Assessment of Cost of Poor Quality Using Knowledge based System

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Abstract:

The Purpose of this paper is intended to help the manufacturing plants monitor the 'Cost of Poor Quality' (COPQ) from SAP (Systems, Application and Products) - a knowledge based system without manual intervention for any calculation. The Cost of Poor Quality would help in analyzing the operating costs for effective and profitable business management. In the era of cut throat competition, successes achieved by market leaders are credited to their improvement initiatives. A common element within many of these successful companies is the use of more powerful cost of poor quality concepts in connecting improvement priorities to strategic objectives, assessing the financial impact of poor quality, understanding the root causes of poor quality, selecting high payback improvement projects and managing the improvement initiative to simultaneously deliver improved financial performance and greater customer satisfaction. The organizations have now realized that linking improvement initiatives to improved financial performance offers the means to build a sustainable competitive advantage through lower costs, increased productivity, greater customer satisfaction and greater sales. Cost of Quality (COQ) is the sum of the costs incurred by a company in preventing poor quality, the costs incurred to ensure and evaluate that the quality requirements are being met, and any other costs incurred as a result of poor quality being produced. Poor quality is defined as non-value added activities, waste, errors or failure to meet customer needs and requirements.

Research has shown that the COPQ is substantial, and often much larger than is shown in accounting reports. For most companies the quality-related cost range from 25 to 40 % of operating expenses. Every time work is not "First Time Right", the cost of quality increases. It is usually more expensive to correct errors than to "get it right the first time", but the latter requires an investment in quality, which, if done properly, is offset by cost savings because less errors occur further down the line. It is a matter of finding the right balance between investing in quality control and working in a cost-effective way. Cutting costs by blanket budget reductions, percentage points or targets usually reduces quality and thus increases the cost of poor quality, if no analysis is made of which factors contribute to good quality and which are hindrances. Poor quality products or service result in unhappy customers and service users. Calculating the cost of poor quality (in the sense of occurrence of deficiencies) allows an organization to determine the extent to which its resources are used for activities that exist only as the result of deficiencies in its processes. Having such information allows an organization to determine the potential savings to be gained by implementing process improvements

Key Words: COQ, PQC-COPQ , SAP-KBS

1. Introduction of COQ:

Cost of quality (COQ) or quality cost is based on tangible costs, which are recognized by the accounting system as expenses because they are based on actual transactions used in the production process. These costs constitute the widely used traditional prevention–appraisal–failure (PAF) model proposed by Feigenbaum. The concept of cost of quality (COQ) has been applied successfully in manufacturing companies and service businesses. Organizations that have instituted a system of quality cost measures have also experienced dramatic positive results. However, COQ has focused on in-house quality costs for an individual firm but not for an entire supply chain.COQ represents a powerful measurement system that translates the implications of poor quality, activities of a quality program, and quality improvement efforts into a monetary language for managers. Moreover, COQ is a language that every stakeholder can understand which is important because it affects operating costs, portability, and consumer need. Thus, it is crucial to extend COQ as an external mea- sure and integrate these costs into supply chain modeling.

Find that adding a known COQ function only for suppliers into the objective function gives a difference of approximately 16% in costs, and changes the solution. When COQ is not included, the

final optimal network will choose key suppliers who have the lowest operational costs, but there is no information in regard to the quality non-conformance cost. Therefore, the selected supplier may run at a high quality non-conformance cost, and receive the same preference that a supplier which operates at a lower quality non-conformance cost because both suppliers have the same production cost.

Thus, choices made solely on production cost could sacrifice quality and lead to additional quality non-conformance costs or corrective action costs in the next stages of the supply chain. Moreover, Campanella states that some managers think that investment in quality programs will always give the company a positive impact on profit and that ignoring quality is reall Y expensive.

Other managers believe it is uneconomical working at zero defects. The real problem begins when managers from different areas, supposedly working together, operate with conflicting perspectives on quality. Usually, once quality costs are obtained, these are used to find specific improvement projects; however, this is not an easy task and it is not clear what action should be taken nor what impact it may have on the quality cost model. Since the traditional cost model represents the hypothesized shape of quality costs and relationships, it can only serve to evaluate the distribution of quality cost categories with respect to total quality costs, sales, and profit.

Table 1: Quality Cost Areas :

Cost Area		Description	Examples
Costs of control (costs of conformance)	Prevention costs	Arise from efforts to keep defects from occurring at all	• Quality planning • Statistical process control • Investment in quality related information systems • Quality training and workforce development • Product-design verification • Systems development and management
	Appraisal costs	Arise from detecting defects via inspection, test, audit	• Test and inspection of purchased materials • Acceptance testing • Inspection • Testing • Checking labor • Setup for test /inspection • Test and inspection equipment • Quality audits
Costs of failure of control (Costs of nonconformance)	Internal failure costs	Arise from defects caught internally and dealt with by discarding or repairing the defective items	• Scrap • Rework • Material procurement costs
	External failure costs	Arise from defects that actually reach customers	• Complaints in warranty • Complaints out of warranty • Product service • Product liability • Product recall • Loss of reputation

2. Cost of Poor Quality:

The COPQ helps to leverage an organization's current investment in people; resources; tools and improvement philosophy into a competitive advantage by eliminating non-value add activities and waste. Cost of Quality is a measure of quality with financial dimension. The COPQ is the compilation of all expenses incurred by an organization to ensure Quality as well as all expenses a company is forced to incur as a result of failure to meet quality requirements. COPQ Considerations As stated earlier, the Cost of Poor Quality is the cost of non-conformance. The non
Conformance included in COPQ report is as below:
Scrap: >Line Spoilage >Machine Spoilage
The considerations in Rework are:
>Rework Date >Rework Cost >Concession >Segregation >Deviation >Rework Problem >Time Spent

However, the scope of this Knowledge based system is limited to External and Internal failure costs which are available in SAP System. The external failure costs are monitored through SAP - BW independently. The data on external failure cost in terms of CPU (cost per unit) /1000 is available in BW at Plant level. This system is intended to track and monitor the data related to internal failure costs. Internal failure cost comprises of Rework & Rejection of Product Unit (PU) only. No other cost like Re-inspection / Retesting, Overtime due to non-conforming product or service, travelling cost due to dealership visits, telephone bills for resolving customer complaints are not considered in Internal Failure Cost. Each Product Unit (PU) has to ensure proper data feeding in SAP & track actions on top 5 concerns of COPQ.

3. Who monitors COPQ?

The Cost of Poor Quality is monitored by the Quality Assurance (Manufacturing) of each Automotive Sector manufacturing plant. The input data must be entered in the system by the Plant Quality Assurance representative of the manufacturing cell. Input Data comprises of:

External Failure Costs in terms of Warranty Repair Costs and Internal Failure Costs :Rework , Line Throw Back , Scrap , User Plant Failure Costs.

4. Review of COPQ:

Cost of Poor Quality should be reviewed on monthly basis in by PU top management. The plant top management should review once in six months & this must be included as an agenda point in Plant Quality Management System review meeting.

5. Quality Cost System Bases:

For effective use of quality cost system ,it may be preferable to have more than one base. Usually for long range planning purposes, total quality costs as a percent of net sales is used.

The followings are typical indices that incorporate this feature:

- Internal failure costs as a percent of total production/service costs
- External failure costs as an average percent of net sales
- Procurement appraisal costs as a percent of total purchased material costs
- Operations appraisal costs as a percent of total production/service costs
- Total quality costs as a percent of production/service costs
- To help in the selection process of indices of cost of quality the following types available bases:
- A labor base : Total labor, Direct labor or Applied labor
- A cost base : Shop cost , Operating cost or Total material and labor
- A sales base: Net sales billed or sales value of finished goods or services
- A unit base: The number of units produced , the number of services performed or the volume of output

6. How COPQ Calculated?

Cost of Poor Quality is calculated by SAP by running the transaction ZMMCPQR which takes scrap and rework data entered by respective cell/module/PU. The correctness of the COPQ is entirely dependent on the proper entry of the scrap and rework data of both in-house as well as suppliers.

COPQ = IFC + EFC,
where;
Internal Failure Cost (IFC) = Scrap Costs + Rework Costs

External Failure Cost(EFC) = Returned Product Costs + Warranty Costs + Product Recall Costs.

Input Factors: M=Material Input, C=Machine Input, H=Human Input

Internal Failure cost = $M_{IF} + H_{IF} + C_{IF}$
External Failure cost = $M_{EF} + H_{EF} + C_{EF}$
COPQ for Material = $M_{IF} + M_{EF}$
COPQ for Machine = $C_{IF} + C_{EF}$

COPQ for company = $M_{IF} + M_{EF} + C_{IF} + C_{EF} + H_{IF} + H_{EF}$

7. Effective Quality cost program:

An effective quality cost program consists of the following steps:

- Establish a quality cost measurement system.
- Develop a suitable 1ongraflge trend analysis.
- Establish annual improvement goals for total quality costs.
- Develop short-range trend analysis with individual targets which collectively add up to the incremental demands of annual improvement goal.Monitor progress against each short-range target and take appropriate corrective action when targets are not being achieved.

8. Poor Quality Cost System Additional Benefits.

- Manageable entity & A single overview of quality.
- Means of measuring change & A problem prioritization system.
- Aligns quality and company goals & Brings quality into the board room.
- A way to correctly distribute controllable poor quality cost for maximum profit.
- Improves the effective use of recourses.
- Provides new emphasis on doing the job right every time.
- Helps to establish new product processes.& Provides a measure of improvement.
- The cost of poor quality gives companies the means to consistently quantify the financial impact of non-value added activities and waste. It is common for companies conducting a cost of poor quality assessment to discover the total cost of poor quality to range from 15 to 25 percent of sales.

9. Frame work of Quality Cost Program Implantation:

- Cost of quality program implantation requires an advocate and champion within the company. The champion of quality costs is ready to develop an overall plan and schedule for quality costs program implementation. The essential ingredients of the plan should include:
- The Management presentation, designed to identify the overall opportunity to show how the program will achieve its benefits and to accomplish management acceptance and support for the implementation plan and schedule.
- Conduct of the planned pilot program
- Education of all functions to develop awareness and interest in participation in the quality cost program
- Development of the internal quality cost accounting procedure
- Overall collection and analysis of quality cost data
- Quality cost reporting and use(integration with the quality management system and quality improvement)

10. Collecting and Reporting of quality Costs:

ISO 9004-1:1994 gives us three models for approaching quality costs and does not exclude others. Therefore adoptions or combinations of three are possible.

- Quality – Costing approach
- Process-cost approach
- Quality- loss approach

10.1 The Quality- Costing Approach: Quality-costing is the conventional approach of categorizing quality costs as prevention, appraisal, internal failure and external failure costs. In this approach those costs are excluded which are part of the normal operation of the plant or service. Ex: cost of lab our associated with making the product or delivering the service, cost of routine maintenance and repair, depreciation of equipment, carrying cost of inventory and so on. A quality cost program based on this conventional model will meet the guidelines recommended in this ISO standard.

10.2 The Process- Cost Approach: The process cost approach looks at costs a process rather than for a product or a profit center. In the process cost approach, costs of conformance and non conformance are defined as follows:

- **Costs of conformance:** The costs incurred to fulfill all the stated and implied needs of customers in the absence of failure
- **Cost of nonconformance:** The costs incurred due to failure of the existing process Cost of conformance costs to assure that only good product or service reaches the customer but excludes normal production costs or running a process. The process cost approach lumps together all costs incurred when a process is running with failure and calls them cost of conformance. Included are not only costs of assuring quality such as costs of prevention ;e.g. Process control but also costs of raw material, labor, energy, etc. Costs of nonconformance is the traditional cost incurred due to failure of the existing process , such as scrap and rework.

13.3 The Quality –Loss Approach:

The quality approach which we attempts to capture the intangible as well as the tangible costs or losses due to poor quality.The tangible losses are the commonly measured failure costs, such as scrap, rework and warranty costs. Intangible losses are the hidden failure costs such as lost due to customer dissatisfaction. This approach more realistic impact of further improvement may be apparent. The quality – costing approach is a proven means of tracking, guiding and motivating quality improvements. The other approaches are based on less experience but have their own advantages, particularly in situations in which it is desirable to include other TQM concerns, such as efficiency and customer satisfaction. The selection of the best approach ultimately will be based on maturity of quality efforts , type of organization or process and other TQM tools applied concurrently.

14. Process for Managing the "Economics of Quality":

ISO/TC 176 document recommends a process for managing the economics of quality which contains dual paths to measure the economic effects of a process.

14.1 One Path (Organization view) consists of the following steps:

- Identify the main activities within the selected process
- Identify, allocate and monitor costs at each step consistent with organization's existing financial system.
- Produce a process- cost report

14.2 The other path (the customer's view) consist of these steps:

- Identifying those causing customer dissatisfaction, customer satisfaction, and customer delight.
- Monitor customer satisfaction.
- Produce a customer satisfaction report.

14.3 The two paths then converge into the following single path:

- Conduct a management review
- Identify opportunities. These could be in correction or prevention of nonconformance, in continuous improvement, or in totally new processes or products to improve customer satisfaction.
- Plan & implement improvement.

15. Quality Cost System Bases:

For effective use of quality cost system ,it may be preferable to have more than one base. Usually for long range planning purposes, total quality costs as a percent of net sales is used.

15.1 The followings are typical indices that incorporate this feature:

- Internal failure costs as a percent of total production/service costs
- External failure costs as an average percent of net sales
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- Total quality costs as a percent of production/service costs

15.2 To help in the selection process of indices of cost of quality the following types available bases:

- A labor base : Total labor, Direct labor or Applied labor
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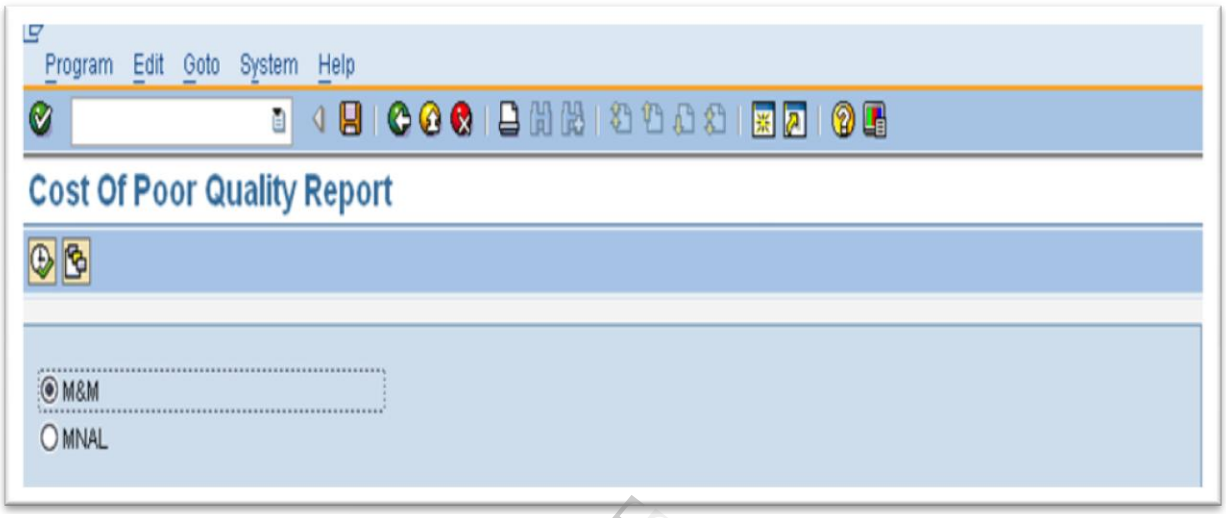
16. Why Use PQC:

Poor-quality cost provides a very useful tool to change the way management and employees think about errors. PQC helps by:

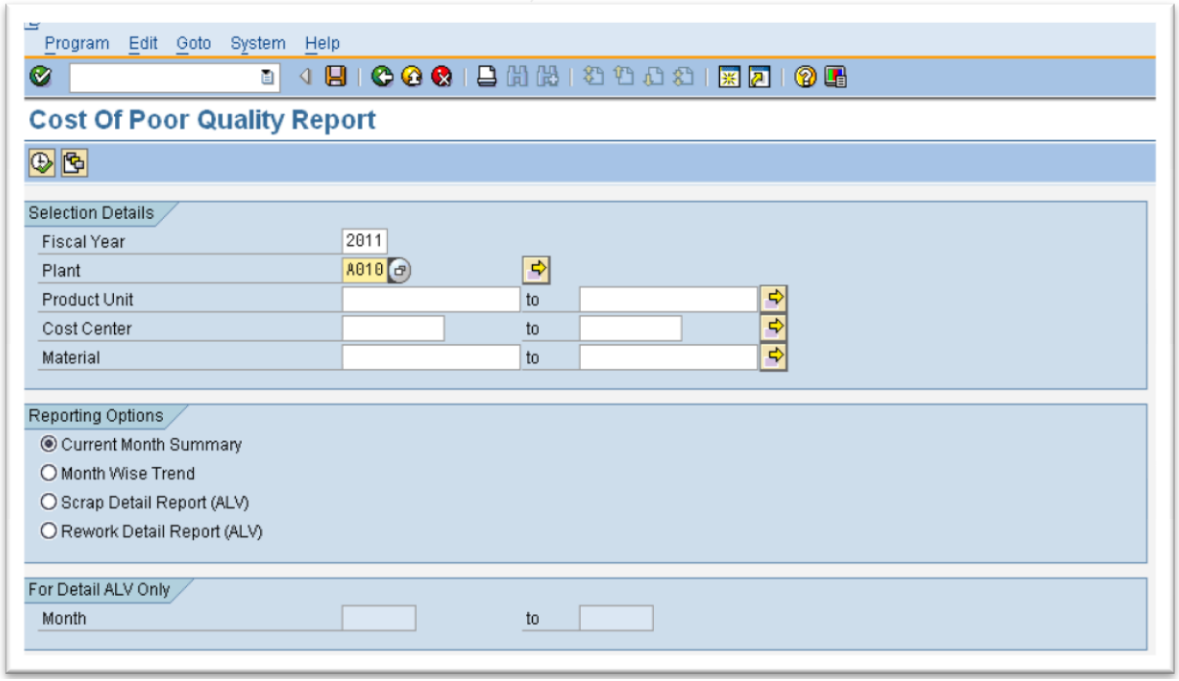
- Getting management attention— talking to management in dollars provides them with information that they relate to. It takes quality out of the abstract and makes it a reality that can effectively compete with cost and schedule.
- Changing the way the employee thinks about errors—when as a result of an employee's actions a defective gear is scrapped, there will be greater impact on his or her future performance. In one case, what is thrown away is only a piece of metal; in the other case, it's a $100 bill. Employees need to understand the cost of errors they make.
- Providing better return on the problem-solving efforts—poor-quality cost "Rs." problems so that corrective action can be directed at the solutions that will bring maximum return. Providing a means to measure the true impact of corrective action and changes made to improve the process—by focusing on poor-quality cost of the total process, sub-optimization can be eliminated.

17. Procedure for viewing the Cost of Poor Quality Report on SAP-Harmony

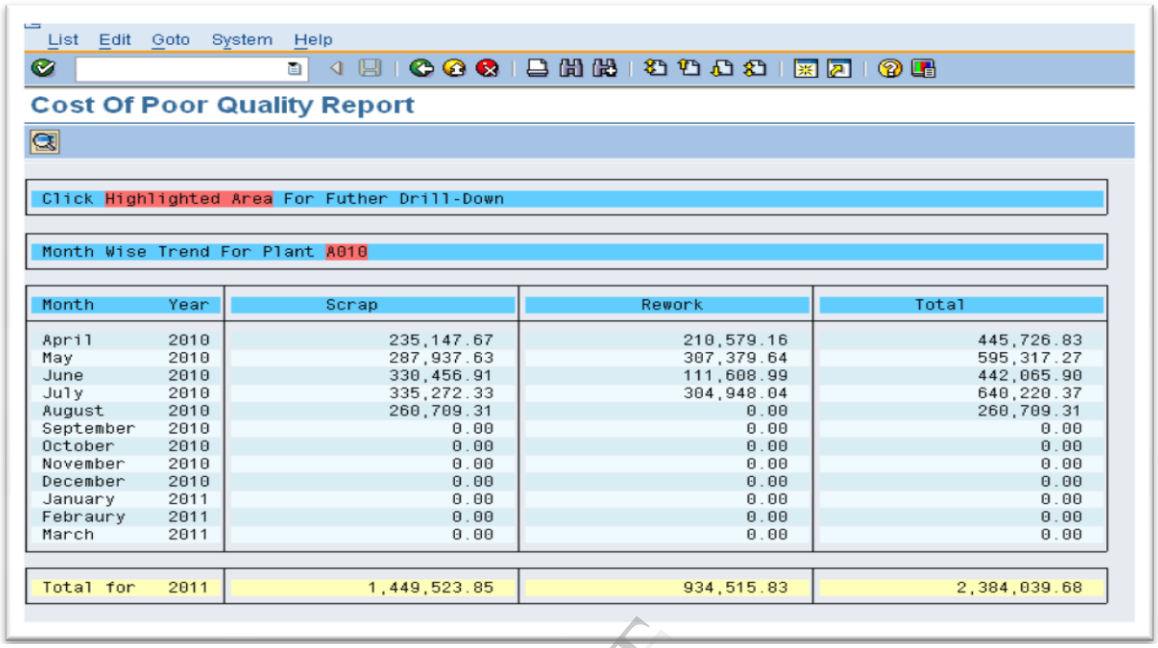
17.1 COPQ Report can be viewed for all the locations and is possible to drill down up to cost center level. Log in to the server from respective locations & Run the transaction "ZMMCPQR" (i.e. Cost of Poor Quality Report).



17.2 Front page shows following details:-
Selection Details: Fiscal Year, Plant, Product Unit, Cost Center, Material Code.
Reporting Details: Current Month Summary, Month Wise Trend, Scrap Detail Report & Rework Detail Report.
For Detail Report specific to Month e.g. scrap detail report or rework detail report to be viewed for specific month Below example shows Fiscal Year as 2011 and Plant as A010.



17.3 Report shows Cost of Poor Quality (in Rs.) per month in terms of scrap, rework and total. Below example shows month-wise trend for Plant A010 (Haridwar) up to July 2010. The report also has highlighted area for further drill down.



List Edit Goto System Help

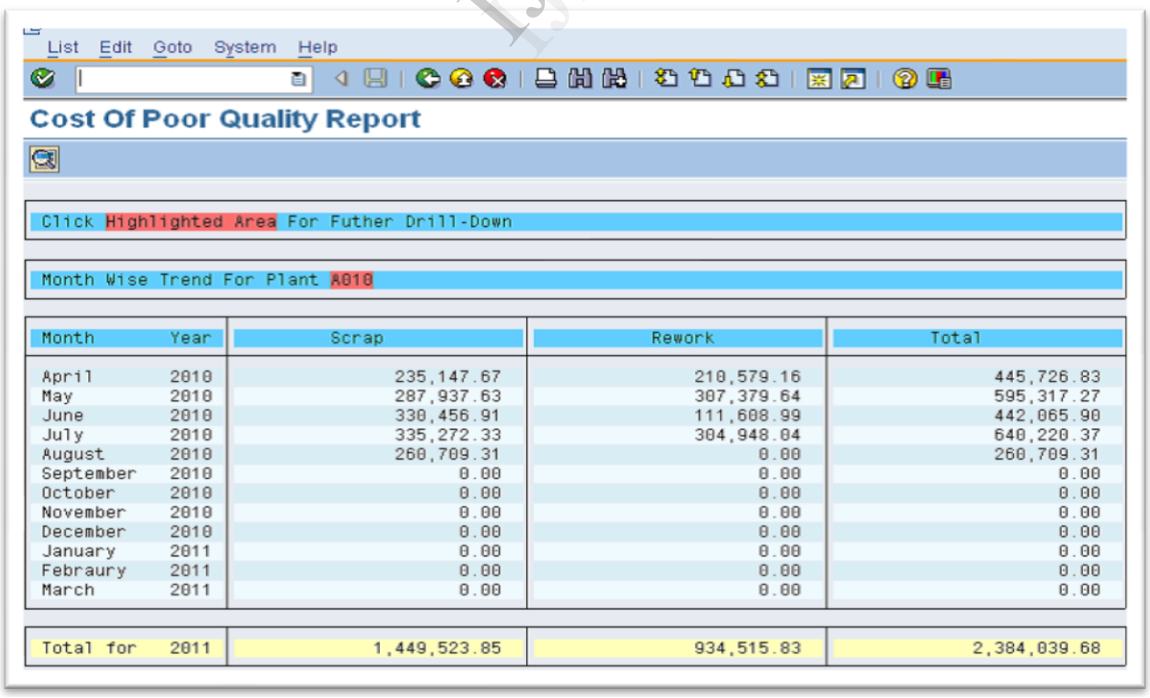
Cost Of Poor Quality Report

Click Highlighted Area For Futher Drill-Down

Month Wise Trend For Plant A010

Month	Year	Scrap	Rework	Total
April	2010	235,147.67	210,579.16	445,726.83
May	2010	287,937.63	307,379.64	595,317.27
June	2010	330,456.91	111,608.99	442,065.90
July	2010	335,272.33	304,948.04	640,220.37
August	2010	260,709.31	0.00	260,709.31
September	2010	0.00	0.00	0.00
October	2010	0.00	0.00	0.00
November	2010	0.00	0.00	0.00
December	2010	0.00	0.00	0.00
January	2011	0.00	0.00	0.00
Febraury	2011	0.00	0.00	0.00
March	2011	0.00	0.00	0.00
Total for	2011	1,449,523.85	934,515.83	2,384,039.68

17.4 Click on highlighted A010, to view, the month wise trend F11, PU wise. E.g. ALFA PU, Transaxle PU and so on…



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Total for	2011	1,449,523.85	934,515.83	2,384,039.68

List Edit Goto System Help

Cost Of Poor Quality Report

Click Highlighted Area For Futher Drill-Down

Month Wise Trend For Plant : A010 and P.U. : ALFA PU

Month	Year	Scrap	Rework	Total
April	2010	7,542.62	42,486.99	50,029.61
May	2010	14,915.57	98,004.73	112,920.30
June	2010	14,503.72	37,275.91	51,779.63
July	2010	16,372.43	304,948.04	321,320.47
August	2010	2,244.19	0.00	2,244.19
September	2010	0.00	0.00	0.00
October	2010	0.00	0.00	0.00
November	2010	0.00	0.00	0.00
December	2010	0.00	0.00	0.00
January	2011	0.00	0.00	0.00
Febraury	2011	0.00	0.00	0.00
March	2011	0.00	0.00	0.00
Total for	2011	55,578.53	482,715.67	538,294.20

Month Wise Trend For Plant : A010 and P.U. : TRANS. AXLE

Month	Year	Scrap	Rework	Total
April	2010	12,840.25	19,343.72	32,183.97
May	2010	1,248.65	0.00	1,248.65
June	2010	0.00	0.00	0.00
July	2010	7,258.97	0.00	7,258.97
August	2010	0.00	0.00	0.00
September	2010	0.00	0.00	0.00
October	2010	0.00	0.00	0.00
November	2010	0.00	0.00	0.00

17.5 Click on the highlighted area, to view the month wise trend of F11 for Plant A010 and P.U. Vehicle Assembly - UV for each cost center e. g. 772600 etc.

List Edit Goto System Help

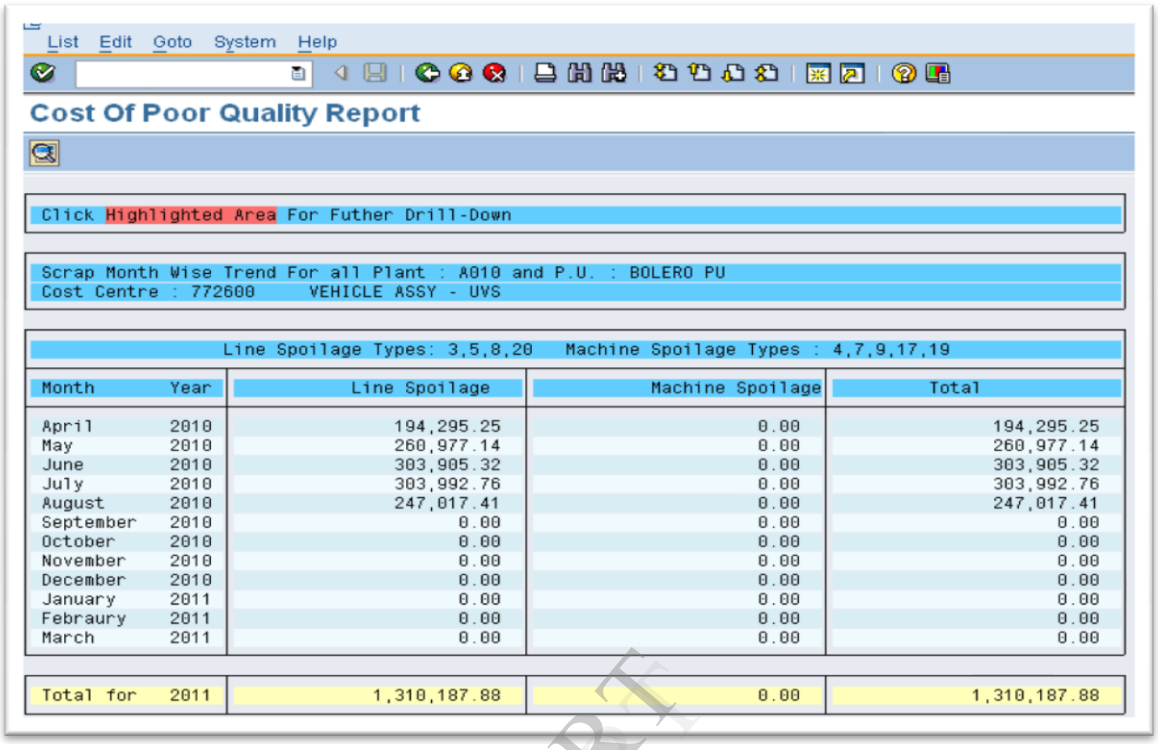
Cost Of Poor Quality Report

Click Highlighted Area For Futher Drill-Down

Month Wise Trend For Plant : A010 and P.U. : BOLERO PU
Cost Centre : 772600 VEHICLE ASSY - UVS

Month	Year	Scrap	Rework	Total
April	2010	194,295.25	148,500.73	342,795.98
May	2010	260,977.14	209,247.11	470,224.25
June	2010	303,905.32	74,284.94	378,190.26
July	2010	303,992.76	0.00	303,992.76
August	2010	247,017.41	0.00	247,017.41
September	2010	0.00	0.00	0.00
October	2010	0.00	0.00	0.00
November	2010	0.00	0.00	0.00
December	2010	0.00	0.00	0.00
January	2011	0.00	0.00	0.00
Febraury	2011	0.00	0.00	0.00
March	2011	0.00	0.00	0.00
Total for	2011	1,310,187.88	432,032.78	1,742,220.66

17.6 To view the month wise trend details related scrap for the cost centre 772600, click on any value under scrap column (i.e. in terms of line spoilage, machine spoilage types and their total cost)



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Cost Of Poor Quality Report

Click Highlighted Area For Futher Drill-Down

Scrap Month Wise Trend For all Plant : A010 and P.U. : BOLERO PU
Cost Centre : 772600 VEHICLE ASSY - UVS

Line Spoilage Types: 3,5,8,20 Machine Spoilage Types : 4,7,9,17,19

Month	Year	Line Spoilage	Machine Spoilage	Total
April	2010	194,295.25	0.00	194,295.25
May	2010	260,977.14	0.00	260,977.14
June	2010	303,905.32	0.00	303,905.32
July	2010	303,992.76	0.00	303,992.76
August	2010	247,017.41	0.00	247,017.41
September	2010	0.00	0.00	0.00
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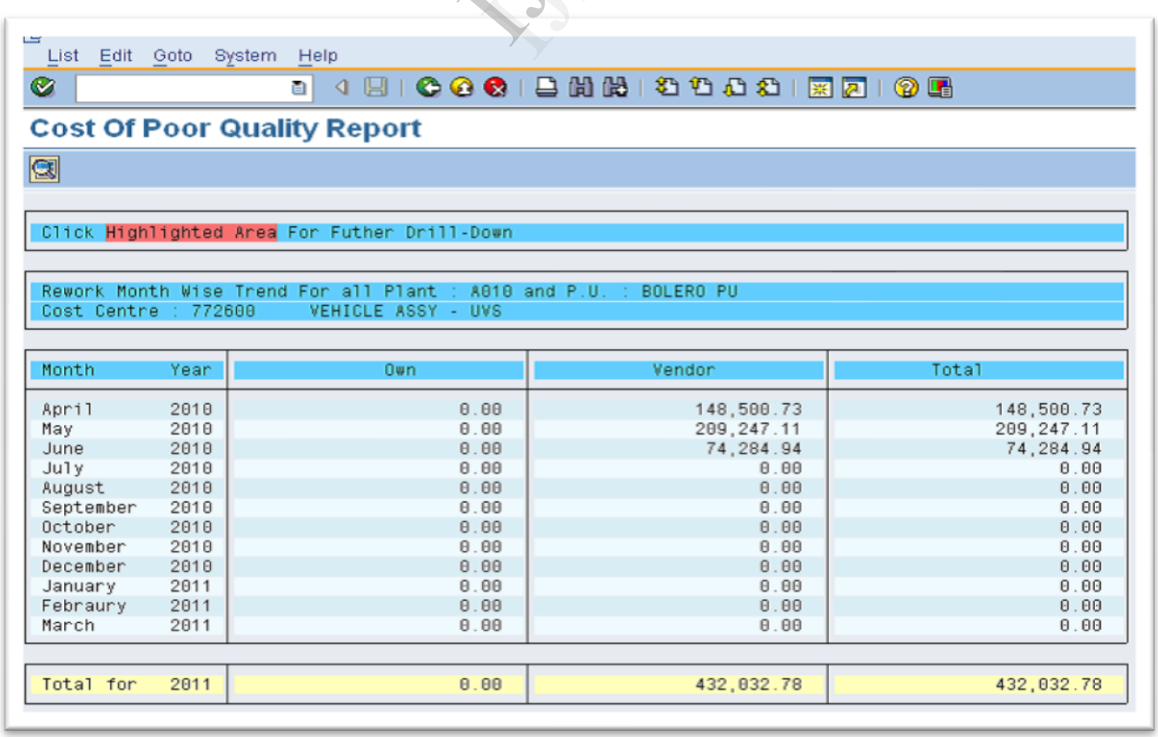
November	2010	0.00	0.00	0.00
December	2010	0.00	0.00	0.00
January	2011	0.00	0.00	0.00
Febraury	2011	0.00	0.00	0.00
March	2011	0.00	0.00	0.00
Total for	2011	1,310,187.88	0.00	1,310,187.88

17.7 To view the month wise trend details related rework for the same, click on any value under rework column (i.e. in terms of rework at Plant and rework at Vendor and their total cost)



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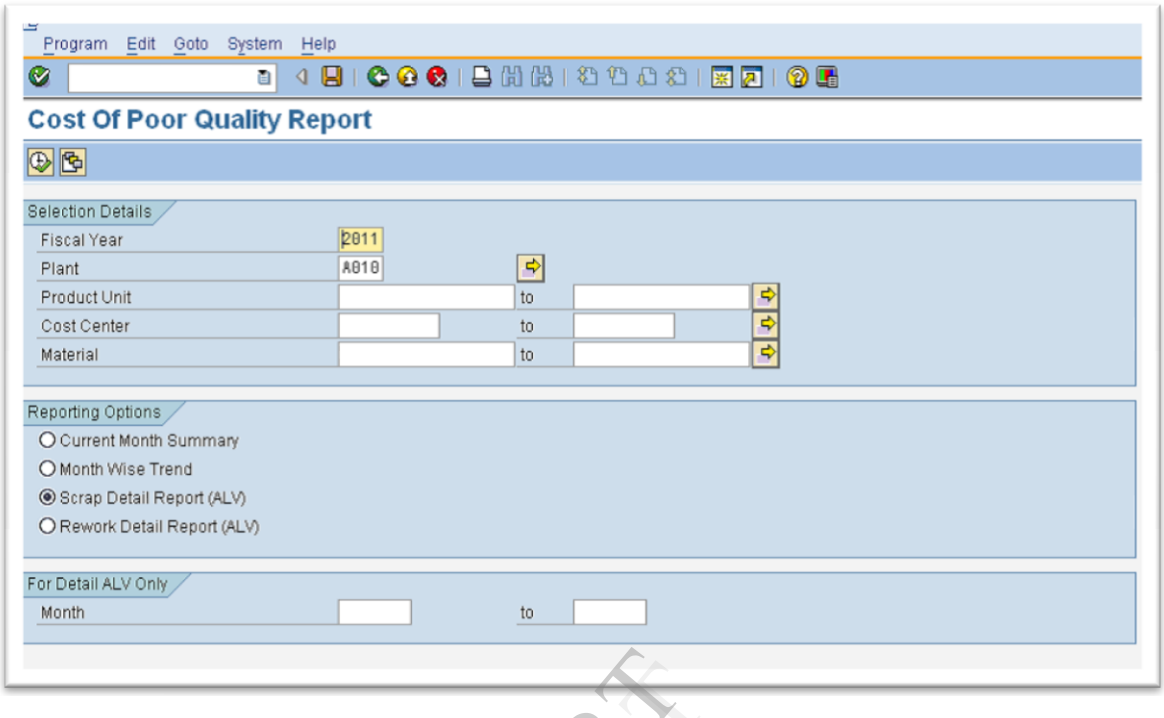
Cost Of Poor Quality Report

Click Highlighted Area For Futher Drill-Down

Rework Month Wise Trend For all Plant : A010 and P.U. : BOLERO PU
Cost Centre : 772600 VEHICLE ASSY - UVS

Month	Year	Own	Vendor	Total
April	2010	0.00	148,500.73	148,500.73
May	2010	0.00	209,247.11	209,247.11
June	2010	0.00	74,284.94	74,284.94
July	2010	0.00	0.00	0.00
August	2010	0.00	0.00	0.00
September	2010	0.00	0.00	0.00
October	2010	0.00	0.00	0.00
November	2010	0.00	0.00	0.00
December	2010	0.00	0.00	0.00
January	2011	0.00	0.00	0.00
Febraury	2011	0.00	0.00	0.00
March	2011	0.00	0.00	0.00
Total for	2011	0.00	432,032.78	432,032.78

17.8 To view scrap details for a specific month (e.g. April 2010); select suitable option in the main page of COPQ Report (the circle will get filled)



18. Conclusion:

18.1 The goal of any quality cost system is to facilitate quality improvement efforts that will lead to operating cost reduction opportunities. The strategy for using quality costs is quite simple:

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

18.2 The cost of poor quality assessment provides an opportunity for companies to

- Set the tone for the improvement process and projects that follow,
- Show its support for the improvement process by making resources available,
- Set a constructive attitude for uncovering and dealing with poor quality practices, and
- Demonstrate its commitment to the improvement process by encouraging and supporting timely identification and elimination of the root causes of poor quality.

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