandard product	Returned material repair
Training	Inspection and test	Other internal failure expenses	Warranty replacement
Supplier quality assurance	In process inspection	Trouble shooting, defect analysis	
Calibration	Setup for inspection and test	Downgrading	
S.Q.A	Inspection and test materials	Modification permits and concessions	
Develop control equipment	Product quality audits	Scrap and rework ; fault of supplier	
Audit	Review of test and inspection data		
	Onsite performance testing		
	Internal testing and release		
	Evaluation of material and spares		
	Data processing, insp. and test reports		

A. Distribution Of Costs Elements

The data has been collected for the items in the table No.2.The distribution of cost of major components is as given below:

Prevention Cost

- Quality administration (20%)
- Design of Equipment (17%)
- Supplier quality assurance (13%)
- Quality engineering & Supplier quality assurance (8%)

Appraisal cost

- Onsite performance testing (28%)
- Inspection and test (13.5%)
- Supplier quality (8.7%)
- 100% inspection (8%)

Internal failure

- In house rejects (26%)
- Rework – remake (11.5%),
- Extra operations (12%),
- Total downtime (18%),
- Scrap and rework; fault of supplier (15%),

External failure

- Customer service (quality reasons) (35%),
- Customer rejects (24%),
- Warranty expense (14%),
- Product service (7.5%)

Since the company is engaged in providing turnkey solutions in various areas quality administration and Design of Equipment consumes a major portion of prevention cost. Similarly the major portion of appraisal cost is consumed by Onsite performance testing. In house rejects accounts for more than one –fourth of internal failure cost and Customer service (quality reasons) and Customer rejects account for two third of external failure cost. The industry should focus on these components and increase the investment in prevention cost to reduce internal & external failure.

B. Relationship Between The Various Quality Cost Categories

TABLE III
PEARSON CORRELATION COEFFICIENTS

Components of Quality costs	Pearson Correlation coefficient
Prevention & Internal failure	-0.359
Prevention & External failure	-0.473
Appraisal & Internal failure	-0.409
Appraisal & External failure	-0.316

As indicated in Table III the prevention cost is negatively correlated to internal failure cost meaning that an increase in the prevention cost with decrease the internal and external failure cost. Similarly, the appraisal cost is negatively correlated to internal failure cost meaning that an increase in the appraisal cost with decrease the internal and external failure cost. This relation is in accordance with the various findings given in the literature.

IV. CONCLUSION

An increase in the prevention cost will decrease the internal & external failure cost. The company should increase the investment in prevention cost to get maximum return on investment in quality. A further research can be carried out by finding the relationship between productivity and prevention cost.

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