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COST OF QUALITY IN HEALTH CARE: A CASE STUDY IN CLINICAL LABORATORY

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Abstract: In today's environment, many laboratories are challenged to maintain or increase their quality while simultaneously lowering their overall costs. The objective of this research is to use the Cost of Quality (COQ) model to estimate the Cost of Quality-related activities at Clinical Laboratory located in Morocco. Using data collected during six month, we allocated the direct costs associated with quality-related activities in the laboratory across COQ's cost categories: prevention, appraisal, internal failures, and external failures. We found that approximately 83% of total cost of quality was spent on costs of "good quality" (prevention and appraisal), while 17% was spent on costs of "poor quality" (internal and external failures). The high percentage of cost of quality spent on prevention and appraisal activities is consistent with efforts to ensure high quality laboratory results. The paper introduces the COQ model and illustrates how it can be applied to a clinical laboratory setting. We begin with an overview of the COQ concept and its four main cost categories, followed by an illustration of how the model can be applied. We then discuss some of advantages of this methodology.
Keywords: cost of Quality, appraisal cost, prevention cost, failure cost, clinical laboratory

1. INTRODUCTION

Many companies promote quality as the central customer value and consider it to be a critical success factor for achieving competitiveness. Any serious attempt to improve quality must take into account the costs associated with achieving quality since the objective of continuous improvement programs is not only to meet customer requirements, but also to do it at the lowest cost. This can only happen by reducing the costs needed to achieve quality, and the reduction of these costs is only possible if they are identified and measured. Therefore, measuring and reporting the Cost of Quality COQ) should be considered an important issue for managers.

There is no general agreement on a single broad definition of quality costs [1]. However, COQ is usually understood as the sum of conformance plus non-conformance costs. Cost of conformance is the price paid for prevention of poor quality (inspection and quality appraisal). Cost of non-conformance is the cost of poor quality caused by product and service failure (rework and returns). According to Plunkett and Dale [2], it is now widely accepted that quality costs are the cost incurred in the design, implementation, operation and maintenance of a quality management system, the cost of resources committed to continuous improvement, the cost of system, product and service failures, and all other necessary costs and non-value added activities required to achieve a quality product or service.

Quality experts have different opinions on measuring COQ. Edward Deming, perhaps the best-known advocate of quality management, believed that the cost of non-conformance (and the resulting loss of good will) was so high that evaluating Cost of Quality was unnecessary. He saw absolutely no value in financial measures related to quality. While for Deming measuring COQ was a waste of time, Joseph Juran and Philip Crosby saw a need for it. They believed that as defect prevention was increased, the cost of rework would decrease by much more than the increase in prevention costs. The net result was lower total cost, and thus "quality is free" [3].

COQ analysis links improvement actions with associated costs and customer expectations, and this is seen as the coupling of reduced costs and increased benefits for quality improvement. Expenditures on improvement and prevention activities are considered as a form of investment, which should bring reduced failure costs. Time and money may be wasted on prevention activities that do not bring appropriate improvement. Deming may believe that the proper objective is to have zero defects. However, for some it may be uneconomical to have a high level of quality; they assume that absolute quality must be sacrificed to achieve other objectives, for example, reduced development cycle time. Therefore, a realistic estimate of COQ and improvement

benefits, the correct trade off between the level of conformance and non-conformance costs, should be considered an essential element of any quality initiative, and thus, a crucial issue for any manager.

We begin with an overview of the COQ concept and its 4 main cost categories, followed by an illustration of how the model of COQ can be applied in a clinical laboratory setting. Finally, we discuss some of the advantages of this methodology.

2. COST OF QUALITY

A failure to meet an expectation of the physician or patient is a failure to conform to their requirements. Crosby [3] defines quality as "conformance to requirements" and says this definition is necessary to allow us to measure quality. Costs of quality result from non conformance and include the costs of all activities intended to enable conformance to requirements as defined by the physician or patient. Conformance must be achieved the first time at each step in the value stream or else costs of quality begin to accrue. Prevention, appraisal, and failure are the elements of the Cost of Quality. (Table 1) [4].

Table 1 . Quality cost categories, definitions, and elements

Types of cost		Description	Elements
Prevention Cost		Result from activities that keep defects from ever occurring.	– Planning for quality, – Quality improvement team meetings, – Quality education and training,
Appraisal Cost		Result of activities that are designed to identify deficiencies at any point along the value stream and maintain high quality levels.	– Auditing products, processes, or services; – Calibrating measuring and test equipment; – Validating instruments.
Failure Cost	Internal failure costs	Accumulated as defects are found and corrected before results are delivered to physicians and patients.[5]	– Repeat testing, – Lost specimens, – High inventory cost because of over ordering of supplies, – Data entry error,
	External failure costs	Accumulate as corrections are made to defects found after delivery of testing results to physicians and patients.[5]	– Unacceptable turnaround time for test results; – Revised reports; – Recalled results;

Failure costs are like an iceberg (Figure 1). Some costs are easy to see and recognize, and some (like the hidden part of an iceberg) are hard to see and identify [6]. Some of these hidden costs are found in functions that support the value stream such as failures associated with billing, resource planning, supply chain, information technology, etc. It is important that these functions are recognized for their contributions to the value stream and to the costs of quality.

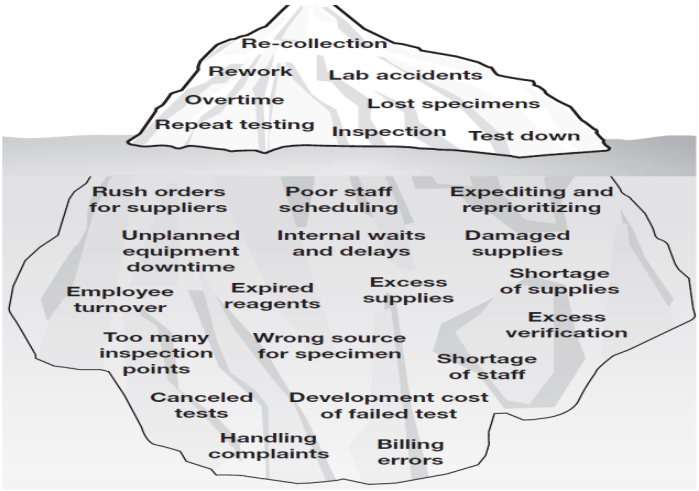

Figure1. The iceberg as a metaphor of activities related to poor quality costs

3. THE THEORY ABOUT COQ

This section presents a survey of published literature on various COQ models. According to research carried out by Sandoval-Chávez and Beruvides [7] six primary theories were found: (1) Juran's model, (2) Lesser's classification, (3) PAF model, (4) the economics of quality, (5) business management and the COQ, and (6) Juran's revised model. Schiffauerova and Thomson [8] classified COQ models into four groups of generic models: (1) PAF or Crosby's model, (2) opportunity cost models, (3) process cost models, and (4) ABC approach. Furthermore, Banasik [9] categorized the COQ models into: (1) Juran's model, (2) Lesser's contribution, (3) PAF model, (4) Harrington PQC, (5) Godfrey–Pasewak accounting COQ model, (6) Carr's service model, (7) Juran's revised COQ model, (8) Beruvides and Sandoval Chávez opportunity cost model, and (9) Beruvides–Chiu capital budgeting model.

Modern COQ models and theory have been developed from the works of Juran, Feigenbaum, Crosby, and Freeman [10]. The COQ models that serve for this study are the PAF classification as well as the revised Juran's model. A short background on the COQ models on which the proposed model is based is presented in the following paragraphs.

Joseph Juran's [11] analogy of 'Gold in the Mine' is defined as the 'total of avoidable costs of quality'. According to Juran et al. [12], this concept suggests that costs resulting from defects were a gold mine in which lucrative digging could be done. Juran [11] also categories Cost of Quality elements as tangible and intangible.

Soon after, Feigenbaum [4] develops the prevention–appraisal–failure (PAF) classification. The PAF classification can add orderliness and uniformity to the ensuing reports. The PAF classification offers specific advantages, such as its universal acceptance, identification of different kinds of expenditures, and provision of criteria to help in deciding whether costs are quality related. The last-mentioned advantage may be the reason why neither Feigenbaum, nor the ASQC, defines the term quality costs. Matters are quality-related if they meet the criteria set by each category [13]. The premise behind Feigenbaum's classification [4] is the following: The reason for the favorable cost result of total quality control is that it cuts the two major cost segments of quality (which might be called failure and appraisal costs) by means of much smaller increases in the third and smallest segment (prevention costs).

According to Porter and Rayner [14] the basic assumptions of the PAF model are that (1) investment in appraisal will reduce failure costs and that (2) further investment in prevention activities will also reduce failure costs. The PAF classification allows practitioners to identify quality-related costs and express each category in terms of percentages of the total cost.

Later, Juran et al. [15] merge Feigenbaum's PAF concept with Juran's original concepts, the result is what is known as the traditional COQ trade-off between prevention, appraisal, and failure costs. Studies during the 1980s show that the traditional COQ trade-off model of Juran is not completely valid. Scheneiderman [16] affirms that the minimum quality cost could lie at zero defects if the incremental cost of approaching a quality level of 100% is less than the incremental return from the improvement. Scheneiderman [16] asserts that a proper way to view quality cost optimization is on the basis of incremental economics.

In response, Juran and Gryna [17] revise the traditional COQ trade-off between prevention, appraisal, and failure costs and eliminate the asymptotic behavior of the cost of appraisal plus prevention. They thus assert that 100% quality conformance might be reached under finite prevention and appraisal cost under the conditions of the twentieth century where a growth of manufacturing and automated inspection technologies occurred. Juran and Gryna [17] limit the application of the new model to certain instances: (1) industries demanding high safety or liability concerns, (2) highly automated companies, (3) companies selling to wealthy customers, and (4) companies struggling to optimize client's expense. Moreover, Juran and Gryna [17] state that 'while perfection is a goal for the long run, it does not follow that perfection is the most economical goal for the short run, or for every situation' and that the minimal point would move close to zero defects if opportunity costs are included in the failure costs. Juran and Gryna's ideas have been challenged by Schneiderman [16], Plunkett and Dale [2], Freiesleben [19], among others. These authors argue that there is no economic level of quality, that spending on prevention can always be justified if the time horizon extends far enough into the future and that the cost-minimal quality level is equal to quality perfection.

Figure 2 compares the classical Juran model with the revised model. Although, not very adequate for current manufacturing processes, the old model still provides a frame of reference for quality costs and quality improvement. Burgess (1996) carries out a quality cost simulation whose results suggest that both views can be reconciled within one model. Burgess supports the classical view in certain time-constrained conditions and the modern view under an infinite time horizon. To sum up, the main difference between the two models is the fact that 100% quality of conformance can be reached at a finite cost in the revised model.

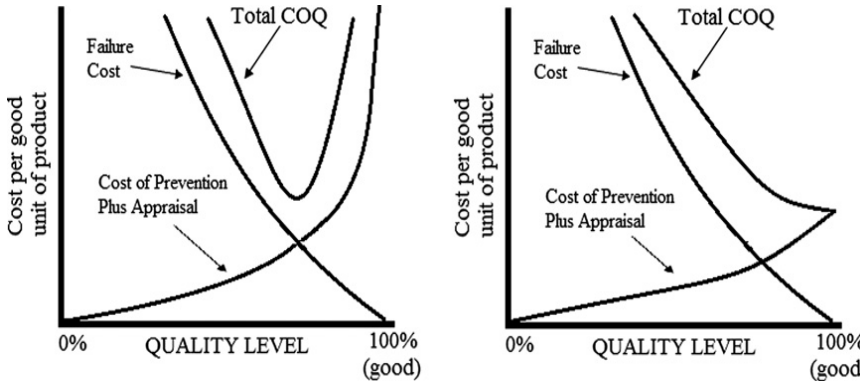

Figure 2. Classical view on the left and the modern view on the right

4. APPLICATION OF THE COQ MODEL IN A CLINICAL LABORATORY

This study analyzed cost data during six month to estimate the COQ in a clinical laboratory located in Morocco. Costs were allocated across COQ's 4 major cost categories: prevention, appraisal, internal failures, and external failures. (Table II).

Approximately 83% of total COQ was spent on costs of good quality (41% prevention costs and 42% appraisal costs), and 17% of COQ was spent on costs of poor quality (11% internal failure costs and 6% external failure costs) (Figure 3).

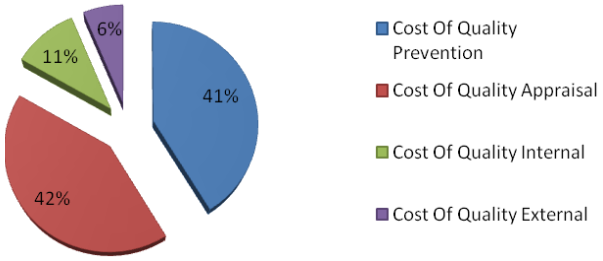

Figure3. Distribution of quality costs

Table 2. Cost of Quality expenses by category

Cost of Good Quality		
Prevention Costs of Quality (COQP)		Total
» Preventive maintenance of laboratory equipment and instruments, » Office supply costs for quality-related preventive activities » Total quality assurance and competence training, and continuing education for laboratory staff » Laboratory information system	9835 $ 481 $ 10996 $ 1509 $	22821 $
Appraisal Costs of Quality (COQA)		
» Cost of Quality control and calibration reagents, » Annual accreditation and inspection costs, » External Quality Assurance proficiency testing, » Other process improvements and quality activities	11598 $ 7317 $ 3074 $ 1265 $	23254 $
Cost of Poor Quality		
Internal Costs of Poor Quality (COQI)		
» Costs of poor inventory management (wasted reagents), » Costs of quality control/calibration failures/repeats for all analyses, » Estimated data entry errors and rework costs, » Processing and accessioning errors and rework costs	3085 $ 2317 $ 303 $ 49 $	5754 $
External Costs of Poor Quality (COQE)		
» Estimated costs of pre-analytical errors, » Estimated costs of analytical errors, » Estimated costs of post-analytical errors	1833 $ 583 $ 1098 $	3514 $

Total costs in the prevention category were estimated to be 22821 $. The highest prevention costs were the expenses associated with the maintenance of the laboratory instruments and equipment (9835 $). Preventive maintenance contract costs are relatively high and turnaround time on repairs can take up to 30 days or more.

Appraisal costs of quality were estimated to be 23254 $. Almost 50% of the costs in the appraisal category are associated with Cost of Quality control and calibration reagents, which are necessary to confirm the accuracy and reliability of test results.

Costs of poor quality, including both internal and external failures, were 9268 $. Internal failure costs were estimated to be 5754 $. In addition, 3085 $ in reagents had expired or were wasted.

External failure costs were estimated to be 3514 $. We classified the errors according to the following 3 stages of the testing process: pre-analytical, analytical, and post-analytical (Table 3). The costs of correcting errors in the pre-analytical phase were estimated to be 1833 $. The costs of errors in the analytical phase were estimated to be 583 $. Costs of post-analytical phase errors were estimated to be 1098 $. (figure 4).

Table 3. Reports by category of external failure

Category	Item	Jan	Feb	Mar	Apr	May	Jun	Total	%Total
Pre-analytical errors	Inappropriate specimen	1				2	2	55	57%
	Wrong anticoagulant		1		1	1			
	Improper conservation method		1			1	1		
	Inappropriate patient's preparation	1	1			1	3		
	Mistakes in patients' identification	2	2	3	7	15	9		
Analytical errors	Expired reagents which may lead to erroneous results				1		1	15	16 %
	Expired controls or calibrators				1	2	3		
	Failure in sampling system	1				1	2		
	Failure in aspiration system of reagents		1			1	1		
Post analytical errors	Wrong matching between sample and laboratory's files		1	1	2			26	27 %
	Wrong copy of results from the analyzer's report to the laboratory report			1		2	2		
	Delay in delivering the results to the physicians, clinics or patients	1	2	2	2	3	6		
	Loss of the results						1		
Total per month		6	9	7	14	29	31	96	100%

The optimal level of COQ has been the source of much debate. Under the traditional P-A-F view, optimal COQ is reached at the point when the costs of improved quality exceed the benefits. More recent quality economic models argue that spending on prevention can be justified until the point where there are 0 defects or deficiencies.

Despite disagreement on the optimal level of COQ, the high proportion of spending on costs of good quality relative to poor quality at the laboratory (83% costs of good quality versus 17% costs poor quality) is consistent with the goal of ensuring high quality outcomes. In this case, we will examine ways to invest in prevention to hopefully decrease overall appraisal and failure costs. This model would allow one to measure the outcome of making such changes.

5. CONCLUSION

The COQ methodology has a number of advantages. First, it can be a useful management tool for identifying and focusing on areas of poor performance and can provide a basis for benchmarking progress and overall spending on quality-related activities over time. Another key advantage of COQ is that it translates quality-related activities into monetary terms that can be easily understood by executives making overall financial decisions. COQ can be a powerful tool by illustrating the true costs of quality-related activities to upper management, which can in turn help them in the budgetary process and making decisions about implementation of cost-control measures.

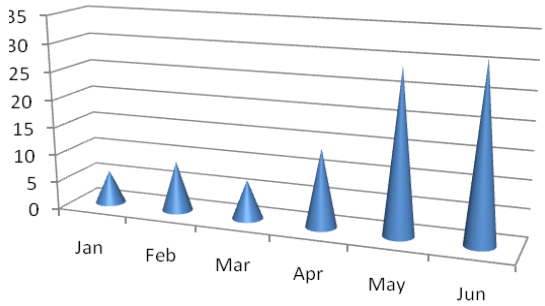

Figure 4. External failure in the period Jan-Jun of the studies

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