

# ANALYSIS OF COST OF POOR QUALITY (COPQ) AND ITS CALCULATION: STEEL INDUSTRY

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**Abstract:** In today's era of high competitive industrial environment there is a need for steel industries to minimize their overall cost of product which will help to increase organization overall profit so that they can survive in highly competitive markets. It is wrong perspective that high quality means involvement of high cost. So, the term Cost of Poor Quality came in picture. The cost which is involved in making product comprises of raw material to final product, whereas there is also cost involve in defective product, reworking of product, customer complaints, sales return and down gradation. After going through the various literature reviews we found that any single model cannot be made to calculate COPQ. This present paper mainly aims to review the literature reviews of COPQ and formulate a model with respect to steel industry for calculation of COPQ also giving the concept of cost mapping which is mainly COPQ mapping. COPQ analysis helps company to achieve business excellence in their respective fields and helps in benchmarking to become excel from their competitors.

**Key Words:** Benchmarking, Cost of quality, Cost of poor Quality (COPQ), Rework, Yield etc.

**Abbreviations:** COPQ- Cost of Poor Quality, TQM- Total Quality Management, NVAC- Non-value added cost, HRM-Hot Rolling Mill, ST- Shrouty/Tiwari.

## 1. INTRODUCTION

Every organization or manufacturing industry believes in giving the good quality of product or service to the customer. To achieve this objective the process from which product or services are going through should have consistency, so that customer satisfaction can be achieved. To supply the defect free material and consistency in product and services, organization should follow the good quality management system. There always a probability in an organization that quality demanded by customer and the production process used in an organization are not in a strategic fit. It is not easily acceptable that there is a cost involvement in manufacturing defective product; one must focus on all the processes to calculate the cost incurred by company for making bad quality product. An organization can increase its profit margin without capital investment just by decreasing the cost of poor quality. So, it is very important for an organization to calculate COPQ.

## 2. LITERATURE REVIEW

Total Quality Management (TQ, QM or TQM) and Six Sigma ( $6\sigma$ ) are sweeping "culture change" efforts to position a company for greater customer satisfaction, profitability and competitiveness. The total quality management concept has undergone many changes and developments ever since it has been evolved. The modification of TQM has produced Six Sigma. Quality states as the standard of something as measured against other things of a similar kind and the degree of excellence of something. COPQ is refinement concept of quality cost analysis. Harrington states that use of COPQ gives company tool for measuring the consequences of poor quality. COPQ was popularized by IBM quality expert H. James Harrington in his 1987 book Poor Quality Costs. Cost of Poor Quality includes all the failure cost associated with a product. If your system, product and process have no flaws then your COPQ is zero. [1]

Quality costs fall into four categories, which are:

- **Prevention costs:** You incur a prevention cost to keep a quality problem from occurring. It is the least expensive type of quality cost, and so is highly recommended. Prevention costs can include proper employee training in assembling products and statistical process control. A focus on prevention tends to reduce preventable scrap costs, because the scrap never occurs.
- **Appraisal costs:** We incur an appraisal cost to keep a quality problem from occurring through a variety of types of inspection. The best way to do it is by inspect both incoming and outgoing parts to and from their work stations. Other appraisal costs include the destruction of goods as part of the testing process, the depreciation of test equipment, and supervision of the testing staff.
- **Internal failure costs:** An internal failure cost comes in to picture when a defective product is produced. It comes out as a scrap and reworking product.
- **External failure costs:** It includes the cost of product recalls, warranty claims, field service. It is highly effective to any firm as it includes cost of losing customers. [2] All these costs help us to determine the level of quality in which one organization should work for minimum quality cost. These costs can be drawn graphically between quality cost per unit and quality level required.

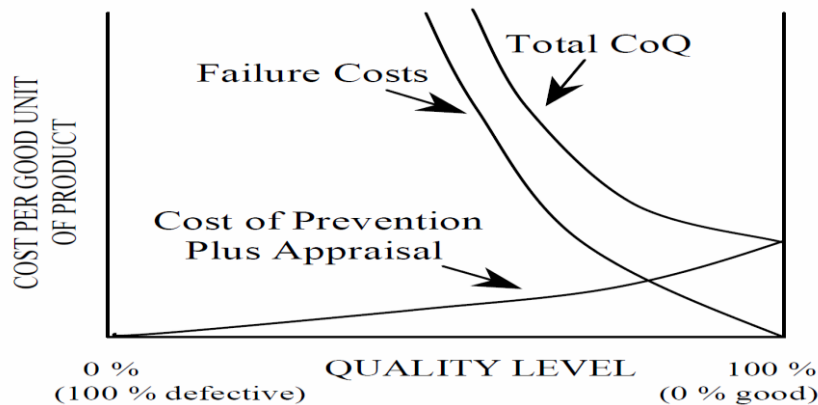
## 2.1 EVOLUTION

If you look at any one of the great standards in the world, look at The Toyota Way, the 6Sigma way, Jurans books, Demings ideas, Shingos great prize, Feigenbaum, Jurans quality modules you will come to a conclusion that from 1950's to current date there are so much researches happened in quality costs. Since this is a topic which hide in itself lot of improvements and optimization scopes. The researcher's contribution in quality cost is summarized in table below: [4]

**TABLE-1:** Evolution Of COPQ.

JURAN	1951	Discussed costs associated with poor quality and how it effects the company.
Feigenbaum	1998	He was the first to classify these costs into categories.
Bergman and Klefsjö	2010	They stated that poor-quality cost and quality costs are not good terms giving the impression that high quality costs, While it in fact is lack of poor quality that costs. They advised to use the term Cost of Poor Quality (COPQ) that will be used throughout this master thesis as a generic name for all costs associated with poor quality.
Sörqvist	2001	He defines COPQ as “the total losses caused by the products and processes of a company not being perfect”.
Harrington	1987	Defines CoPQ as “all the cost incurred to help the employee do the job right every time and cost of determining if the output is acceptable, plus any cost incurred by the company and the customer because the output did not meet Specifications and/or customer expectations”.
Krishnan	2006	Stated by Krishnan (2006) visible and invisible CoPQ can be visualized as an iceberg, where only a little amount of the costs can be seen and the rest is hidden under the water.
Gryna	1999	States that invisible COPQ is three or four times of visible costs. He has divided invisible COPQ into ten categories.

Fig1- Graphical Representation of Different Quality Costs [3]:



**2.2 SIGNIFICANCE:**

Graph tells us the optimum point where we get maximum quality and minimum cost in other words fully utilization of resources is possible at that condition. As quality level increases(X-axis) the failure cost will decrease and prevention and appraisal cost(Y-axis) will increase as these are cost incurred so that defect should not produce. The total cost curves tell us the quality level for minimum quality cost.

**2.3 QUALITY COST PARADOX:**

We know that quality costs divided into Invisible and Visible Category and further divided into Invisible and Visible Category and further classified to these four categories, Different researchers give importance to different costs. Some said prevention cost should not be under consideration, some says NVAC’s should be considered, in this paper author neglects both prevention and appraisal cost.

TABLE-2 Quality Cost Considerations by Researchers. [4]

Giakatis et. al. (2001)	Prevention losses are costs due to poor investments and prevention costs is investments for good quality. Appraisal costs are in order to maintain Accepted Quality Level.
Sörqvist (2001)	Exclude prevention costs because it is not considered to be costs as a result of poor quality.
Harrington (1987)	Non-value added costs should be included as a part of COPQ due to their major effect on the costs in an organization.
Modarress and Ansari (1987)	Over processing and will therefore be included in the waste costs category.

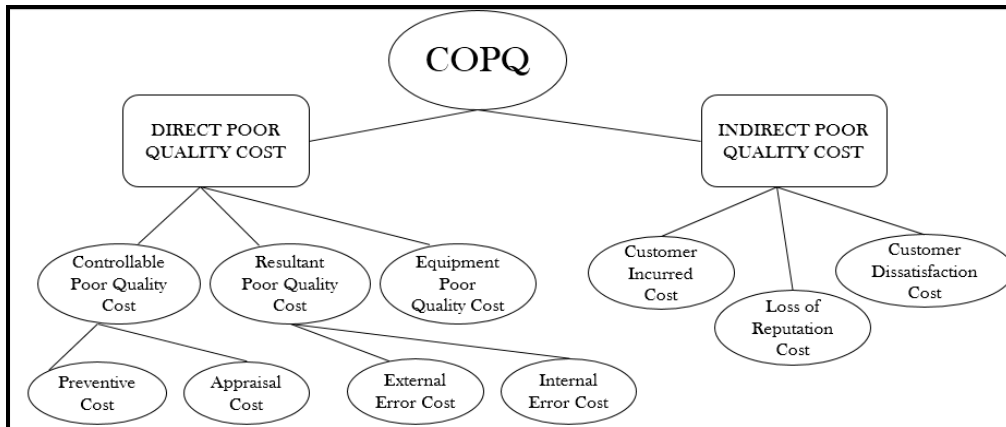
Fig.3-Visible and Invisible Costs Krishnan Iceberg Models [5]



2.4 CLASSIFICATION OF COPQ (HARRINGTON):

So many classifications are proposed for COPQ by Juran And De Feo (2010), Gryna (1999), Giakatis (2001), Modarress and Ansari (1987), Harrington (1999) depending on the cost they considered for calculation purpose. One of the classifications. of COPQ as given by Harrington is mentioned here for a reference

Fig.2- Classification of COPQ (Harrington) [1]



$$\text{COPQ} = \text{Costs (External failures + Internal failures + Appraisal + Preventive action)}$$

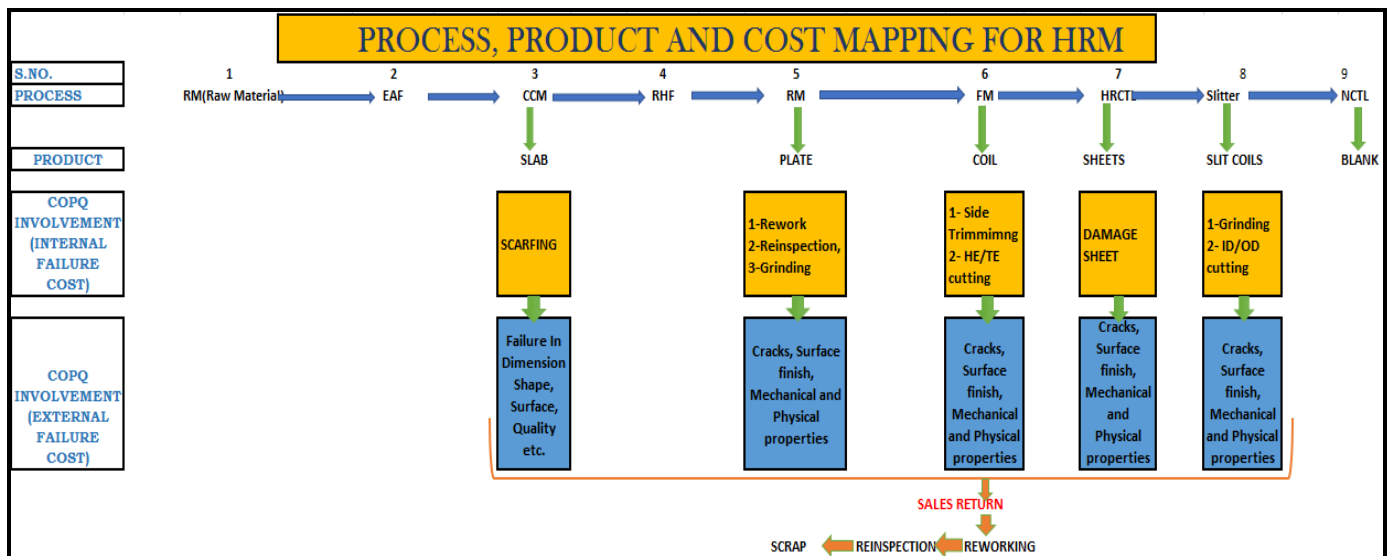
3. PROPOSED METHODOLOGY:

Author proposes the following Methodologies for Calculation of COPQ:

I] After analyzing the literature reviews we found that all researches are concentrating on mainly process and product mapping. Author wants to add Cost mapping so that all the details required for COPQ calculation can be clubbed together. **The example of Product Mapping, Process Mapping and Cost Mapping for HRM given below as excel template:**

II] Following below mentioned steps are proposed as guideline to carryout COPQ:

- 1) Formation of team includes persons from different department.
- 2) Brainstorming on various processes and product involve in manufacturing.
- 3) Note the outcome of brainstorming and analyze step wise.
- 4) Do process mapping of which COPQ to be calculated.
- 5) Do product mapping by specifying the state of product in each process.
- 6) Categorization of different costs involved in process.
- 7) Collection of data at various stages and even at the small processes which happens in processing material. Thorough study of data and calculation by addition of various non-value added cost.
- 8) Conclusion on COPQ.



### III] Least importance of Appraisal and Preventive cost:

During literature review it was found that all the literatures are categorization of Cost: mainly focused on following cost involve in calculation of COPQ-

- 1) Preventive Cost
- 2) Appraisal Cost
- 3) Internal Failure Cost
- 4) External Failure Cost

Author want to add here that that Preventive and Appraisal cost are not to be considered in calculation of COPQ, following reasons can be valid:

- 1) Preventive and Appraisal costs are basic requirement of product manufacturing. There is ambiguity in considering these costs because its already there in system, since COPQ calculation is next step after product manufacturing it may count as twice. Since every manufacturer or producer always want to make good quality of material so preventive and appraisal costs must be taken care off.
- 2) After only inspection and testing of material/product we can reach to a conclusion that material is pass or fail or rework is required or not, so appraisal cost is cost involved before down gradation not after. But if material gets failed in inspection and testing procedure than the cost incurred for rework should be included in cost of poor quality.

So, Formula for COPQ will be-

$$COPQ = (\text{Internal Failure Cost} + \text{External Failure})$$

**Modified Formula:** Above formula can also be written by considering scrap after Internal and External failures.

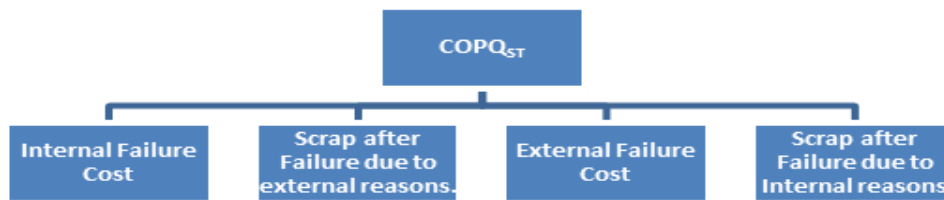
$$COPQ_{ST} =$$

$$(\text{Internal Failure Cost} + \text{Scrap after failure due to Internal reasons}) + \text{External Failure} + \text{Scrap after failure due to External reasons})$$

**TABLE-3:** Category of Internal and External Failure cost

Internal Failure Costs:						
Rework	Heat Treatment	Defective Products	Grinding	Welding	Installation Failure Cost	
External Failure Costs:						
Rework	Heat Treatment	Defective Products	Equipment Failure Loss	Grinding	Welding	Sales Return

**Fig- 4** Representation of Failure Costs



**4. CONCLUSION:**

Different research journal’s and reviews provided a good exposure to COPQ calculation for an organization, Author mainly proposed three main criteria for COPQ calculation, other than product and process mapping author included cost mapping so that data can be linked with process and product manufacturing specifically. Author also suggested that COPQ calculation can be completed without considering Preventive and Appraisal cost as these costs are basic requirements for manufacturing and operations. Author proposed nine steps as a guideline to carry out COPQ calculation. Author want to put, instead of capital investment in an organization one can increase its profit margin by decreasing its Cost of Poor Quality, therefore an organization must analyze it to be efficient.

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