

## Dynamics of the Cost Related to the Large-Scale Production of Automotive Components

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**Abstract** – Nowadays, we are aware that quality has a high price. To meet the quality level required by the client, the organization must be mindful of and understand the importance of quality costs. The idea that quality has a high price must first be considered from the point of view of the expenses with non-quality. The prime objective of this paper is to evaluate and analyze non-quality costs, establishing a procedure for collecting and assessing non-quality costs. Once the cost of non-quality is determined, the organization is given a chance to decide how to use its resources to reduce and prevent quality costs pro-actively.

**Keywords:** Cost reduction, non-quality, quality costs, evaluation of non-quality, improving non-quality costs

### I. INTRODUCTION

Measuring quality through an indicator system costs time and money, but non-quality is more expensive. The consideration of quality as expensive is due to the non-measurement of the price of non-quality. Some of its consequences, especially in the large-scale production, are duplication of processes, repetition of works, correction errors, unnecessary stocks.

There are estimates that, within an organization, quality costs, including quality losses, vary between 5% and 25% of total turnover, depending on organization type and evaluation systems implemented.

Quality has a leverage effect on the organization's financial performance. Generally, if you consider:

a = profit / turnover,

b = quality assurance costs / turnover,

then the effect of reducing the costs incurred for quality assurance with an R ratio is equivalent to increasing the turnover with

$$1 + R (b / a) \quad (1)$$

In the past, the cost of poor quality was mainly used to measure manufacturing costs. Lately, it has been concluded that in all departments, processes, and

activities they are produce costs, because things were not done right at the time. Today, we understand that any enterprise or production unit must have the basis of implementing the quality management system (SMC) to be in line with the quality standards. For implementing the SCM, a set of organizational structures, responsibilities, procedures, processes, and resources is needed. One of the favorable effects at the company level is the reduction of non-quality costs (Dumitrescu, 2017).

By applying clear procedures and evaluating the data on quality costs, the management team manages to reduce disorganization and reduce costs, focusing on increasing quality.

The costs with non-quality are a special topic, because of their correct collection and evaluation, management decisions depend on quality improvement and continuous improvement.

Defining quality costs is often difficult because (Dumitrescu, 2017):

- A series of quality costs are not measurable; these can only be estimated;
- There is a time gap between the occurrence and the identification of the failure;
- Multiple failures appear during the utilization at the final customer.

The cost of non-quality could be defined as the difference between the current cost and reduced cost if there were no errors and defects in the design, production, marketing, and use. It is possible to calculate the cost of non-quality in % of turnover (2), added value (3), and the number of employees (4):

$$I_1 = \frac{CONQ}{T} \times 100 \quad (2)$$

$$I_2 = \frac{CONQ}{AV} \times 100 \quad (3)$$

$$I_3 = \frac{CONQ}{NE} \times 100 \quad (4)$$

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CONQ = Non-quality costs; T = Turnover; AV = Added value ; NE = number of employees

Two types of non-quality cost are defined (ASQ, 2018):

- *Internal failure costs* are costs to remedy defects that are discovered before the product or service is delivered to the customer. These costs occur when the process or work don't reach the required quality standards and are detected before they are transferred to the customer.
- *External failure costs* are costs incurred to remedy defects discovered by customers. These costs occur when products or services that fail to reach design quality standards are not detected until after transfer to the customer.
- The quality cost system, once established, should become dynamic and have a positive impact on the achievement of the organization's mission, goals, and objectives.

## II. RECORDING OF NON-QUALITY COSTS – A PROCEDURE MODEL FOR USE IN AUTOMOTIVE COMPONENTS

Cost reduction is the keyword in the automotive branch because of customers requiring 0 defect strategies at minimum costs. It is important for companies to develop procedures to assess quality costs from all processes and departments involved.

For better data collection and evaluation of quality cost, a procedure was developed and implemented in the beginning of 2019, showing the different approaches of quality cost during the years.

### A. Purpose

This procedure instruction defines the procedure for recording non-quality costs for cable harnesses, pursuing the following objectives:

- Transparency to costs which are charged externally, as well as costs occurred internally;
- Creating a database for evaluations / analyses which indicate that actions or decisions are needed;
- Improvement of the interface between the departments of "Finance" and "Quality", in order to accelerate the processing of

conformity costs and to structure it so that it is defect-free.

### B. Terms and definitions

Non-quality costs are costs which are incurred in influencing the production process or customer supply process in a preventive or reactive manner, in order to ensure conformity of the product to the requirements of the customer.

*Internal defect costs* are costs arising for the elimination of defects discovered before the product is delivered to the customer. These costs occur when the requirements of the customers are not met by the product: Scrap through their own fault or by multiple testing, Sorting/rework/0 fault gate, Problem investigation.

*External defect costs* are costs arising for the elimination of defects by customers. These costs occur when the requirements of the customers are not met by the product and are not detected until after reaching the customer: Warranty, Recall action, Product liability, Problem investigation, Sorting/rework at the customer, 0 km failures, Field failure, Logistics costs, Replacement costs/ defective parts at customer

### C. Responsibilities

A responsibilities matrix for the entire organization was created, to have a clear and structured view of all departments involved and responsible for the non-quality cost. Once all departments play a role in cost reduction, quality costs are getting much more important to collect and supervise.

While departments such as Production and Quality play a key role in the occurrence and collecting of internal defect costs, which have to be reported to controlling and compared to the logistics data, the departments of Purchasing, Sales and Development are not involved, as these costs are non-quality cost, caused by internal mistakes and leading to non-conformities, as shown in Table 1.

For external defects, all departments have to be involved and collaborate. The responsible department is Quality, due to failure of preventing the defects from happening in house. Also, the quality department must collaborate with all involved department in order to prevent, appraise and detect the quality costs, as shown in Table 2.

Table 1 - Responsibilities matrix for Internal defect costs

Internal cost types Detailed data	Responsibilities by department							
	P	L	Q	A	C	IE	S	RD
Scrap through own fault	R	I	C		I			
Sorting/Rework	R	I	C		I			
Scrap caused by multiple testing	R	I	C		I			
Problem investigation	C	C	R		I	C		
Zero fault gate	C		R					

RD - Development; IE - Industrial Engineering; P - Production; L - Logistics; Q - Quality; A - Purchasing; C - Controlling; S - Sales; R - responsible ; I - information ; C - collaboration

Table 2 - Responsibilities matrix for external defect costs

Internal cost types Detailed data	Responsibilities by department							
	P	L	Q	A	C	IE	S	RD
Warranty/Recall actions/Product liability	C	C	R	I	C	C	C	C
Problem investigation	C	C	R			C		
Sorting/rework at customer	C	C	R		C	C		
0-Km failures	C	C	R		C	C	C	C
Logistic extra costs (shipping)		C	R					
Replacement costs/defective parts at customer	C	C	R					

**D. Recording of costs**

Internal defect costs must be recorded daily in the quality sheets and then put in the monthly report. Cost such as sorting/rework and 0 fault gates are reported daily in the company, so all departments should react for decreasing these costs, meaning the work for sorting/rework and 0 fault gates should be done right to avoid generating more cost. Costs such as “problem investigation” are reported monthly by calculating the hours spend by the quality team to analyze internal issues. Scrapping cost is determined monthly together with the Logistics department.

External defect costs are reported monthly, after the quality team analyses. The process should be performed pro-actively in the sub-steps of a complaint investigation, complaint processing, and invoice control.

Finally, the report goes to the Finance department and the Management, so they can set priorities based on the data. Documentation and records for this procedure are quality-related costs sheets and annual Quality Cost Reporting.

**E. Dynamics of quality costs applying the procedure**

Before applying the procedure, analysis of data collection and evaluation shows a clear gap between Quality records and financial records. Quality cost is recorded only over sorting and rework sheets, according to daily records of operators and quality officer, while financial data, such as claims, are recorded without further investigation or sorting costs, as shown in Figure 1.

Fig. 1. Q Costs Recording 2018 (company internal documentation)

**Recording of quality-related costs**

Year 2018 Company X  
Project:X.23

Quality costs	Month												Costs	
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
<b>Internal Failure Costs</b>														
Scrap through own Fault	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00 €
Scrap by max. 3 x electrical check	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Sorting / Rework	1.356,57	811,63	1.269,57	1.252,55	1.137,44	717,01	765,34	123,76	1.576,76	1.897,90	876,23	587,12	12.371,88	
Problem Investigation	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00 €
<b>Total internal</b>	1.356,57 €	811,63 €	1.269,57 €	1.252,55 €	1.137,44 €	717,01 €	765,34 €	123,76 €	1.576,76 €	1.897,90 €	876,23 €	587,12 €	12.371,88 €	
<b>External Failure Costs</b>														
Warranty	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00 €
Product Recall	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00 €
Product Liability	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00 €
Problem Investigation	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00 €
Sorting / Rework at Customer	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00 €
0-km-defectives / Recall	3.307,08	6.563,63	0,00	0,00	2.419,73	545,90	0,00	0,00	4.305,00	0,00	0,00	0,00	17.141,34 €	
External costs recharged	382,40	219,65	0,00	0,00	84,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	686,05 €	
<b>Total external</b>	2.924,68 €	6.343,98 €	0,00 €	0,00 €	2.335,73 €	545,90 €	0,00 €	0,00 €	4.305,00 €	0,00 €	0,00 €	0,00 €	16.455,29 €	
<b>Total</b>	4.281,25 €	7.155,61 €	1.269,57 €	1.252,55 €	3.473,17 €	1.262,91 €	765,34 €	123,76 €	5.881,76 €	1.897,90 €	876,23 €	587,12 €	28.827,17 €	

As internal failure costs, there is no evidence of scarping harnesses (showing a clear gap between Quality and Logistics) or investigating problems. Once recorded, these costs will increase the total costs of internal failures, showing a real quality status and allowing further analysis and improvements. Figure 1 shows the improvements brought by the procedure in recording costs. As in 2018 only Sorting and rework

costs were recorded, the first 6 months of 2019 show new record on Scrapped harnesses and problem investigation.

**F. Reducing methods of non-quality costs**

After introducing the procedure model as a defined way of calculating and assessing quality cost, in the first six months of the year 2019, the organization

could see following important data to determine how to use its resources to reduce and prevent quality costs pro-actively.

1. Cost generated by scrapping harnesses is an important cost and must be reduced: is 16% of the total cost for internal failures. As a method of cost reduction, it is important that the organization is analyzing the processes and failures that lead to scrapping a harness. Implementing corrective measures and improving process operation could eliminate this cost.
2. Investigation of problems is strictly related to generated sorting and rework cost. This is 6,3 % of the total cost for internal failures. By introducing a Pareto Analysis by a defect and working on eliminating the top 5-rework/sorting problems, the investigation costs are further reduced.
3. Problem investigation 6,4 % and sorting/rework costs 10,5% for external costs is also an important cost to collect and assess. Setting a target in first response analyses reduces sorting and rework costs at the customers, by establishing the parts affected in the first 24 hours from receipt of the complaint. Thus, problem investigation costs will also decrease by not having repetitive failures to analyze. Reacting in time and spend resources on preventive measures is the right way to reduce costs and, thereby, external failures.

Once the cost of non- quality is determined, the organization is given a chance to determine how to use its resources to reduce and prevent quality costs pro-actively. This methodology allows a better planning and investing in quality.

### III. CONCLUSION

The cost of non-quality is a key indicator for the organization and should be treated accordingly. It gives the organization valuable information about the risks and opportunities to improve products and, if necessary, methods are applied it determines the opportunities to improve processes. After evaluating the non-quality costs, the organization is aware of managing quality by implementing processes of continuous improvement.

Finally, the most efficient and productive investment would be prevention. Although the prevention costs are high in the implementation phase, the results are key element of quality management.

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