Guideline

Quality Deficiency cost (QDC)

1. INTRODUCTION

The aim of this guideline is to define ***Quality Deficiency cost (QDC)*** and methods required to facilitate the application of QDC in Business Management System.

2. PURPOSE

The purpose of this guideline is to give guidance and examples for implementation of ***Quality Deficiency cost (QDC)*** in the organization to improve the efficiency and effectiveness of organization's processes. Other methods may be used to calculate the ***QDC*** as per the organizations requirements.

3. TERMS, DEFINITIONS, ABBREVIATIONS

For the purpose of this guideline in general, the terms, the definitions and abbreviations given in many international standards such as ISO/TS 22613 (IRIS), IATF 16949 and supporting standards of ISO 9001 apply.

QDC[1] : Additional costs resulting from nonconforming products, processes or equipment

Note 1 to entry: QDC can be distinguished by causer (e. g. sales, engineering, production, purchasing, project management) and on phase of occurrence (e. g. tender, design, production, post-delivery)

Note 2 to entry: QDC can include:

a) additional labor, material or other direct costs in the context of failure or change due to incorrect design and the resulting actions taken (e. g. rework, redesign, repurchase, special shipments);

b) costs due to downtimes;

c) costs of scrap;

d) costs of products rendered unusable by or oversupply of storage;

e) costs due to accepted third-party claims and costs due to claims not asserted by the organization against third parties;

f) costs due to penalties for default or delays

Note 3 to entry: QDC can also be called nonconformity costs

[1]ISO/TS 22163:2017

4. STANDARD REQUIREMENTS

6.1.3 Actions to address risks and opportunities — Supplemental[1]

The organization shall establish, implement and maintain a documented risk management process.

This process shall consider:

a) the requirements described in 6.1.1 and 6.1.2 ;

b) regular review and update of risks and actions ;

c) retention of documented information from risk assessments, reviews and actions.

NOTE 1 FMEA can be applied for managing risks in business planning, design and development, projects or production.

NOTE 2 FMECA can be applied for managing risks of critical functions or items (e.g. safety-related).

In addition, this process should:

i. involve customer and external providers in joint work on risk assessment and response ;

ii. require a multidisciplinary approach for risk reviews ; and

iii. evaluate its effectiveness based on ***QDCs.***

[1]ISO/TS 22163:2017

9.3.2.1 Management review inputs – supplemental[2]

Input to management review shall include:

a) ***cost of poor quality*** (cost of internal and external non-conformance);

[2]IATF 16949:2016

9.1 General[3] Resources support the operation of all processes in an organization and are critical for ensuring effective and efficient performance and its sustained success. The organization should determine and manage the resources needed for the achievement of its objectives, taking into account the associated risks and opportunities and their potential effects. Examples of key resources include: a) ***financial resources***;

[3]ISO 9004:2018 section - Financial resources

9.4 Technology[3] Top management should consider technological developments, both existing and emerging, that can have a significant impact on the organization's performance in processes related to product and service provision, marketing, competitive advantage, agility and interaction with interested parties. The organization should implement processes for detecting technological developments and innovations by considering:

a) the current levels, and emerging trends of technology, both within and external to the organization; b) the ***financial resources*** needed to adopt the technological changes, or to acquire another organization's technological capabilities, and the benefits of such changes;

[3]ISO 9004:2018 section - Financial resources

5. RESPOSIBILITY

- All employees of the organization are responsible to report QDC as per defined system.
- Process owner are responsible to analyse the *QDC* data and initiate the actions.
- Top management is responsible to review the projects and guide the process owners.

6. UNDERSTAND QDC

As the name suggest the literal meaning of Quality Deficiency cost (QDC) is, "*additional costs resulting from nonconforming products, processes or equipment"*. [1]

The additional cost is occurred whenever something is happening which was not planned, so cost occurred because of additional resources have to be applied in terms of 5 M.

In this article we shall try to understand terms Cost of Quality (COQ), Cost of poor quality (COPQ) and Quality Deficiency Cost (QDC).

Is QDC a Hidden Cost?

The QDC may be understated as "hidden costs", those occur in both manufacturing and service industries.

QDC may include:

1. Potential lost sales;

2. Costs of redesign of products due to poor quality;

3. Costs of changing processes due to inability to meet quality requirements for products.

4. Costs of software changes due to quality reasons.

5. Costs of downtime of equipment and systems including computer information systems.

6. Costs included in standards because history shows that a certain level of defects is inevitable and allowances should be included in standards:

> ***a.*** *Extra material purchased:* The purchasing buyer orders 6 % more than the production quantity needed.
>
> ***b.*** *Allowances for scrap and rework during production:* History shows that 3% is normal and accountants have built this into the cost standards. One accountant said, our scrap cost is zero. The production departments are able to stay within the 3% that we have added in the standard cost and therefore the scrap cost is zero."
>
> ***c.*** *Allowances in time standards for scrap and rework:* One manufacturer allows 9.6 % in the time standard for certain operations to cover scrap and rework.
>
> ***d.*** *Extra process equipment capacity:* One manufacturer plans for 5 % unscheduled downtime of equipment and provides extra equipment to cover the downtime. In such cases, the alarm signals ring only when the standard value is exceeded. Even when operating within those standards, however, the costs should be a part of the QDC. They represent opportunities for improvement.

7. Extra indirect costs due to defects and errors. Examples are space charges and inventory charges.

8. Scrap and errors not reported. One example is scrap that is never reported because of fear of reprisals, or scrap that is charged to a general ledger account without identification as scrap.

9. Cost of errors made in support operations, e.g., order filling, shipping, customer service and billing.

10. QDC within a supplier's company. Such costs are included in the purchase price.

These hidden costs can accumulate to a large amount, sometimes three or four times the reported failure cost. So it is very important to find, investigate and improve the systems to eliminate or reduce the hidden costs.

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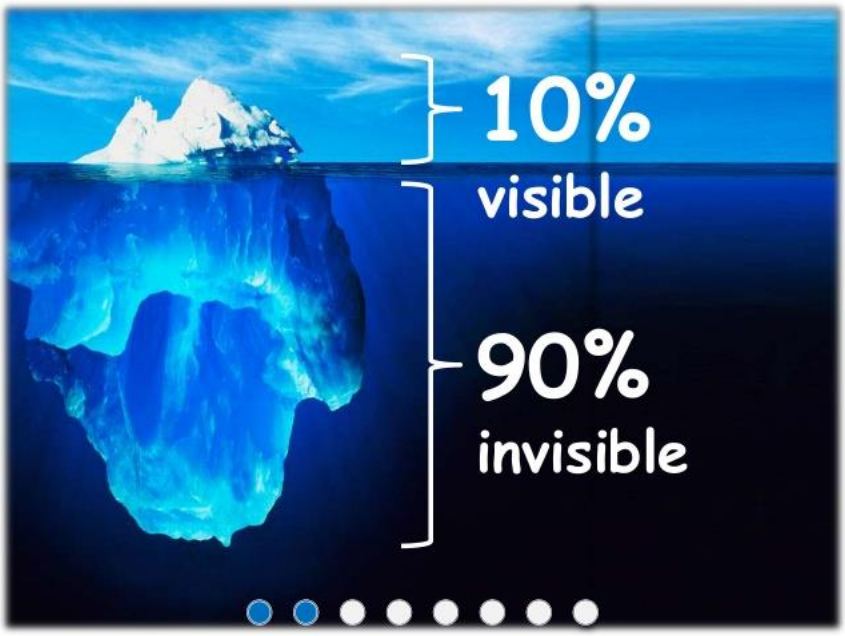


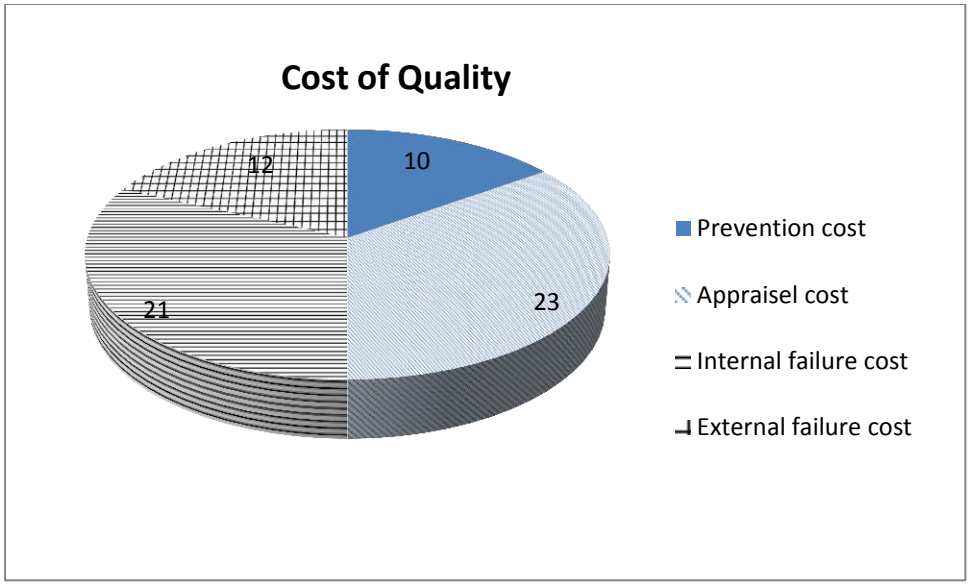
Why QDC is so important for an Organization to improve the effectiveness and efficiency of Business management system (effective QMS system should provide profit to the organization).

We can understand QDC is very important KPI to monitor; it is a barometer to understand overall organization's efficiency and effectiveness, but to understand this we need to understand cost of quality also-

7. COST OF QUALITY

Cost of Quality is bigger umbrella which includes cost of non-conformance i.e. QDC and cost of conformance.

1. Cost of conformance (cost incurred in finding, correcting and preventing defective work) and
2. Cost of non-conformance (cost incurred in non-conformity creation/ generation).



Above Chart is just to understand the concept of Cost of Quality

1. Cost of conformance- It is sum of costs of all the activities carried out to assure customer requirements (i.e. sum of Prevention cost and Appraisal cost). It is of two types

1.1 Prevention cost:

These are the costs incurred in keeping failure and appraisal costs to a minimum, or in other words to prevent defect/ failure from taking place, it includes-

- Cost of QHSE system including their audits
- FAI cost (to customer as well as from suppliers)
- Preventive and predictive maintenance cost of equipment
- Cost of training (internal and external)

1.2 Appraisal cost:

These are the cost incurred in conduction inspection and audits of the products at all stages of its processing in order to determine conformance to standards, these includes-

- Cost in quality control activities (e.g. verification of EPPPS supplied parts, in process quality gates, finish goods inspection)
- Calibration cost
- Cost of inspection equipment

2. Cost of non-conformance: (It is also called QDC) or Failure cost (sum of internal failure cost and external failure cost)

2.1 Internal Failure Costs:

These are the costs associated with defects that are found prior to transfer of the product to the customer - e.g.

- Scrap
- Rework
- Contribution loss of Cost of disassembled bearings
- Cost of disassembly process
- Cost incurred due to supplier material rejection

2.2 External Failure Costs

These are the costs associated with defects that are found after product is shipped to the customer.

- Cost incurred in customer complaints handling
- Late delivery charges
- Cost due to Customer Annoyance - Cost due to customer annoyance will be defined as per following criteria:
  - ☒ Any stoppage or reduction in existing share of business
  - ☒ Any stoppage on offer of new business of NPD.
  - ☒ Customer annoyance will be considered for any quality and design issues faced by customer.

Cost of Quality (or QDC) can be expressed in

- Values i.e. ₹, $, £, ¥, €
- % age of sales value

There is lot of debate how QDC should be expressed, in absolute value or % of some reference value (like production value, sales value). Then we should answer only one question, what is the purpose of calculating QDC, to reduce losses in money terms because of occurrence of non-conformities or just to remain happy with improved KPI.
Anything which resembles balance sheet approach or Profit and loss account approach (where we write assets (I say profit) on one side and liability (loss) on another side of the table) is correct method to describe cost of poor quality. No balance sheet is affected by %; it is affected by net absolute figure (total losses incurred in all the processes after converting into money). Top management of the organization and major stake holders (e.g. financial institutions, lenders, bankers) understand only one language i.e. money language and they are interested on ROI (return on investment) and organizational financial health.

As a consistent means to measure one aspect of the QDC, we count how many defective parts produced and multiply this number by a calculated dollar figure. The belief is that, for this aspect only, QDC rises and falls with the number of parts produced.

Another different method now being suggested is to not just count the number of defective parts, but also count how many parts are produced / sold. The thought is that it's more meaningful to know the *percentage* of line items that were declared as defective. This means that even if we are writing up more lines items, if it's a lower percentage of the total number of items ordered, it's good news.

The counterpoint is that this moves the focus to the wrong factor. While it's good that the percentage is going down, the costs incurred by having to write up more items is going up and that means *the COPQ for this aspect is going up*. To reduce this COPQ, the focus should be on reducing the *number of NCR's that have to be initiated* by eliminating the root cause of the NC's. This will take care of the percentage also.

8. EXAMPLES OF QDC IN LINE WITH DEFINITION OF QDC AS PER ISO/TS 22613

QDC can be distinguished by causer	sales,	Cost of customer acquisition (CAC) - CAC can be calculated by simply dividing all the costs spent on acquiring more customers (marketing expenses) by the number of customers acquired in the period the money was spent. For example, if a company spent $1050 on marketing in a year and acquired 100 customers in the same year, their CAC is $10.50 per customer. COPQ for CAC may address for those customers who are lost (e.g. 20 customers lost, then CAC for lost customers shall be 20*10.50 = $ 210.00) Cost of forecast - Wrong forecast may lead to undesired investments that may block the money for indefinite period. Thorough analysis of forecast process is essential before initiating investment decisions based on forecast projected by sales function. Make or buy decision may	Suggested KPIs can be- 1. CAC for lost customer 2. Forecast accuracy (e.g. ± 2%, more gap between forecast and actual may lead to two situations 1. Missing opportunities (when forecast is negative), 2. Leaving the resources idle (when forecast is positive).

		help before making some big investment based on future growth. Example- Organization has purchased a machine worth Rs 10 million, and its Break even period in 36 month, because of wrong forecast revised BEP period is say 60 months. What is QDC? Simplest manner that machine was supposed to deliver 10/3 = 3.3 million production to recover its cost, now it is delivering 10/5 = 2.0 million worth production, so QDC for each five years is 3.3-2.0 = 1.3 million. See such a huge cost which was never calculated. Customer defections - Profit margin on current revenue lost due to customers who switch for reasons of quality. An important example of this category is current contracts that are cancelled due to quality. The contribution of those contracts can be considered as QDC. New customers lost because of quality - Profit on potential customers lost because of poor quality. The contribution of those contracts can be considered as QDC.	
	Engineering (including Design),	Material procured / tool developed without confirming design robustness, as a result procured material is of no use and tool development cost go in vain. Additional labour, material or other direct costs in the context of failure or change due to incorrect design and the resulting actions taken (e. g.	Product development cost = Planned vs actual

		rework, redesign, repurchase, special shipments);	
	production,	Scrap, rework/ rectification, man power idle Stores - *Inventory shrinkage:* Loss due to the difference between actual and recorded inventory amounts.	
	purchasing,	wrong item, wrong quantity, items lying in the stock for more than one year, obsolete items (product as well as machine spares)	
	project management	penalties because of missing time lines i.e. costs due to penalties for default or delays, costs due to accepted third-party claims and costs due to claims not asserted by the organization against third parties;	
	On phase of occurrence (e. g. tender, design, production, post-delivery)	Tender - quoting lower rate than actual cost; tender rejected because of incomplete/ wrong information filled Post-delivery - Warranty failure Design - Changing design of one component without estimating the impact on other connected components	
QDC can include:	a) additional labor, material or other direct costs in the context of failure or change due to incorrect	1. Identify ECN which are generated as a part of Internal Design Failure; 2. The associated cost shall be tool modification cost, Obsolete material cost, man hour lost to redesign the product/ process. 3. Costs of changing processes due to inability to meet quality	

	design and the resulting actions taken (e. g. rework, redesign, repurchase, special shipments);	requirements for products. 4. Costs included in standards because history shows that a certain level of defects is inevitable and allowances should be included in standards: **a.** Extra material purchased: The purchasing buyer orders 6% more than the production quantity needed. **b.** Allowances for scrap and rework during production: History shows that 3% is "normal" and accountants have built this into the cost standards. One accountant said, our scrap cost is zero. The production departments are able to stay within the 3% that we have added in the standard cost and therefore the scrap cost is zero **c.** Allowances in time standards for scrap and rework: One manufacturer allows 9.6% in the time standard for certain operations to cover scrap and rework. **d.** Extra process equipment capacity: One manufacturer plans for 5% unscheduled downtime of equipment and provides extra equipment to cover the downtime. In such cases, the alarm signals ring only when the standard value is exceeded. Even when operating within those standards, however, the costs should be a part of the cost of poor quality. They represent opportunities for improvement.	

	b) costs due to downtimes;	Loss of capacity of equipment due to failures. = (down time / cycle time) X machine contribution e.g. down time is for 60 minutes, machine cycle time is 2 minutes, contribution per piece for that machine is say INR 1.05, so QDC shall be = (60/2)X1.05 = 30X1.05 = INR 31.50, This calculation helps to keep inventory of spares.	
	c) costs of scrap;	All sorts of scrap	
	d) costs of products rendered unusable by or oversupply of storage;	-Shelf life items became un usable - Product deteriorated in the store because of misplacement, rusty, damage. - Carrying cost (additional inventory actual cost * 12%). The 12% carrying cost includes space occupied in the store + money blocked.	
	e) costs due to accepted third-party claims and costs due to claims not asserted by the organization against third parties;	Third party claims cost	

	f) costs due to penalties for default or delays	Late delivery charges  If plant capacity (or more specifically the product for which late delivery charges are paid) is well below 90%, then something very serious w.r.t. production planning process.	
QDC can also be called nonconformity costs	nonconformity costs	Non conformity costs like (including non-conformity costs because of wrong decisions, biggest source of hidden cost): Like scrap, rework, issue of wrong purchase order, hiring a wrong employee for the organization etc.	

9. HOW TO MAKE BENEFITS FROM QDC OR COQ IN THE ORGANIZATION?

First of all make everyone understand in the organization, the purpose of calculations and potential benefits derived from the data.

ITS MAIN PURPOSE IS TO DIG OUT HIDDEN WASTAGES (COSTS) WHICH ARE NORMALLY MUCH HIGHER THAN VISIBLE COSTS; EXPLORE TO IMPROVE THE SYSTEM FROM BASIC (ROOT) BY ADOPTING VARIOUS TOOLS LIKE RISK AND OPPORTUNITY ASSESSMENT, SWOT ANALYSIS, FMEA AND ROOT CAUSE ANALYSIS USING PROBLEM SOLVING PROCESS.

Calculation method should not be too cumbersome and in no way it should put extra burden on the employees to collect and calculate the data.

10. RETURN ON QUALITY

Improvement requires an investment of resources, and the investment must be justified by the blossoming benefits of improvement, it can be called the comparison of benefits to investment the “return on quality (ROQ)”. Thus ROQ is really a return of investment (ROI) in the same sense as other investments such as equipment or an advertising program.

In the simplest manner suppose one QDC project require INR 1000 expense with an estimated saving of INR 500 is more worthy than a project which require INR 5000 investment with an estimated saving of 1000.

First case ROQ = 500/1000 = 0.5

Second case ROQ = 1000/5000 = 0.2

Using the expanded scope of cost of poor quality, the benefits of an improvement effort involve both reductions in cost and increases in sales revenue.

Some of the issues involved in estimating the benefits are-

Reduced cost of errors: Expected savings, of course, must be based on specific plans for improvement. Often, such plans have a goal of cutting these costs by 50% within 5 years, but such a potential benefit should not be assumed unless the problem areas for improvement have been explicitly identified and an action plan with resources has been developed

Improved process capability: Expected savings can come from a reduction in variability (of product characteristics or process characteristics) and other process losses such as redundant operations, sorting inspections, retrieving missing information, and other non-value added activities.

As with other benefits, these expected savings must be based on improvement plans.

Reduced customer defections: One early indicator of defections can be responses to the market research question, "Would you purchase this product again?"

Example: In a survey, 10.5 % of a sample of current customers of washing machines said they would not repurchase; the reason was dissatisfaction with the machine, not with the dealer or price.

At $50 profit per machine, the lost profit due to likely customer defections was then estimated.

Progress has been made in quantifying the benefits of an effort to reduce defections. The parameters include the economic effect of losing customers over the "customer life", the level of quality to retain present customers and the effect on retention of the quality of handling customer. The end result customer defections reduced drastically and main reason of defection was removed i.e. "dissatisfaction with the machine"

Increase in new customers: This is a most difficult benefit to quantify and predict. Quality improvements that make goods or services attractive to new customers will increase sales revenue but the amount and the timing depend on many internal actions and external market forces.

'*Note that as the cost of poor quality is reduced, additional resources become available to finance new features for the goods and services-without increasing the price'.* The result can be a dramatic increase in market share.

The investments required to achieve the benefits may include diagnosis and other forms of analysis, training, redesign of products and processes, testing and experimentation, and equipment. Many improvement projects require very low cost equipment or facilities. The investment is mainly in analysis work.

An issue in calculating an ROQ is the matter of assumptions and estimates. Both must be realistic for the ROQ to be viewed as credible.

The rate of return on an investment in quality activities translates into the ratio of average annual benefits to the initial investment.

$$\text{ROQ} = \frac{\text{Annual savings}}{\text{Investment}}\%$$

11. GAINING APPROVAL FOR THE QUALITY IMPROVEMENT PROGRAM

To initiate the Quality Improvement Projects, The resources must be justified by the expected benefits. For every hour spent to identify one of the vital few problems, we often spend 20 hours to diagnose and solve the problem.

To gain approval from upper management for a quality improvement effort, following steps is recommended-

1. Establish that the costs are large enough to justify action.

a. Use the grand total to demonstrate the need for quality improvement. Also, don't inflate the present costs by including debatable or borderline items.

b. Relate the grand total to business measures. Interpretation of the total is aided by relating total quality costs to other figures with which managers are familiar.

Two universal languages are spoken in the company.

- At the "bottom," the language is that of objects and deeds: output of 400 tons per week, rejection rates of 3.6%, completion of 9000 transactions per week.
- At the "top," the language is that of money: sales, profit, taxes, investment.

The middle managers and the technical specialists must be bilingual. They must be able to talk to the "bottom" in the language of objects and to the "top" in the language of money

c. Show the subtotals for the broad major groupings of quality costs, when these are available.

d. A helpful grouping is by the four categories discussed above under Categories of Quality Costs.

e. Typically, most of the quality costs are associated with failures, internal and external. The proper sequence is to reduce the failure costs first, not to start by reducing inspection costs. Then as the defect levels come down, we can follow through and cut the inspection costs as well.

2. Estimate the savings and other benefits:

a. Don't imply that the quality costs can be reduced to zero.

b. For any benefits that cannot be quantified as part of the return on quality, present these benefits as intangible factors to help justify the improvement program. Sometimes, benefits can be related to problems of high priority to upper management such as meeting delivery schedules, controlling capital expenditures, or reducing a delivery backlog. In a chemical company, a key factor in justifying an improvement program was the ability to reduce significantly a major capital expenditure to expand plant capacity. A large part of the cost of poor quality was due to having to rework 40% of the batches every year. The improvement effort was expected to reduce the rework from 40% to 10%, thus making available production capacity that was no longer needed for rework.

3. Calculate the return on investment resulting from improvement in quality. Where possible, this return should reflect savings in the traditional cost of poor quality, savings in process capability improvement, and increases in sales revenue due to a reduction in customer defections and increases in new customers.

4. Use a successful case history (a "bellwether" project) of quality improvement in the company to justify a broader program.

5. Identify the initial specific improvement projects. An important tool is the Pareto analysis which distinguishes between the "vital few" and the "useful many" elements of the cost of poor quality.

6. Propose the structure of the improvement program including organization, problem selection, training, review of progress, and schedule.

12. KEY SUMMARY

- QDC to be calculated in terms of money (e.g. $, €, ¥, ₹)
- ROQ is very important while identifying the project under QDC.
- Encourage everyone in the organization to report QDC; this shall help to free the resources for some more useful work.
- The top management should not use QDC to punish someone.

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