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A Case Study on Measurement Effectiveness

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Abstract: *Ensuring the measurement effectiveness of Cost of Quality (COQ) implementations presents steadily a practical managerial problem. Even though there are many approaches to measurement COQ, optimal methods for this purpose in real conditions often depend on confrontation and evaluation of different calculation models. The paper based on a case study describes a procedure for comparison between so called controllable costs and incurred cost of poor quality. Presented study confirms assumption of a propitious influence of preventive costs on an overall COQ and a change of structure of separate cost of quality items*

Keywords: *Cost of quality, Assessment approaches, Comparison, Controllable costs, Costs oF non-conformance*

1. INTRODUCTION

A measurement and evaluation of quality system is inherent component of introduced quality management system in a firm. It's not sufficient to use particular system, when the firm doesn't have the information about its economic yield. An effective monitoring and assessment is possible to implement by using the exact and regular evaluation system and cost of quality control. In a process of achieving higher quality the principle of the highest quality at the lowest price is applied. The lowest price is achievable by monitoring and managing the COQ during the entire order fulfillment process. The introduction of this system shows mainly improvement of processes by lowering losses caused by flaws. It also improves customer's satisfaction. Besides the external gains, this monitoring also helps to identify ineffective processes and therefore initiate activities for internal improvement of quality in a firm. In spite of mentioned evident effects, in many cases it is hard convince management of the need to track COQ (Pursglove and Dale, 1996). By Viger and Anandarajan (1999) only about half of the companies they studied calculated costs of quality. The aim of the article is to demonstrate existing methods of monitoring the costs of quality and on the particular case treats the approach to the solution of this current problem.

2. APPROACHES TO THE COQ CLASIFICATION

Cost of Quality, sometime also called Cost of Poor Quality - COPQ (Fargher and Morse, 1998; Juran and Godfrey, 1999) are defined by the EOQC dictionary (1989) as the complete costs related to low quality that were invested by a producer, consumer /end user and society. Crosby (1979) sees quality as "conformance to requirements", and therefore, defines the COQ as the sum of price of conformance and price of non-conformance. According to Bland et al. (1998) the cost of poor quality of an organization is the difference between the actual operating cost and what the operating cost would be if there no failures in its system and no mistakes by its staff.

Since each department in a firm has specific responsibility to fulfill quality requirements, then the COQ can arise in any phase of the process and in any department of the firm. Due to this reason it is appropriate to monitor COQ by departments individually.

There are several viable approaches that can be applied for monitoring the costs of quality. Feigenbaum in 1943 first devised a quality costing analysis when he and his team developed a dollar-based reporting system (Harrington, 2002).

A basic division, which is used in current practice, comes from two basic conceptions.

1. Classification of COQ by category
2. Classification of COQ by purpose

2.1. Classification of COQ by category

I: Direct COQ that are consisting from:

a) **Controllable COPQ**- their amount can be directly influenced by the management of the firm. Here belongs prevention cost and appraisal cost. Appraisal costs are comprehended as the total cost associated with all processes and procedures required for inspection. For this sort of costs applies: „if we increase prevention cost then we shall decrease overall cost caused by flaws" and so the total number of flaws is decreased. However direct proportion doesn't apply to appraisal cost because these costs don't have a direct influence on lowering the number of flaws. Only thing that changes is the mutual ratio between internal and external flaw costs. By investing into appraisal cost it is only possible to identify emerged flaws before they would penetrate to the customer or to the next operation. To ensure the quality are appraisal costs irreplaceable because the prevention is not always effective. By increasing the appraisal costs the precipitate cost will decrease because the flaws will be discovered even before the dispatch and the repair cost is lower than in the case when it is discovered by the customer.

b) **Incurred COPQ** –the amount of costs is influenced directly by manageable costs. They have two parts – internal and external failure cost. Internal failure cost is associated with defects found before the customer receives the product or service and external failure cost is associated with defects found after the customer receives the product or service.

c) **Conditioned COPQ** - they cover the costs for the equipment, which is required due to the low quality. These costs will not only cover the monitoring, testing and inspection devices but also the room required for devices. However, it's not necessary to monitor these costs distinctively. It is also possible to register them as items of prevention cost or appraisal cost.

II: Indirect COQ

a) **Life cycle cost (LCC)** it is the total cost of ownership of a product during its operational life including recycling. By Corrie and Atkins (1991) the life cycle cost of an asset is defined as 'the total cost of the asset over its operating life, including initial acquisition costs and subsequent running costs'.

b) **Cost due to customer's dissatisfaction**

c) **Cost due to loss of goodwill**

III: Society's cost due to environmental externalities

These costs belong to the least examined group of COQ. They can be defined as „ total firm's expenses to eliminate the loss caused by not meeting the ecological standards of products, processes and services. Here belong groups of costs, which are more or less covered by taxpayers. However firms have no interest in

monitoring the above mentioned costs nowadays. It is obviously not reasonable, because the knowledge of the amount of cost and the source of its origin could enable preventive actions. Such actions could negate the influence on the environment and in the end it could all become one of the next competitive tools of the firm.

2.2 Classification of COQ by purpose

All categories of costs in individual activities are registered by this classification. This means, that in each monitored activity prevention cost, appraisal cost and failure internal and external cost are being calculated.

3. APPROACHES TO THE COQ ASSESSMENT

3.1 Traditional approach to the COQ assessment

It is a classical method of register and evaluation of COQ and this are divided into costs which emerged from internal operating activities and external operating activities. Individual cost items for internal operating activities are then analyzed by PAF model (prevention,appraisal, failure).

The basic reasoning with the PFA model of assessment the costs of quality is that the prevention and appraisal costs are considered as cost saving investments and failure cost is considered as losses. This approach divides all expense items linked with quality into four basic groups, while no expense item is one-sidedly preferred.

Prevention: Efforts to determine customer requirements and to ensure that those requirements are met.

Appraisal: Efforts to check whether the requirements are met before the service or product reaches the customer.

Internal Failure: Rework before a service or product is provided to the customer.

External Failure: Rework after the product or service reaches the customer because requirements were not met.

Using this approach to assessment the quality costs should not only provide an overview about the adequacy of its expenditure, but mainly it should enable its management so the highest efficiency of process could be reached.

3.2 Process approach to the COQ assessment

This approach is appropriate for organizations with a stabilized system of quality management and acquired method of management based on a principle of system and process approach. Consequently it is a higher degree of QOC assessment, which complies with TQM concept.

COQ assessment using the process approach has been successfully designed and implemented within many companies. Goulden and Rawlins (1995) for instance describe a hybrid process model, which uses flowcharts. These were found to be most effective process modeling tools as they facilitated understanding and better interdepartmental communication.

In this approach are the costs divided basically in two main groups. These are:

a) COC (Cost of conformance) – costs that are necessary for ensuring the quality, thus the costs of products and services which will ensure requirements of standards for a given process by an effective method.

b) NCOC (Cost of nonconformance)- are the costs of wasted time, material and capacity related to the formation of nonconformance inside of the process.

Therefore the process cost is given by the sum of COC and NCOC. This approach is based on the idea that each person in an organization contributes to a process and that is why each process should have one identified owner who would be responsible for quality and efficiency. However it doesn't only concern the people who influence the process. Among further factors, which play an important role in the process are equipment, materials, environment which exist in this environment. Each of these factors needs further identification. This identification would distinguish COQ from NCOQ.

Deming (1982) emphasized that the cost of non-conformance and the resulting loss of good will was so high that evaluating COQ

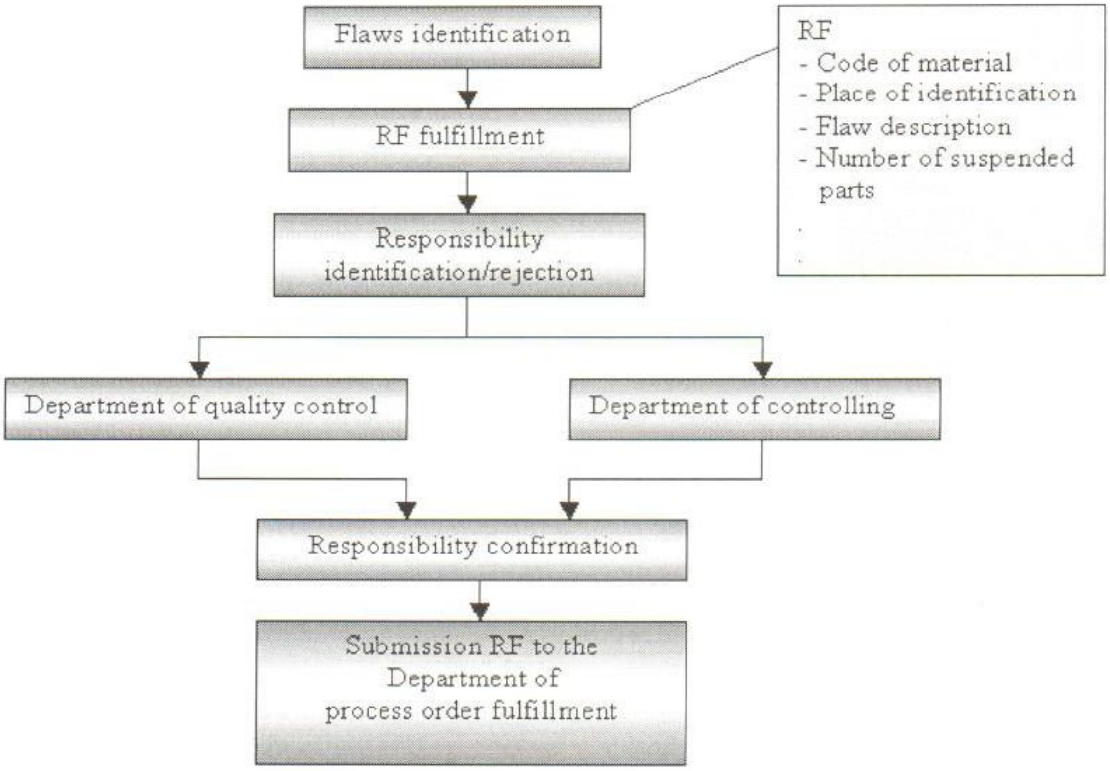

Figure 1 Algorithm of RF management

was unnecessary. He saw absolutely no value in financial measures related to quality.

3.3 Approach to the COQ assessment based on assessment of NCOC

This approach focuses on internal and external losses caused by a poor quality and identifies material and nonmaterial sorts of losses. The abstract notion - external nonmaterial losses are for example the losses related to a future sale caused by customer's dissatisfaction. Then one of the typical internal nonmaterial losses can be for example: lowered productivity of labor caused by inappropriate ergonomics, reworking and so on. Besides the direct costs this approach takes also into account particular items of indirect cost.

3.4 Approach to the COQ assessment in automotive industry

This approach can be in a simple form generalized by the following relation for the calculation of total cost of quality costs, which is mainly applied in quality management system by the standard QS 9000.

Preventive cost + Appraisal cost + Internal failure cost + External failure cost – External recalculation = Total COQ

4. FIGURE 5 CASE STUDY ON COQ MEASUREMENT AND ASSESSMENT IN AUTOMOTIVE INDUSTRY

In a firm where the study was conducted are ordinarily quality costs measured and evaluated in regular monthly reports or annual reports with the aim of their optimal control and further reduction. The cost of quality separately on specific analytical accounts by the place of origin on individual cost centers by individual cost sorts is monitored. In a given firm applies the following categorization of quality costs:
Prevention cost. It is cost that are caused by

monthly work output of section of quality – thus cost of process quality control, cost of input material inspection, cost quality planning, cost of auditing organization, cost of measurement instruments and devices calibration, cost of department quality staff, cost of amortization material and nonmaterial investment needed for quality insurance.

have to be performed only by firm's staff but also by some outside firm. Recalculation of costs is done by the following method. Department of controlling then puts a requirement for issuing an invoice and subsequent recalculation of resulted costs. Thus recalculated costs are monitored as the only one profitable item in a framework of quality costs in a firm. The section of input

Table 1.

Cost category	Jan.	Feb.	March	April	May	June	Average
Prevention cost	0.76 %	0.81%	0.37%	2.34%	0.76%	0.62%	0.94%
Appraisal cost	0.52%	0.54%	0.41%	0.41%	0.34%	0.40%	0.44%
Internal failure cost	2.66%	1.08%	0.80%	2.08%	-2.26%	-0.13%	0.71%
External failure cost	0.03%	0.02%	2.32%	0.14%	0.00%	0.16%	0.45%
Total COQ	3.97%	2.45%	3.90%	4.97%	-1.16%	1.05%	2.53%
Specified limit	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%

Part of these costs also are the salary costs of maintenance staff where the base of this cost is information about the average number of workers operating preventive maintenance in a firm. Theoretically the costs related to evaluation of suppliers also belong to this group.

Appraisal cost. In the framework of this item the costs of staff operating production, final or additional trials are monitored. It includes also the other related cost of testing and measuring tools, which are used for this purpose.

Internal failure cost. To monitor these costs a firm use a Report Form (RF) about suspending of parts and increased costs. It is a form, which is filled in when there is a need to carry out unintended work due to the occurrence of flaws in production. The document exactly describes whether it was possible to do the repair on suspended parts. If the erroneous parts were suspended and their further use is not possible then they will be liquidated. Scheme of management of the document RF is displayed on Figure 1.

External failure cost. Here belong travel costs, accommodation costs, and other cost related to disposal of deficiencies. The Department of controlling evaluates them monthly or at the end of an action. External repairs however don't control mainly monitors credential complaints addressed to firm suppliers or flaws created by insufficient / late awareness of desired customer changes.

Overall cost of quality. They are made of a sum of all above mentioned items however from this sum the figure of external recalculated costs of quality needs to be subtracted. From these total costs of quality are then individually monitored single items of cost sorts related to the relevant financial income of firm. In the following Table 1 are displayed actual figures in the chosen monitored period of time.

The first half of calendar year is in this case the monitored period. During the evaluation of these items is monitored period always one calendar month and the real summary is realized in one trade year. On the basis of mentioned figures it is possible to observe that in a firm are the biggest costs in this area related to the prevention costs, then to the internal failure cost, and the lowest percentage belong to appraisal cost and external failure cost evenly. A conclusion from the one-year study was that the evolution of figures changes depending on actual conditions in a firm. However obtained figures based on this approach of cost measurement didn't allow analyzing relevant correlations.

Table 2.

Cost category	Jan	Feb	Mar	Apr	May	Jun	Suma
Prevention cost	51,969	55,211	31,959	162,871	54,992	46,032	403,034
Appraisal cost	35,508	37,302	34,902	28,296	24,696	29,496	190,200
Controllable COQ	87,477	92,513	66,861	191,167	79,688	75,528	**593,234**
Internal failure cost	180,806	74,334	67,736	144,829	-163,784	-9,434	294,487
External failure Cost	1,800	1,194	196,705	9,979	0	11,694	221,372
Occurred COQ	182,606	75,528	264,441	154,808	163,784	2,260	**515,859**
Total cost of quality	270,083	168,041	331,302	345,975	-84,096	77,788	1,109,093
Company income	6,800,674	6,852,765	8,490,917	6,961,597	7,246,235	7,401,714	43,753,902

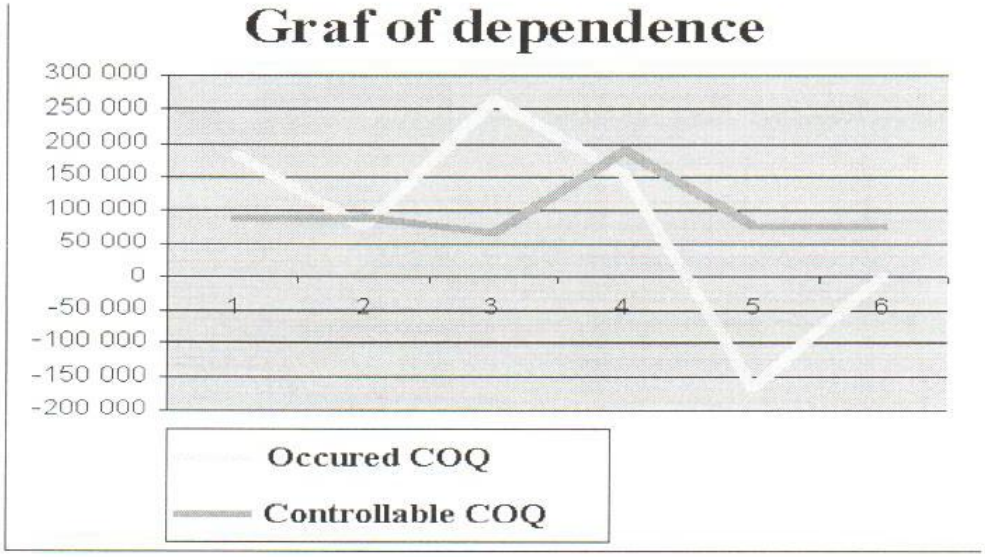

Figure 2 Dependence of Occurred COQ on Controllable COQ

Rather interesting is the evolution in the month of May when the quality of cost figures were reaching minus figures due to the minus item of costs before the dispatching from the factory. This situation is a result of extremely high recalculation of COQ on external originator of caused flaw. This minus item of ost represents in this case profit of company.

Innovative method of measurement and evaluation of COQ

By using above described method of monitoring the cost of quality in a firm it is only possible to evaluate the absolute amount of single cost items, or their proportional rate on relevant income of the firm.

According to innovative method of measurement and evaluation of COQ it is considered efficient to sort single costs into two

groups (Falisová and Modrák, 2004):

- Controllable COQ
- Occurred COQ.

Controllable COQ is regarded as the sum of prevention costs and appraisal cost and Occurred COQ is regarded as the sum of internal failure cost and external failure cost. By this sorting (see Table 2) and the following graph (Figure 2) it is possible to monitor mutual dependence of Occurred COQ on Controllable COQ.

5. DISCUSSION AND CONCLUSION

The cost and the quality mutually correlate while the general effort is to lower cost to the minimal rate and to increase quality to the desired level. Simultaneously it is known that between the quality of a product and the cost required to fulfill its quality should exist certain balance because it was proved that investing in quality improvement is more profitable than expanding the production. This claim is valid only when investment for the quality improvement won't exceed the amount of anticipated financial effect, which is supposed to be reached by this investment.

Presented study by innovative method of measurement and evaluation of COQ confirmed the know assumption of a propitious influence of preventive costs on an overall COQ and a change of structure of separate cost of quality items.

In specific circumstances it creates a condition for a possible strategy of COQ management, while the solution indicates generic signs for their use in similar applications.

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