ABC quality cost model: a case study

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ABSTRACT

The purpose of this article is to show the advantage of introducing the ABC quality cost model in a small company in the field of machining and industrial tooling, how to manage production costs and, as a consequence, control its processes. To achieve the processes and/or products quality, not only the increase of costs needed to maintain the established quality level should be considered. The literature on this subject shows that quality programs, such as Total Quality Control, continuous improvement and other, in fact, decrease production costs, due to the elimination of rework and non-conformity of products delivered to customers, both internal and external. Moreover, any well-structured quality program is a fundamental element of survival, in today very competitive market. In order to develop a quality program, satisfying appropriate financial criteria, appropriate tools of quality cost management should be applied, supported by a continuous data collection system. This activity also requires the establishment of corrective actions, goals and objectives, evaluating the quality performance, in view of the expected results. By means of this case study, developed in a real company, it was possible introduce the costing model ABC to measure its quality costs, identifying and defining its main costs classification. Relevant sources of materials and operational waste generated, corrective and preventive action plans were identified and implemented, reducing by 76 % their quality costs over 12 months. It was concluded that the quality cost management in a small company similar to the one under an analysis, is an advantageous method for decision-taking, appropriate to leverage finance and minimize conformity deviations. After 36 months quality costs decreased further by about 92 %.

KEY-WORDS: Activity Based Costing (ABC). Finances. Quality-costs.

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NOMENCLATURE

ABC   Activity Based Cost

AE   Monthly estimated theoretical pointing at time of quotation

AR   Monthly real appointment h

C   Calibration and maintenance of instruments and means of control

CEN   Cost of exceeding needs

CG   General value of all purchased materials cost general value

CM   Derived material purchases loss rate

CMP   Monthly cost in kg of each type of raw material lost

CP   Value of lost material costs due to purchase error

D   Waste / scrap production

E   Loss ratio from packaging

F   Loss ratio from processes suppliers

FE   Monthly failure arising packing

FEI   Monthly failure due to receipt inspection error

FEM   Monthly failure due to measurement error during process

FEP   Monthly failure due to quality planning error

FF   Failure originating from processes suppliers

I   Inspection

OS   Service order

OSP   Monthly scheduled service order

P   Quality planning

PAF   Prevention, assessment and failure

PMP   Monthly weight in kg of each type of raw material lost

Q   Product quality assurance and service

QFE   Company employees table in quantity

QIE   Total number of active instruments in the company

QP   Monthly quantity of parts produced

QR   Monthly quantity of parts rejected

QT   Monthly number of parts reworked

RJ   Rejected parts index

RT   Reworked parts Index

T   Staff training

VC   Monthly amount spent on calibration

VT   Monthly value of training investments

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INTRODUCTION

Quality is conceptualized by companies as a main value for the customer, considering this as an essential factor for success, in competitiveness, in face of competition. However, as stated by Coral (1996), any attempt to improve quality impacts investments and costs associated with the realization of the product or service, according to established standards. Therefore, continuous improvement programs must always take into consideration the impacts of economic and financial investments, and these programs do not only address customer needs, but also the company's market dynamics. Thus, to produce better, with little investment, without harming commercial competitiveness, it is necessary to reduce expenses and costs necessary to achieve quality. To reduce these costs, it is necessary to know, identify, measure and monitor the production chain. Identifying and measuring quality costs are therefore considered an essential activity for managers. The company needs to be prepared for new challenges which first of all require a change in personal mind-set.

Several successful case studies in companies are presented with data and reports on the application of quality costs. Vasconcelos, Rossetti, and Meirelles (2014) conducted a bibliographic analysis, composed of 31 articles published in 12 countries, concluding that the importance of implementing and measuring quality costs within an organization is quite diverse, that is, it varies greatly from company to company. Kumar, Shah, and Fitzroy (1998) present the quality cost studies carried out in various countries. The authors conclude that not all countries accept the means of managing quality costs. There are other published works on quality costs, such as Porter and Rayner (1992), who conducted a comprehensive search of the published literature and presented a detailed review of quality cost models, focusing mainly on PAF model and its limitations. There are also other models, such as Juran's or process cost model, as well as the integration of quality costs and benefits improvement processes. Tsai (1996), in his publication on activity-based costing, reviews models and literature on accepted quality costs. The categorization of all FAP models is proposed by Burgess (1996) in three classifications.

According to some authors, such as Feigenbaum (1994), ASQ Quality Costs Committee and Campanella (2000), quality costs should not have this name, but costs of non-quality (or cost of poor quality); however, they are known and called quality costs.

In the environment of strong global competition that companies face today, this article is intended to assist in the assessment of quality costs by allowing the production and accounting departments to associate in one company activity. Measuring and monitoring these costs enables companies to strategically pursue cost-cutting activity, leading to higher revenue and profit, competitiveness and customer satisfaction, and these are key elements to leverage the success of any company. Taking as an example the case of products of the machining and tooling company studied, through this article, it was intended to prove that investments in improvement projects, measurement system and monitoring of the production chain, result in the reduction of quality costs.

The main objective of this paper is to prove that the application of a quality cost methodology is a viable and potentially advantageous alternative to

methods limited only to financial accounting. This became evident when this methodology was applied during the early stages of product design development.

It is hoped that the practical and objective approach of the theme will favor the understanding and the efficient adaptation of the methodology, in other small companies.

MATERIALS AND METHODS

This article tested the premise that from real production data records it is possible to create a relatively simple but accurate enough mathematical model to meet the quality cost management needs of a small business. when this methodology is most often applied only to large companies (PLUNKETT; DALE, 1988; PORTER; RAYNER, 1992). It was shown that the company was able to reduce its costs and losses, caused by the lack of conformities, during the manufacturing process of its products and service provision.

This article was developed focusing on the costing of metal machining parts, manufactured in a tool shop, in non-serial process. The factors of work organization that influence the creation of a favorable environment for the sharing of workers' knowledge should be evaluated (MUNIZ JUNIOR et al., 2010). It has as key elements of the company, from top management to the other administrative and operational levels (TREHAN; SACHDEVA; GARG, 2015). In order to establish what can and needs to be done, all alternatives must be considered as to how the established objectives, can be achieved, taking into account the assessment and prediction of the environment, together with the company operational capacity (GIACAGLIA, 2005). In the area of tooling it is very difficult to maintain an operational order, precisely for the following reasons: specific products and outsourcing of surface treatment operations; wire erosion and other services, which the company does not perform internally. These are small and medium sized parts with different geometries and high-quality requirements.

PROBLEM DEFINITION

There is usually no single formula or definition about quality costs (SÖRQVIST, 1997), as quality conforms to requirements. Quality costs are given by compliance and non-compliance costs. However, quality cost calculations are not present even at the Malcolm Baldrige National Quality Award winning companies (BAATZ, 1992; SCHIFFAUEROVA; THOMSON, 2006). Riccio, Segura, and Sakata (1999), in a survey on quality cost research in Brazil, found that studies involving this topic began in 1996. Most of these authors highlight the concern of companies with quality of their products or services and present the measurement of quality costs in the most diverse types of companies (RICCIO; SEGURA; SAKATA, 1999). Utilizing quality costs is not a widely used concept and companies rarely have a realistic idea of how much of their revenue is being lost because of poor quality (SCHIFFAUEROVA; THOMSON, 2006).

In order to obtain an analysis of the quality costs, an action to improve the resulting costs is necessary to meet customer expectations (FEIGENBAUM, 1994; SAKURAI, 1997; ROBLES JÚNIOR, 2003). There are currently a considerable

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number of companies that are looking for both theoretical and practical application tools to implement quality cost reduction system models. Current literature on this topic is limited to a quality cost model, and only a limited number of articles review all models of quality cost assessment in companies and their successful outcomes. The objective of this article is to demonstrate results in a small company, during the first year, after the implementation of a quality cost model.

BACKGROUND

QUALITY COST PARAMETERS

As there is no defined standard for quality cost surveys, the best parameter to be applied is defined by the company's quality managers, as well as the means and models of quality data collection, differing substantially from one company to another to meet the needs of each particular company (SÖRQVIST, 1997). Many companies benchmark with other companies that have created the quality cost program to guide them in identifying quality cost elements (OAKLAND; OAKLAND, 1998). However, most quality specialists report that quality cost programs should be developed to the extent that each organization integrates with the company's accounting structure and system and not just be copied (ASQ QUALITY COSTS COMMITTEE; CAMPANELLA, 2000).

QUALITY COST MODELS

The PAF model is the most commonly used in determining quality costs (AOIEONG; TANG; AHMED, 2002; LOVE; IRANI, 2003). The purpose of this model is to emphasize that investments in prevention and evaluation minimize spending on external and internal failures. Daniel and Reitsperger (1991) and several other authors (PORTER; RAYNER, 1992; COLE; BACDAYAN; WHITE, 1993) discuss both conflicting views on the economic level of quality cost , illustrated in Figures 1 and 2.
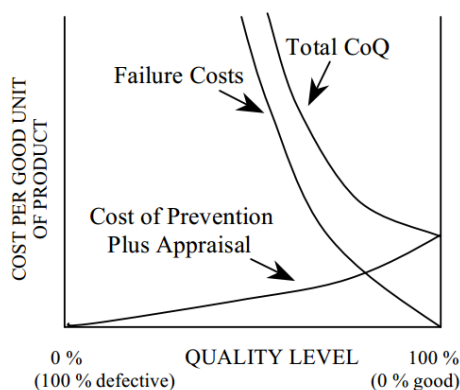
Figure 1 - Optimal quality cost model
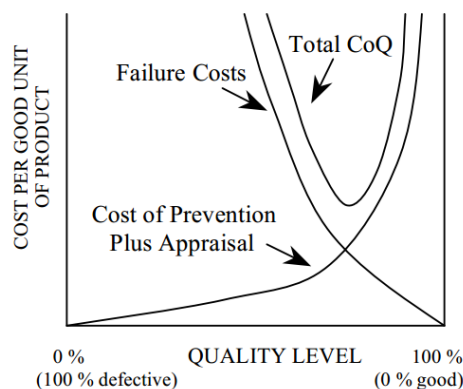
Source: Juran and Gryna (1991)

Figure 1 shows that at the optimal quality cost, 100 % of the desired level of total quality desired is not reached. To reach this level, investments in prevention and evaluation increase dramatically until failure costs are fully reduced.

Figure 2 - Optimal cost model of quality being zero defects

Source: Daniel and Reitsperger (1991)

Figure 2 shows that with the optimal quality cost, 100 % of the desired total quality level is achieved through continuous improvement, reducing failure costs without the need for significant increases in prevention and costs evaluation.

Most popular Quality Cost Models are Crosby's model (CROSBY, 1999), PAF model (GOULDEN; RAWLINS, 1997), Opportunity Cost model (LEONE, 2000; LEONE; LEONE, 2010), Process Cost Model (ROSS; WEGMAN, 1990), and ABC model (presented in next section).

Activity Based Costing (ABC Model)

The ABC model identifies with absorption costing by not separating fixed costs, but rather appropriating them to goods or services, making this a disadvantage (MEGLIORINI, 2012). Other problems are cited by Kaplan and Anderson (2007), consequence of the implementation of ABC costing:

a)   The storage, processing and presentation of data is expensive;

b)   Incurs a theoretical error in ignoring the possibility of idle capacity;

c)   Interviewing and data collection processes are time consuming and expensive;

d)   It generally focuses on specific processes and does not provide an integrated view of profit opportunities across the enterprise;

e)   Not easily upgradable or adaptable to changing circumstances;

f)   The data used in the method are subjective and difficult to validate.

However, using the ABC costing model facilitates quality cost measurement and reporting by detecting non-value-added quality costs. This gives the organization an insight into where to apply continuous improvement. Success depends on the vision of the organization's process or activity, strong

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communication between technical and accounting areas, high level of managerial support and involvement, as well-organized multi-functional team. Özkan and Karaibrahimoğlu (2013) explore the role of ABC costing in supporting quality measurement in small and medium enterprises (execution, advantages and disadvantages).

Other case studies also show that failures are reduced after the implementation of the quality cost measurement system. Using the ABC model as a quality cost measurement method suggestion, a case study conducted in China presents the same results as the research described above, in which the use of the ABC method helps to measure and report the quality cost (LIU et al., 2008).

APPROACH

This chapter dedicated to the methodology aims to characterize the research carried out in this case study, as well as the methods and techniques that were employed in the execution of the research for survey, processing and analysis of data collected in the case study. **In summary, the main characteristics of the method employed in this case study are described in Table 1.**

Table 1 – Methods used in the present article

Search Rank	Applied Methodology
Approach	Quantitative
Nature of research	Applied
Technical procedure	Case study
Method	Bibliographic research; Documentary research

Source: Author (2016)

RESEARCH EXECUTION: DATA COLLECTION

In the present article the following techniques were applied and described: bibliographic research, documentary collection and direct observation.

The bibliographic research carried out in this chapter aimed to make the reader aware of theories that will be applied in the following chapter, as well as to serve as a base the study, showing the use of valid and recognized techniques and methods, available in the literature, besides demonstrating their knowledge by the researcher.

Document collection refers to the collection of data extracted from documents (written or not) from primary sources. In this case, the company under study provided monthly expenditure statements and results of quality performance indicators over a twelve-month period: June 2014 to July 2015.

To extract information regarding the company operation, direct observations were used. Observation is a technique that consists not only in seeing and hearing, but in examining and impartially interpreting the facts that are occurring. Some limitations of this technique hinder data collection and may markedly influence the research: the observed may tend to create favorable or unfavorable impressions to the observer; the duration of events is variable and,

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in the event of simultaneous events, data collection becomes difficult; finally, the non-spontaneous occurrence of facts masks the actual data that could be collected.

APPLICATION OF THE METHODOLOGY IN A REAL CASE IN THE STUDIED COMPANY

The records of this case study conducted over twelve months were specifically related to a small business. The company studied is from the industrial machining and tooling segment, located in the State of São Paulo.

It is a tooling company provider of metrology and quality inspection services.

The Company studied has been in the market since 2008. Its main customers are automotive and auto-parts companies that make up 80 % of its customers and the rest are non-automotive companies, such as aerospace and various segments that require special tooling and machining services.

The company studied acquires externally the processes of heat treatment, surface treatment and calibration of measuring devices. These processes are controlled through vendor qualification and / or critical review of the certificates received. For machining processes carried out by company suppliers, product compliance is evidenced through dimensional reporting, and, for ISO 9001 certified suppliers, dimensional reporting is not required. For the wire erosion process, no dimensional report is required, but the supplier must belong to the list of qualified suppliers of the studied company. In this case, compliance is ensured in the metrology of the company studied, through measurements and / or tests on counterparts.

The company studied has a quality management system certificate, which is granted and audited by a certification body accredited by INMETRO, the Brazilian national metrology institution. Through the certification audit, the certificate was proven and granted ensuring that the management system of the studied company is implemented, maintains and meets the requirements of NBR ISO 9001: 2008.

The senior management of the company studied ensures that the company quality policy is appropriate, communicated and understood throughout the organization, and is disclosed as follows.

The Manufacturing Process in the Company

Each manufactured product receives an OS, and because it is specific production, its products are varied. In its production line, a wide range of items to be produced is distributed throughout the processes, and each tooling professional is responsible for developing their operations and processes, according to each type of product and activity.

In tooling there is no manufacturing roadmap, or step-by-step operating processes; skilled workforce in this area already requires professionals to be skilled and able to develop the process of each drawing before preparing the raw material, and starting material preparation, machine adjustments, tooling verification.

Evaluation of the Methodology for Defining the Best Option in the Case of the Studied Company

To conduct this study in the company, some quality cost models were evaluated to define the best method to be applied.

The classic PAF model was the first to be evaluated; however, as it is a method in which the standard cost is not complete and for leaving out the cost treatment information for each product, it is not feasible to apply.

The process cost model is also not feasible for the company studied, since the production of its process is not serial, and performing a process cost control does not facilitate the apportionment of costs for each product. In forming the company's selling costs, costs are tied to each product manufactured and not to each process or operation.

When evaluating the opportunity cost or intangible model, the unfeasibility was quickly concluded, because the studied company produces according to each purchase order received, which generates the OS, and the opportunity costs are not the most relevant to the company.

What could be observed during the study is its differential in worrying, asking the customer, when necessary, if what he is asking is really what he needs.

Methodology Applied to the Case of the Studied Company

As suggested by Feigenbaum (1994), quality costs can be classified into two groups: costs to achieve quality (prevention and evaluation); and costs of when it is not obtained (internal failures and external failures) as shown in Figure 3. This is the most used model, and according to Papa and Calarge (2004), it is known as the PAF model.

Figure 3 - Quality cost areas
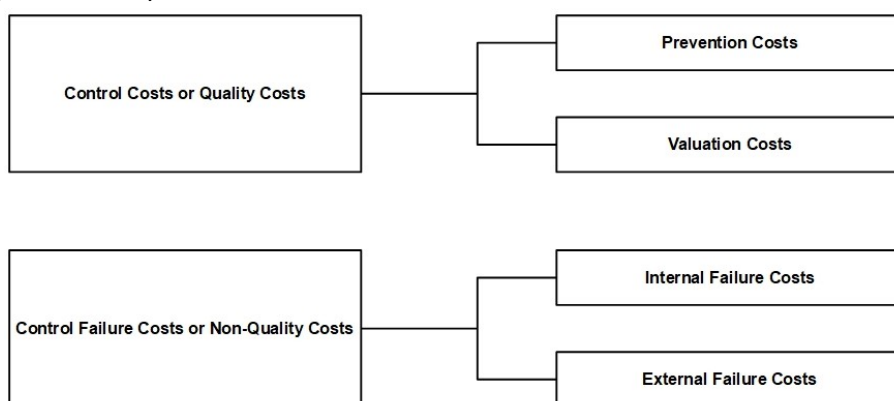
Source: Feigenbaum (1994, p. 152)

Due to its operational conditions, specific and non-serial processes, for the company studied the best costing model needs to enable data collection by work order, which links the costs to each product manufactured, regardless of the whole process keeping several items, being produced at the same time. For this reason, **the activity-based costing model ABC was chosen to be associated with the PAF classification system**.

This model tends to fit the needs of the company as it absorbs the costs per activity (product), leaving the departmental view and entering the productive field, becoming an advantage for the company. The ABC model tracks the company's most relevant activities.

In the ABC model, the activities are directed as an apportionment of the processes performed, called cost driver. Thus, for the company, a specific cost driver was created for each type of activity. With the ABC model it is possible to use multiple assessment bases. The disadvantage of this model is that because it is a much more accurate and objective method, it needs to be treated with more attentive criteria, but this disadvantage is minor compared to the other systems.

Classification of Quality Cost Components

To identify the quality cost classifications of the studied company, the Feigenbaum definition was used as the basis for the common and most commonly used classifications (FEIGENBAUM, 1994), as follows.

Prevention costs

According to Feigenbaum (1994), prevention costs are the costs used to prevent failures from occurring. These costs in prevention aim to control the quality of the products, so as to avoid costs arising from errors in the production system.

Miguel and Rotondaro (2012) classify as prevention costs those that prevent the occurrence of defects and nonconformities, comprising quality expenses to avoid unsatisfactory products. To identify potential problems, areas such as quality engineering, product design improvement, prototypes and laboratory testing, quality manual and procedures, employee training and development are involved.

For the company the types of costs that will be used to form the prevention class are described in Table 2.

Table 2 – Classifications of enterprise prevention cost definitions

Most commonly used and selected classifications	Company-defined cost type to form prevention class
c; h; k; o	Quality planning
g; i; m; o	Product and service quality assurance
a; j	Staff training

Source: Author (2016)

Valuation costs

According to Feigenbaum (1994), are the costs of actions taken to identify defective components or units before they are sent to internal or external customers.

Miguel and Rotondaro (2012) classify as evaluation costs, the costs related to inspections and tests required to ensure that the product or service conforms

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to specifications and performance requirements. They cover costs of maintaining company quality levels through product quality analysis. The most appropriate definition is the one elaborated by Juran and Gryna (1991): "It is the costs incurred in determining the degree of compliance with the quality requirements".

For the company, among the Feigenbaum relation cost types, the cost types that will be used to form the valuation class are described in Table 3.

Table 3 – Classifications of enterprise valuation cost definitions

Most commonly used and selected classifications	Cost type defined by the company to form the valuation class
a; c; g; i	Inspection
b; d; h	Instrument calibration and maintenance

Source: Author (2016)

According to Miguel and Rotondaro (2012), the costs of failures or non-quality are subdivided into internal and external failures.

Internal failure costs

According to Feigenbaum (1994), are those that occur due to some failure of the production process, either by human or mechanical source.

Miguel and Rotondaro (2012) classify as costs of internal failure, the costs in which the use of resources for correction and elimination of undesirable causes that are detected in the company itself, or detected externally, by the suppliers, or by the clients. These costs are associated with defects or failures found before the product or service reaches the consumer (JURAN; GRYNA, 1991). They result from failure to meet quality requirements through a product, good or service after delivery, such as product performance failures and customer complaints.

According to Bank (1998), costs for exceeding requirements or requirements are the costs associated with providing a product / service that exceeds specifications or contractual terms.

For the company, among the Feigenbaum ratio cost types, the cost types that will be used to form the internal failure class are described in Table 4.

Table 4 – Classifications of enterprise internal failure cost definitions

Most commonly used and selected classifications	Company-defined cost type to form internal failure class
e; g	Waste
d	Rejection
b; c	Rework
f; h	Exceed needs
a	Packing

Source: Author (2016)

External failure costs

According to Feigenbaum (1994), these occur due to some failure of the production process outside the manufacturing environment.

Robles Júnior (2003) classify as costs of external failure, the costs generated by problems that occur after the delivery of the product to the customer.

For the company, the costs associated with external failures were those associated with activities outside the manufacturing environment, but before delivery to the customer. **From the Feigenbaum ratio cost types, the cost types that will be used to form the external failure class are described in Table 5.**

Table 5 – Classifications of enterprise external failure cost definitions

Most commonly used and selected classifications	Company-defined cost type to form external failure class
b; c	Subcontracted processes
d; h	Purchase of materials

Source: Author (2016)

Relationship between Quality Cost Categories

The categories presented, referring to the quality cost classifications, make it possible to conduct a study between their relations, in order to look for the optimal point of investments in quality. It also allows to discover the cost-benefit ratio, that is, the relationship between the increase in prevention costs, and the savings obtained by decreasing failures (SLAUGHTER; HARTER; KRISHNAN, 1998).

It is also empirically proven that initial spending on prevention can mean a decrease in the total cost of quality.

Basis for Quantifying Quality Costs

There are several ways to present the costs of quality. The various components of quality costs that appear in the reports can be expressed either monetarily or through the percentage ratio of quality costs to other company performance indicators.

According to Robles Júnior (1994) it is possible to use several bases to perform the quantification of the percentage of quality costs.

Box 1 presents the complete formation of the cost classes that the company will apply, as their cost types already defined in Tables 2, 3, 4 and 5, and the basis for formulating a mathematical model of quality cost management during the 12 months of study.

Many information surveys to generate the mathematical model and formulas were taken from the quality manual of the company (STUDIED COMPANY, 2011). In addition to the fact that **the company monitors the quality management system processes through internal audits and perform measurements, when applicable, according to the process interaction flowchart**

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(Figure 5) and process monitoring and measurement worksheet (STUDIED COMPANY, 2011, Annex 4).

Box 1 – Complete formation of cost elements

Class	Cost type	Basis for calculation	Reference
Prevention	Quality planning	− Measure the performance in relation to the planned one, not being influenced by the real variations; − Planning of the quality management system.	Robles Júnior (1994); Studied Company (2011, 5.4.2)
	Product and service quality assurance	− Measure the percentage of the quality cost in relation to the cost of the manufactured unit; − Production control and service provision.	Robles Júnior (1994); Studied Company (2011, 7.5.1)
	Staff training	− Competence, training and awareness.	Studied Company (2011, 6.2.2)
Valuation	Inspection	− Measure the behavior of quality costs in relation to productivity; − Measurement and monitoring.	Robles Júnior (1994); Studied Company (2011, 8.2)
	Instrument calibration and maintenance	− Control of measuring and monitoring devices.	Studied Company (2011, 7.6)
Internal failure	Waste	− Percentage of the amount of material wasted in relation to the total of the good units produced; − Measurement and monitoring of processes.	Robles Júnior (1994); Studied Company (2011, 8.2.3)
	Rejection	− Percentage of the quantity of refugee products in relation to the total of the good units produced; − Control of nonconforming product.	Robles Júnior (1994); Studied Company (2011, 8.3)
	Rework	− Percentage of the quantity of products reworked in relation to the total of the good units produced; − Control of nonconforming product.	Robles Júnior (1994); Studied Company (2011, 8.3)

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Class	Cost type	Basis for calculation	Reference
	Exceed needs	− Critical analysis of product related requirements.	Bank (1998); Studied Company (2011, 7.2.2)
	Packing	− Preservation of the product.	Studied Company (2011, 7.5.5)
External failure	Subcontracted Processes	− Measure the costs of services that vary; − Production control and service provision.	Robles Júnior (1994); Studied Company (2011, 7.5.1)
	Purchase of materials	− Measure the costs of raw materials that vary; − Acquisition.	Robles Júnior (1994); Studied Company (2011, 7.4)

Source: Author (2016)

Using Indicators to Manage Results

Quality management based on quantitative indicators with monetary aspects may be more effective as it generates greater questioning and awareness by senior management (MATTOS; TOLEDO, 1998). The only indicator that has this requirement is the costs of quality, which, according to Feigenbaum (1994), is the common economic denominator through which top management of companies and members of the quality system can clearly and effectively communicate in business terms.

According to Robles Júnior (1994), cost measurement seeks to meet some objectives, among which are:

a) To set financial objectives for quality programs, prioritizing those that make it possible to bring better results to the company faster;

b) Know how much the company is losing due to the lack of quality to sensitize the different levels of the organization, in the challenge of continuous quality improvement.

The classification of the quality cost components of the company was defined in the quality cost areas as shown in Figure 4 and is listed in Box 2.

Box 2 – Classification of components for quality cost measurement

Class	Cost type	To contain
Prevention	Quality planning	− Costs associated with the planning team, and management project, aiming to guarantee to meet the requirements and standards according to customer requirements.
	Product quality assurance and service	− Costs associated with quality control and measurement during the manufacturing process and final inspection.
	Staff training	− Costs associated with conducting the training and qualification of employees, as well as internal training of the quality department.

Class	Cost type	To contain
Appraisal	Inspection	− Costs associated with incoming inspection of materials in the aspect of quality, quantity and price, which are materials of direct or indirect use.
	Calibration and maintenance of instruments	− Costs associated with calibration of the instruments and means of control, such as instruments of metrology and production equipment (manometer, etc.).
Internal failure	Waste	− Costs of raw materials and product lost and wasted during the manufacturing process.
	Rejection	− Products and services costs rejected for not being as the company's quality standards and / or customer.
	Rework	− Costs in discarded products and services, requiring additional processes to achieve the standard of quality, since it was not done right the first time.
	Exceeding the needs	− Loss costs overzealous and unnecessary operations in the operating process.
	Packing	− Costs associated with rejection caused by improper packaging.
External failure	Process outsourcing	− Costs associated with the results service providers because they fall below the standard required time and quality to meet customer specifications.
	Purchase materials	− Costs associated with poorly budgeted amounts above the market price quotations, delivery time not respected, poorly clarified technical specifications.

Source: Author (2016)

This way, the data necessary to carry out the company's quality cost reports, besides being collected by accounting, is also taken from other sources, such as the department of quality management and control and production management. All cost-generating activities (purchasing, acquisition, rework, rejection, evaluation and external services) are directly linked to the OS number of the specific product in question.

FORMULAS AND GOALS APPLIED TO MEASURE COST OF COMPANY QUALITY

Box 3 presents defined formulas and goals, applied by the company, in the first year of the implementation of the quality cost model.

These formulas were developed to enable the measurement of each type of cost of the specific quality of the studied company, according to the basis for calculation of Box 3.

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Box 3 – Formulas and goals for implementing quality costs

Class	Cost type	Formula	Goal 1st year	Goal 2nd year
Prevention	Quality planning	$P = \dfrac{FEP}{OSP}$	0 %	0 %
	Product quality assurance and service	$Q = \dfrac{FEM}{OSP}$	0 %	0 %
	Staff training	$T = \dfrac{QFE}{VT}$	Management	Management
Appraisal	Inspection	$I = \dfrac{FEI}{OSP}$	0 %	0 %
	Calibration and maintenance of instruments	$C = \dfrac{VC}{QIE}$	Management	7 %
Internal failure	Waste	$D = \dfrac{CMP}{CMA}$	0 %	0 %
	Rejection	$RJ = \dfrac{QR}{QP}$	3 %	1 %
	Rework	$RT = \dfrac{QT}{QP}$	5 %	3 %
	Exceeding the needs	$CEN = \dfrac{AR}{AE}$	Management	+ 2 % - 8 %
	Packing	$E = \dfrac{FE}{OSP}$	0 %	0 %
External failure	Process outsourcing	$F = \dfrac{FF}{OSP}$	0 %	0 %
	Purchase materials	$CM = \dfrac{CP}{CG}$	0 %	0 %

Source: Author (2016)

METHOD APPLIED FOR MEASURING PREVENTION COSTS

To perform the measurements and monitoring of the results presented during the 12 months of the case study, the company monthly collected all cost values of the specific quality of each cost type.

To transform the values into performance indicators, the formulas established in Box 3 were used.

QUALITY PLANNING

The indicator selected to quantify quality planning was compliance with action plans and deadlines, as well as critical analysis, to see if what the customer really needs of is what they are asking for, and whether the company can afford to accomplish. When a failure is identified by quality planning error, this indicator is fed with the result of the relationship between FEP (Monthly Failure for Quality Planning Error) and OSP (Monthly Scheduled Work Order).

With this relation, it is possible to demonstrate in the month indicator the percentage of failures resulting in quality costs for this index.

The formulas for this calculation and others are shown in Box 3.

PRODUCT AND SERVICE QUALITY ASSURANCE

The indicator selected to quantify product and service quality assurance was the rate of failures resulting from error during product measurement, i.e. quality control and performance monitoring during the manufacturing process.

When an internal failure is evidenced and characterized by this error during the manufacturing process, the resulting costs are based on poor quality assurance and thus addressed as a preventive failure.

Appropriate actions are taken to remedy the problem, and a corrective action report is opened to investigate the root cause, thus preventing its recurrence in new cases.

The indicator is fed with the results of the relationship between FEM (Monthly Failure due to Measurement Error during process) and OSP (Monthly Scheduled Work Order).

STAFF TRAINING

When training is required, it is identified by those in charge of the areas that judge the needs, according to the activity of each employee.

It is up to the HR department to research the cost, workload, and entity to conduct approved training, along with enrollment and payment, and perform a training control (company standard form) to administer planned, completed, or canceled training.

Upon completion of the training, an effectiveness assessment is performed, and its outcome is calculated by dividing the total points, obtained by the possible points, multiplied by 100. When the effectiveness of the event / training is less than 75 %, a corrective action report is issued to assess the need for possible action and, if necessary, retraining.

The indicator for quality cost management is fed with the cost results obtained from the ratio of QFE (Number of Company Employees) and VT (Monthly Value of Investments in Training).

This indicator is managerial, there is no goal, but it is expected that the better the overall results of quality costs, the lower the costs of loss of failures

and corrections, thus justifying the upward trend of investments in training required, provided within a coherence.

METHOD APPLIED FOR MEASURING EVALUATION COSTS

INSPECTION

The indicator selected to quantify product and service inspection was the failure rate resulting from initial product measurement errors.

When an evidenced internal failure is characterized by material receipt inspection errors of direct or indirect use of the product and service, the resulting costs are based on the inspection, thus directed to the evaluation cost.

Actions are taken to correct the problem, and a corrective action report opens to investigate the root cause. The company has implemented a form called Receipt Inspection Report (RIR), which provides all information relevant to the material received.

The indicator for quality cost management is fed with the cost results obtained from the ratio of FEI (Failure to Receive Inspection Error in Month) and OSP (Monthly Scheduled Work Order).

With this relationship, it is possible to demonstrate in the month indicator the percentage of failures resulting in quality costs for this index.

INSTRUMENT CALIBRATION AND MAINTENANCE AND QUALITY ASSURANCE

The company maintains a control system of the measuring equipment, necessary to evidence the conformity of its products, as established in its quality manual. Calibrations are performed externally by subcontractors, which have traceable standards and belong to the Brazilian Calibration Network (RBC).

The indicator for quality cost management is fed with the cost results obtained from the ratio of CV (Monthly Value spent on Calibration) and QIE (Total Quantity of Active Instruments in the Company).

With this relationship, it is possible to demonstrate in the month indicator the percentage of failures resulting in quality costs for this index.

METHOD APPLIED FOR MEASURING INTERNAL FAILURE COSTS

WASTE

Some of the main reasons for the occurrence of waste during the production process are due to insufficient professional qualification, use of low cost and inferior quality raw materials, lack of operational attention and machine setup. Significant losses in quality costs that are classified as waste started to be observed and internal actions were taken by the company.

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The indicator for quality cost management is fed with the cost results obtained from the ratio of PMP (Monthly weight in kg of each type of raw material lost) and CMP (Monthly cost per weight in kg of each type of raw material lost).

With this relationship, it is possible to demonstrate in the month indicator the percentage of failures resulting in quality costs for this index.

REJECTION

The company studied ensures that products that do not meet the requirements are identified and controlled to prevent unintended use or delivery. Its quality manual sets out procedures for defining the controls, responsibilities and related authority for handling the nonconforming product.

Products that eventually present nonconformities are segregated, evaluated and their disposition defined by personnel respectively designated, with authority for this activity. When the nonconforming product is reworked or repaired, it is inspected anew to demonstrate compliance with the requirements.

Nonconformities are appropriately recorded in the report of corrective actions and preventive actions, on which the destination to be given to the product is available.

When nonconformity of the product is detected after delivery to the customer, or initial use, the studied company shall take appropriate action with respect to the effects, or potential effects, of the nonconformity.

Thus, one of the most important records verified by the company, after measuring the quality costs, was the evidence of lost parts rejected. By measuring the number of discarded parts in July 2014, the company identified that 6.4 % of its loss was due to discarded production as a result of the lack of operational standardization stemming from the lack of adequate quality in not meeting company and industry standards.

The indicator is fed with the results of the relationship between QR (Monthly Quantity Rejected Parts) and QP (Monthly Quantity Produced Parts). In this indicator the relationship is not by OS, but by QP, because the goal is to relate the number of parts rejected.

With this relation, it is possible to demonstrate in the month indicator the percentage of failures resulting in quality costs for this index.

REWORK

By measuring the number of nonconforming parts that required rework to meet specific requirements, in July 2014, the company found that 7.3 % of its loss was reworked as a result of a lack of operational standardization stemming from the lack of adequate quality in not meeting company and customer standards.

The indicator is fed with the results of the relationship between QT (Monthly Quantity of Reworked Parts) and QP (Monthly Quantity of Parts Produced). In this indicator the relationship is not by OS, but by QP, because the goal is to relate the amount of reworked parts. With this relationship, it is

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possible to demonstrate in the month indicator the percentage of failures resulting in quality costs for this index.

EXCEEDING NEEDS

The measurement of exceeding needs consists in monitoring the execution of operations with excessive operational zeal, in case of operations outside the specification of the design (BANK, 1998).

The company has a policy of performing operations beyond what is necessary to please the end customer, but this is a market strategy. The company is aware of this overzealousness and even though it does not charge these additional operations in its budgets, it knows that it will gain customer confidence by keeping this additional information as a strategy.

One problem, identified in the company as a side effect of being charged for total quality is intense, is that professionals seek to reach the highest quality standard and often perform operations with excessive operating zeal, in order to exceed the expectations of the customer.

When this initiative by the professional does not come from the management strategy of the company, it becomes a free operation without strategic value, since the management of the company is unaware of these facts and cannot benefit from the customer with these achievements.

By measuring the theoretically available hour / machine quantity and comparing it with the actual quantity, it was found that there was a loss of productive capacity, with a 23 % discrepancy in the theoretical hour / machine comparison with the actual one.

Thus, the company adopted a labor pointing operation for each OS, comparing in the end the amount of theoretical hours with the number of actual hours. This indicator is managerial, although the ideal is 0 %, it is known that in tooling the indicator 0 % is impossible to be achieved when comparing the estimated theoretical time of a process with the real time used.

The indicator is fed with the results of the relationship between AR (Monthly Real Pointing) and AE (Monthly Estimated Pointing at the time of quotation).

The indicator acts as a monitor and manager of company results. It is expected that the higher the company's overall positive results in quality costs, the lower the costs of exceeding needs.

PACKAGING

The company preserves the product during the internal process and delivery to its intended destination in order to maintain compliance with the requirements as set up in its quality manual.

When evidenced nonconformity arises from improper packaging of the product, during the process or after its completion, the costs are based on packaging, thus directed to the cost of internal failure.

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The indicator is fed with the results of the relationship between FE (Month Pack Failure) and OSP (Month Scheduled Work Order).

METHOD APPLIED FOR MEASURING EXTERNAL FAILURE COSTS

SUBCONTRACTED PROCESSES

Some operational processes are outsourced by the company studied, because in its facilities are not performed all possible processes in a tooling and machining.

When these processes do not meet the initial requirements specifications, the company takes immediate action according to the type of problem, such as complaining to the supplier, ordering new products and services, or returning material and purchasing from another supplier.

Often the company has to assume the cost as the vendor does not come up with a better solution.

There are consequences that reflect the company's image to the end customer. In order to minimize these costs and inconveniences, a classification of two types of suppliers was adopted to determine relevance among them to differentiate methods, criteria and weight as follows:

- Those that directly affect the final quality of the product;

- Those that do not directly interfere with the final quality of the product.

Suppliers whose evaluation values are smaller or equal to a defined score will be excluded from the LFQ.

The indicator is fed with the results of the relationship between FF (Failure from Process Suppliers) and OSP (Monthly Scheduled Work Order).

MATERIALS PURCHASE

When in receipt of materials and services irregularities are detected due to a poor purchase, an opportunity for improvement is evidenced in the purchasing department.

In July 2014, the company identified that 9 % of the loss amounts resulted from purchases and materials purchased incorrectly due to miscommunication and internal technical terminology.

The indicator is fed with the results of the relationship between CP (value of materials costs lost due to purchase error) and CG (value of general costs of all materials purchased).

RESULTS OF IMPLEMENTATION OF QUALITY COST MODEL IN THE COMPANY

PERFORMANCE INDICATORS AND RESULTS

In order to perform the performance and results evaluation, being able to obtain comparative values before and after the implementation of the quality cost model in the company, it was necessary to have knowledge of all the initial costs. In the first month of the study, all the costs of quality costs were collected and transformed into a percentage. The initial costs were represented as 100 % of the quality costs results of the studied company. This percentage was distributed among the quality cost component classifications that the company determined. Thus, during the twelve months studied, monthly evaluations were performed, comparing with the results collected in the first month, that is, results obtained by the company before the implementation of the chosen methodology and application of the quality cost.

Figure 4 shows the evolution of the cost of quality in the company during each month of the first year of implementation.

The results presented during twelve months were very satisfactory. It was evidenced that the chosen methodology was successful from the second month, with a 16 % reduction in the cost of the total quality of the company. Each month, the decrease in the cost of quality was clearly visible, and in the fourth month of implementation, the cost of quality fell by 51 % compared to the results of the initial month.

In the fifth month of implementation, an increase in total costs can be observed. The company attributed this increase to the comfort zone achieved due to the positive result achieved in the initial four months, which reflected an increase in the cost of quality in the following month, with a lower value of cost reduction in quality compared to the previous month.

With this experience of results obtained in November / 2014, the company was able to see the risk of putting all the effort to lose. Awareness raising was carried out, weekly performance meetings and action plans for necessary improvements were made, maintaining focus and control.

At the end of twelve months of the implementation of the cost of quality, there was a significant 76 % reduction in the cost of quality.

Figure 4 - Indicator assessment of quality costs

Source: Author (2016)

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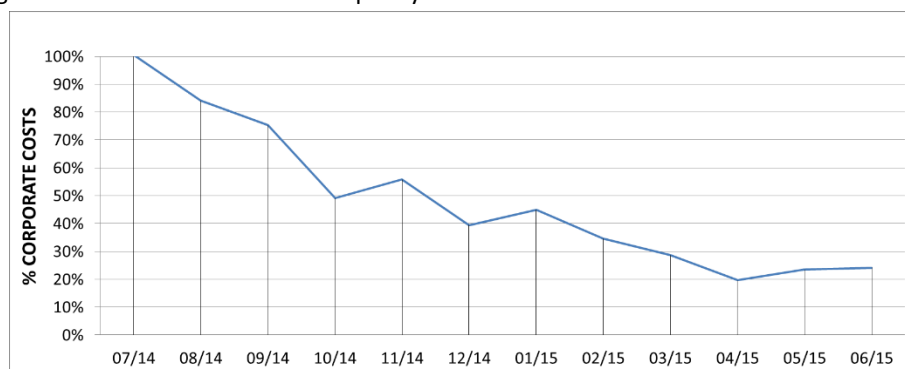
Figure 5 further clarifies the understanding for enterprise quality cost classifications by category. Of the four categories, the cost element of internal failure was the one with the highest result. Its initial value represented 38.9 %, and after 12 months, 5.6 % of quality costs. This represents a real reduction of 33.3 %, and specific improvement with 85 % performance in this category.

The second category with the highest result was the external failure class. Its initial value represented 17 %, and after 12 months, 0 % of the quality costs, representing a real reduction of 17 %, and specific improvement of 100 % performance in this category. This shows that the failure costs are the most representative for the company studied.

The third category with the highest score was the evaluation class. Its initial value represented 30 %, and after 12 months, 14.3 % of the quality costs. Representing a real reduction of 15.7 %, and specific improvement with 52 % performance in this category. Last but not least was the prevention class. Its initial value represented 14 %, and after 12 months, 4 % of the quality costs. Representing a real reduction of 10 %, and specific improvement with 71 % performance in this category.

Figure 5 - Evaluation indicator of the quality costs by category
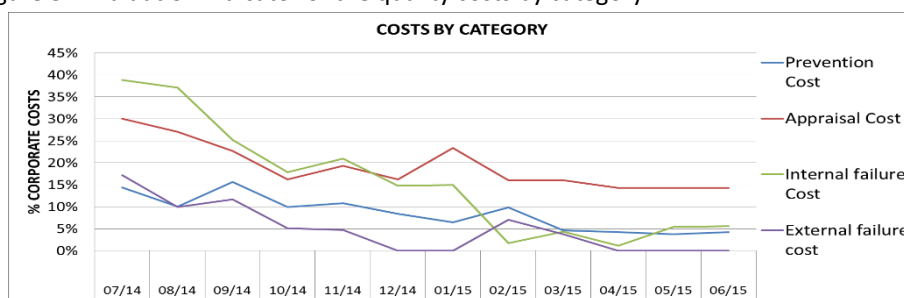
Source: Author (2016)

Figure 6 shows the results of quality planning measurements. In the first month of deployment, a measurement resulted in an 8 % failure rate resulting from quality planning, ranging up to the fifth month. From the sixth month, the goal was reached and maintained, without further failures due to quality planning error. With all staff working to ensure verification of action plans and reports, all potential flaws and questions have been addressed in advance.

Figure 6 - Indicator assessment of quality planning quality costs

Source: Author (2016)

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R. Gest. Industr., Ponta Grossa, v. 15, n. 4, p. 83-120, Out./Dez. 2019.
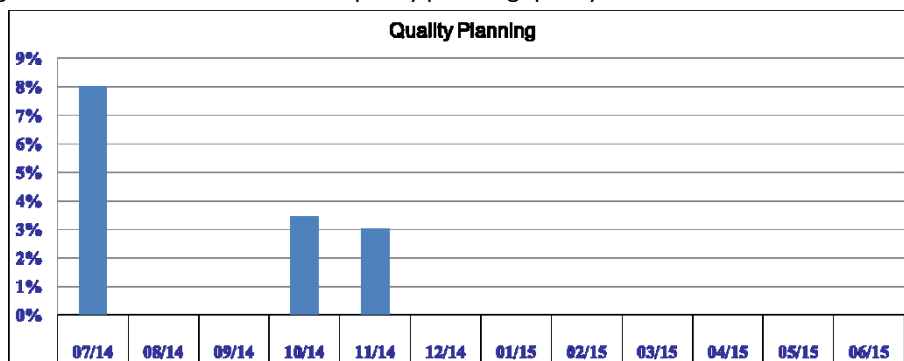
Figure 7 shows the results of product and service quality assurance measurements. In the first month, one measurement resulted in a 0 % loss rate, but in the two consecutive months, a trend showed a 4 % and 8 % rate. Actions were being taken, but even so, these results alarmed the direction of the company and a new strategy was admitted. This index is one of the most demanding monitoring, because it depends on the entire operational productive framework, and there are many variables that can influence the results. One of the actions required was operational replacement, as it was clearly evident that there were a small number of employees who were not committed to the success of the quality cost reduction program. In the eighth month, there was another index above 5 %, and in the other months the desired result was achieved.

Figure 7 - Indicator assessment of quality costs in quality assurance

Source: Author (2016)

Figure 8 shows the results of training cost measurements. In the first month, a measurement resulted in over 6 % of the quality costs representing training. As this indicator is managerial and there is no goal, but a monitoring to evaluate trends, it is possible to observe that in the first half of the implementation, the costs of training had a great fluctuation, reaching its highest peak around 8 %. In the second half of the year, the stability and harmonization of the indicator became clear, costs were significantly reduced and practically stable over the last five months monitored.

For the second year, it is expected to remain close to 4 %, accepting an increase of up to 5 % to 5.5 %, which is justified by system maintenance and improvements.

Figure 8 - Evaluation indicator of quality costs related to training
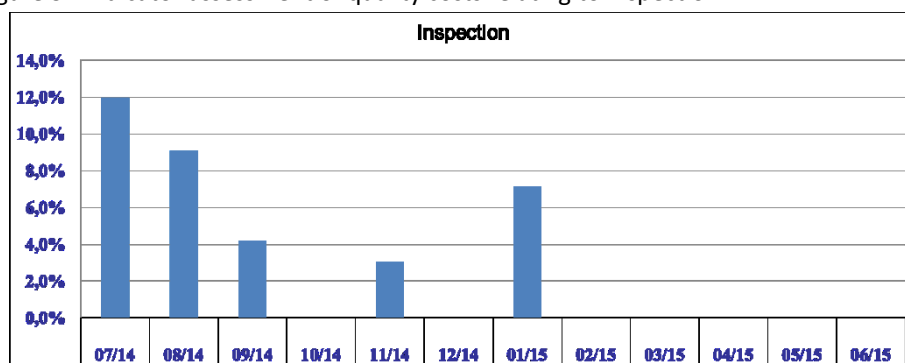

Source: Author (2016)

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R. Gest. Industr., Ponta Grossa, v. 15, n. 4, p. 83-120, Out./Dez. 2019.
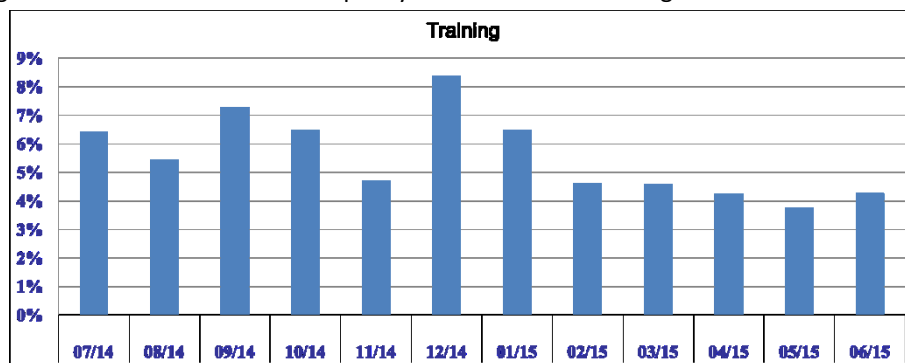
Figure 9 shows the results of measuring inspection costs. In the first month, a measurement resulted in a 12 % loss rate due to inspection failure. Internal actions were taken to intensify this activity effectively and, in the first quarter, reached 4 %.

In the following month, it reached the target of 0 %, but oscillating until the seventh month, when it reached 7 %. From the eighth month it was possible to reach and maintain the stable target.

Figure 9 - Indicator assessment of quality costs relating to inspection

Source: Author (2016)

Figure 10 shows the results of measuring instrument calibration costs. In the first month of implementation, a measurement resulted in a cost ratio of around 18 % of quality, representing calibration and maintenance of control and measurement instruments.

As this is a managerial indicator and there is no goal, but monitoring to assess trends, it can be observed that after the first quarter, calibration costs decreased slightly, stabilizing over the six consecutive months and again a further reduction, followed by stability over the last three months within 14 %.

For the second year, the goal was revised and changed from management to 7 %. In order to achieve this goal, which means a reduction of 50 % in this final index of the first year, the studied company made a new revision in the criteria of acceptance of the instrument calibration results and also the deadlines for the realization of new calibrations.

As many instruments were calibrated but not used, being kept in the metrology for months, and even unused throughout the calibration frequency period, the company studied classified unused instruments to not start their calibration period until first use is made.

During this unused period, the instrument is stored in a disused area as an approved and calibrated instrument, but in standby. When this instrument needs to be in use, then its calibration period is counted from the date of its first use, not from the date of its calibration.

Thus, it is expected to be able to reduce these costs to the new target set.

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Figure 10 - Quality costs of the evaluation indicator with calibration instruments
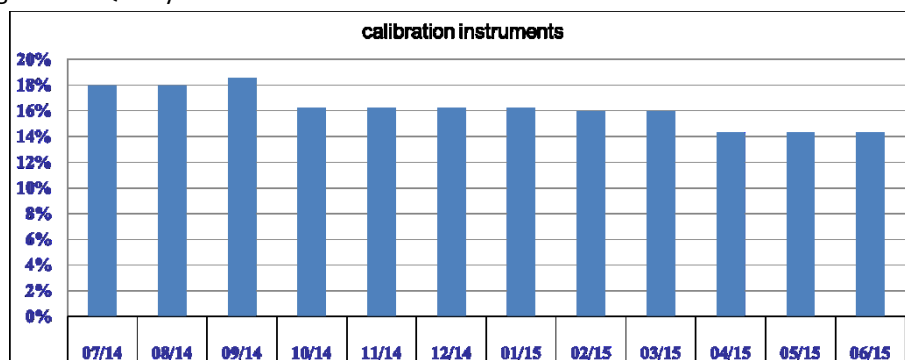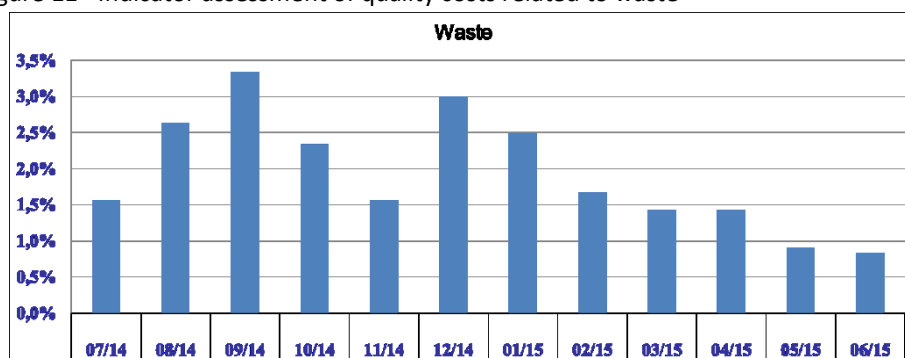

Source: Author (2016)

Figure 11 shows the results of measuring waste costs. In the first month, a measurement resulted in a 1.6 % loss rate, significantly increasing to over 3 % in the third month. This caught the attention of the company's top management.

This indicator is linked to factors with medium-term returns, as they depend on training, awareness and culture of qualified suppliers. In the fourth and fifth months, the results appeared with a significant reduction depending on the action plan applied; however, the actions taken were not enough to stabilize within the target.

The company's management has assumed that management has entered a comfort zone, as the index has skyrocketed from 1.6 % in the fifth month to 3 % in the sixth month, an 87 % jump in 30 days. Therefore, a new approach was applied, with some corrective actions. Following this approach, there has been a steady and steady reduction in the last six months, closing at 0.8 %.

The second year is expected to work hard and prevent waste from increasing again as there were two major peaks in the first year. Top management is aware that this indicator needs to be closely monitored, as the tendency to increase suddenly is very strong.

Figure 11 - Indicator assessment of quality costs related to waste

Source: Author (2016)

Figure 12 shows the measurement results of rejection costs. In the first month, a measurement resulted in an index of over 6 %. In the third month, it reached 3.5 %, a very satisfactory reduction in the beginning due to the improvements implemented. But in the fourth month it increased, reaching in

the fifth month 4.4 %. This result worried the direction of the company. By applying a methodology of continuous improvement, the company was able to minimize these points and, in the ninth month, reached a value below 1.5 %. It closed the last three months steadily, below 1 %, within the 3 % target. For the second year the company revised its rejection acceptance target to minimize and limit to 1 %.

Figure 12 - Indicator assessment of quality costs related to rejection
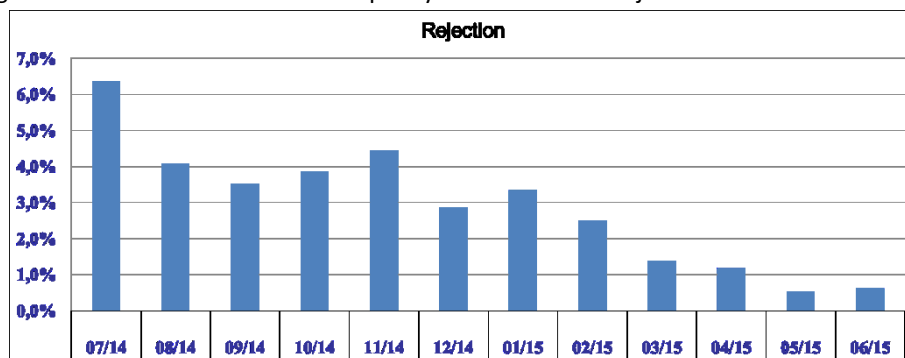
Source: Author (2016)

Figure 13 shows the rework cost measurement results. In the first month, a measurement resulted in an over 7 % loss rate. It is observed the particularity that this indicator is associated with the rejection indicator. This is because reworked parts are not always approved and are eventually rejected. Most of the highest peaks in both rejection and rework indicators are in the same months.

In the last four months of the study, it closed with a trend around 2 %, and last month 1.3 %, within the 5 % target. For the second year the company revised its rework acceptance target to minimize and limit to 3 %.

Figure 13 - Evaluation indicator of quality costs related to rework
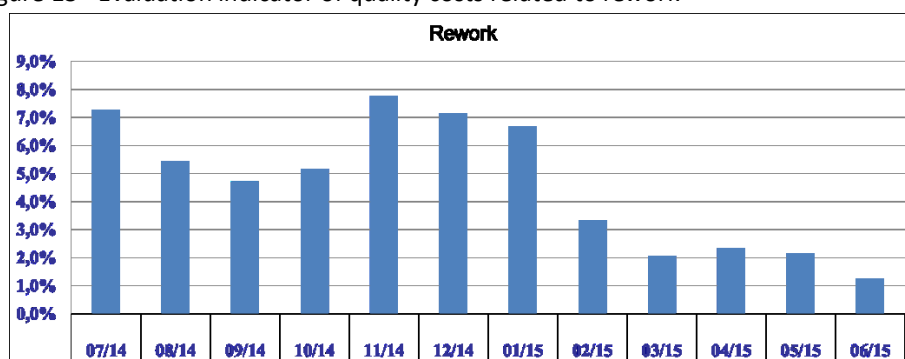
Source: Author(2016)

Figure 14 shows the measurement results of costs exceeding requirements. In the first month, a measurement resulted in an over 15 % loss rate. This is the chart that caught the most attention, as it is a managerial indicator of the relationship between real-time and estimated manufacturing of a product during its manufacturing operational process. This indicator contributes to the company's strategy management, as its results help to adjust the budgeted values, giving the manager feedback on possible trading margins, even when it comes to costing the client.

The values of this indicator show the percentage of operating time being performed above the estimated. Thus, when the indicator values are negative, it means that the real time is below the estimated theoretical, but it does not mean that the process is being of inferior quality but that it is possible to produce the product, according to design and quality required, with less time than estimated. With this indicator, the budgeter can work on his calculations and reasoning, update himself, align himself with actual production, and even make strategic discounts when it comes to budgeting, taking advantage of the competition.

As a benefit, the company studied can continue to provide good quality products with the possibility of reviewing their prices. Maintains its profit margins and minimizes its losses with super quality. In the second month, there was an increase of this index, followed by a continuous fall, until reaching the results below zero from the seventh to the tenth month. For the company, this negative indicator period represents operating time gain. For the second year, the company set a range by forming a target field, allowing it to swing within the range of 2 % to -8 %.

Figure 14 - Indicator assessment of quality costs ref. exceed the needs
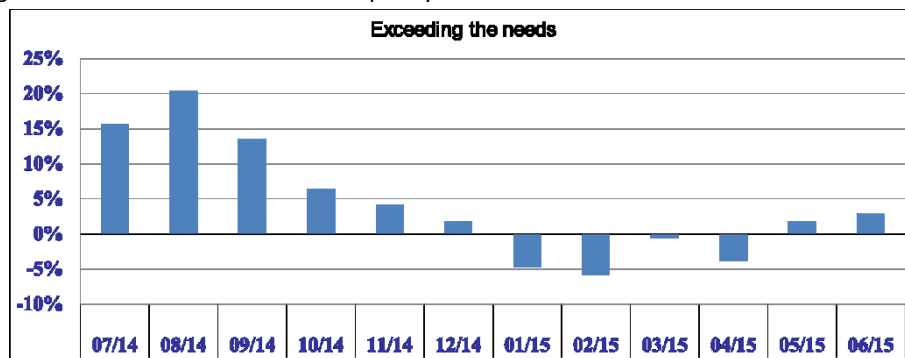
Figure 15 shows the results of measuring loss costs resulting from packaging problems. In the first month, one measurement resulted in an 8 % loss in packaging and improper handling. Internal actions were taken to intensify this activity effectively and, in the first quarter, reached 0 %. In the following month, the goal remained, but oscillating until the seventh month. Timely corrective actions have been taken to eliminate the root cause. From the eighth month the goal was achieved and maintained.

Figure 15 - Indicator assessment of quality costs ref. loss on packaging

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R. Gest. Industr., Ponta Grossa, v. 15, n. 4, p. 83-120, Out./Dez. 2019.
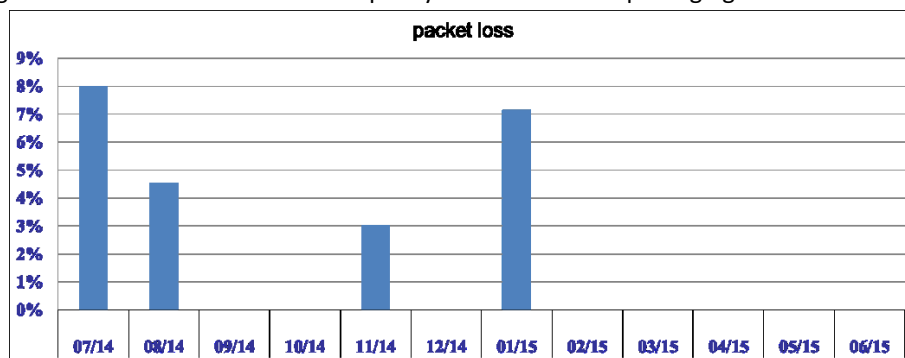
Figure 16 shows the results of measurement of loss costs by the subcontracted process. In the first month, a measurement resulted in an 8 % loss rate. Then a reduction in the second month, but further increases in the third month to over 8 %. Finally, the company was able to reduce to 0 % in the sixth month, but along several instabilities.

This caught the attention of the company's top management. This indicator is dependent on long-term factors, as the qualified supplier must have a partnership relationship for the company's success. The biggest difficulty in measuring this indicator is that it would be appropriate if all suppliers were evaluated monthly, but this does not occur. Subcontracted service providers are only evaluated when the studied company contracts its services, which does not necessarily occur every month. The contracting of services and subcontracted processes vary according to the purchase orders that the studied company receives from its customers, as in the case of specific production, there are suppliers that provide their services once a semester: this has a wide oscillation. During the first year of the study, the company needed to develop new suppliers and even began to perform some in-house processes that were previously subcontracted. This is due to the difficulty of finding specific and qualified suppliers to meet the requirements and needs of the company. One of the developed processes to be performed internally is the process of vulcanization of parts.

In the last three months the result had reached 0 %, but the company's management is committed to continuously monitor this indicator, so as to be able to monitor the results of suppliers, and is willing, if necessary, to replace all to develop new suppliers.

Figure 16 - Evaluation indicator of quality costs subcontracted process
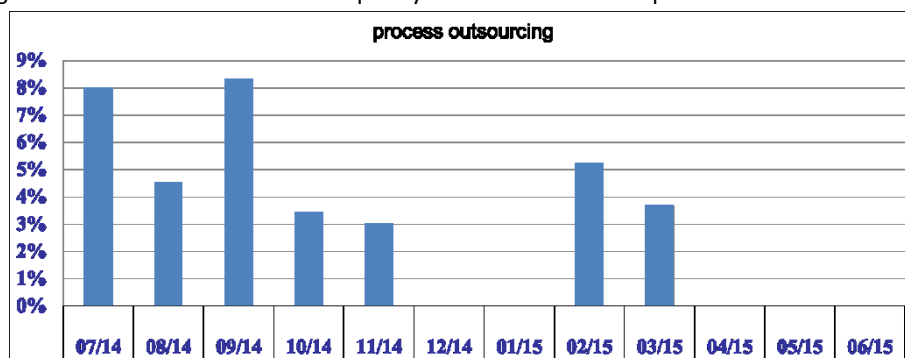
Source: Author (2016)

Figure 17 shows the results of measuring loss costs by the material purchasing process. In the first month, a measurement resulted in a 9 % loss rate, followed by visibly satisfactory results, when in the fourth month it reached values below 2 %, thanks to the continuous improvement actions applied. Finally, it was able to reduce to 0 % in the sixth month, which would be maintained over the months, if it were not a specific situation in the eighth month, which again led to 2 %. In February 2015, a delay in the delivery of a special raw material led the company to perform overtime activities to meet the end customer's delivery deadline. These costs were related to the cost of lost material purchases as the buyer did not pay attention to the supplier's deadline when closing the order.

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Figure 17 - Evaluation indicator of quality costs related to the purchase of materials
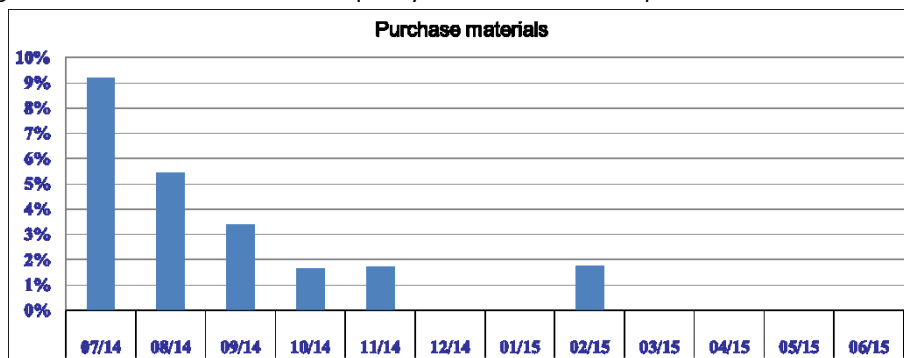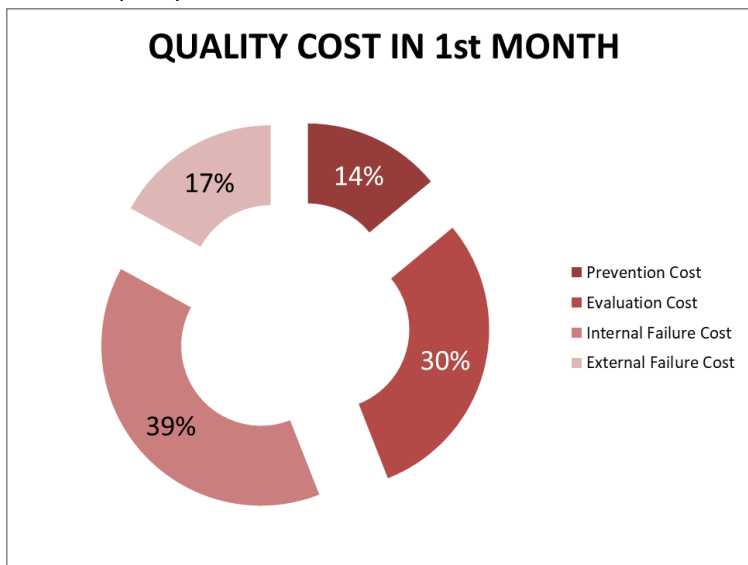
Figures 18 and 19 compare the results of the cost of quality of the studied company, subdivided by the classes of prevention, evaluation, internal failure and external failure.

The result of this case study is observed, with 76 % reduction in quality costs of the studied company.

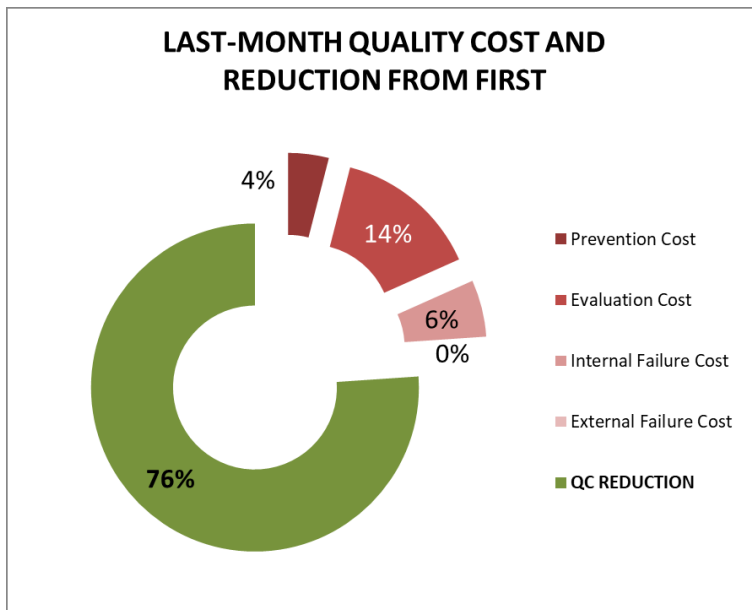Figure 18 - Costs of quality in the first month

OPTIMAL QUALITY COST EVALUATION

Figure 20 shows the total quality cost curve, correlation between control costs and failure costs. In this correlation, it is possible to visualize the optimal cost of quality, reached in the tenth month of implementation, April 2015, considering that the desired total quality level was reached.

This behavior confirms the statement by Daniel and Reitsperger (1991), shown in Figure 2 that, with the optimal cost of quality at the level of 100 % of the desired total quality, through continuous improvements, it is possible to
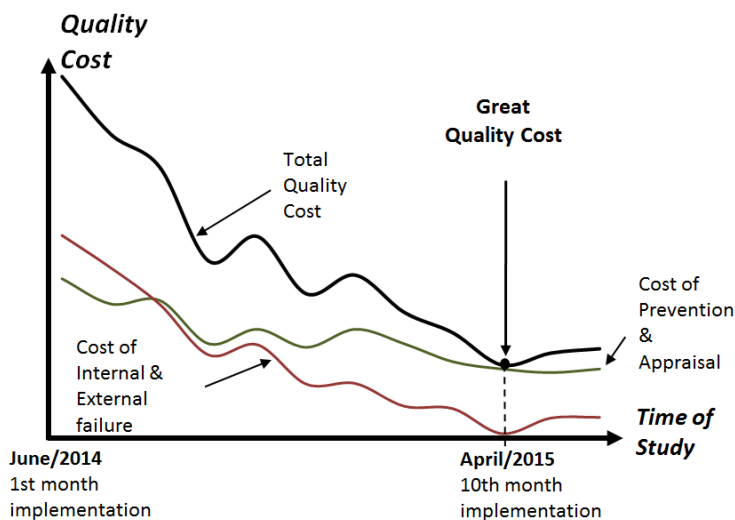
reduce failure costs without the need for significant increase in prevention and evaluation costs.

Figure 19 - Quality costs in the last month compared to the first month

LAST-MONTH QUALITY COST AND REDUCTION FROM FIRST

- Prevention Cost
- Evaluation Cost
- Internal Failure Cost
- External Failure Cost
- QC REDUCTION

Source: Author (2016)

Figure 20 - Diagram great quality cost

Source: Author (2016)

In Figure 20, the optimal cost of quality for zero defects is limited by the business process. After the tenth month, when the optimal cost of quality was reached, failure cost values increased, but as a stable effect. Any attempt at improvement will be linked to innovation and / or process change efforts to reduce these failure costs. For prevention and evaluation costs, the company set new targets for the second year, aiming to reduce this line and thus reduce the total cost of quality.

CONCLUSIONS AND FINAL CONSIDERATIONS

With the study carried out in the studied company, it was observed that investments in improvement projects and measurement and monitoring system led to significant results of 76 % in the reduction of quality costs in the first year. The correlation between failure costs and prevention and evaluation costs demonstrated that the company achieved its optimal cost of quality within 10 months of deployment. It was concluded that the method had an appropriate use, bringing as major benefit to the company a new tool for decision making, as well as for the control of quality costs and also for the improvements of its process. The company abandoned the theory of management under a factory manager and no longer practiced traditional accounting management that focused on efforts to reduce product costs rather than focusing on activities that would reduce quality costs and increase profitability, made possible by the implementation of the quality cost model. It is suggested that this system developed during the study be practiced continuously in the studied company, and this validation is released as possible applications in other companies of the same segment and with their particularities in common. Thus, it is expected to unite new information that contributes to new studies and applications, aspiring to improve quality engineering in this type of organization.

FUTURE STUDIES

With the study conducted in the company studied, it was observed that new studies on how successful companies make decisions regarding quality improvement and how they reduce quality costs should be performed. Specifically, more detailed research on the collection and measurement of quality costs in real environments should yield useful information on quality cost best practices. Encouraging companies to report data and help in design comprehensive systems as well as quality cost measurement should be part of any quality management program. The methodology is complex and not well documented. Quality cost programs provide a good method for identifying and measuring quality costs and thus specific actions to reduce quality costs are allowed. Intensive education at real levels is necessary for managers to better understand the concept of quality cost in order to fully understand the benefits of the approach in order to increase their ability to implement a quality cost measurement system and financial savings. It is noticeable that after 36 months quality costs decreased further by about 92 %.

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Modelo ABC de custo da qualidade: um estudo de caso

ABSTRACT

O objetivo deste artigo é mostrar a vantagem de introduzir o modelo ABC que mede o custo da qualidade em uma pequena empresa de usinagem e ferramental industrial, como gerenciar custos de produção e, como consequência, controlar seus processos. Para alcançar a qualidade dos processos e / ou produtos, deve-se considerar não apenas o aumento dos custos necessários para manter o nível de qualidade estabelecido. A literatura sobre esse assunto destaca que programas de qualidade, como Controle de Qualidade Total, melhoria contínua e outros, de fato, diminuem os custos de produção, devido à eliminação do retrabalho e da não conformidade dos produtos entregues aos clientes, internos e externos. Além disso, qualquer programa de qualidade bem estruturado é um elemento fundamental de sobrevivência, no mercado hoje muito competitivo. Para desenvolver um programa de qualidade, satisfazendo critérios financeiros apropriados, devem ser aplicadas ferramentas apropriadas de gerenciamento de custos de qualidade, suportadas por um sistema contínuo de coleta de dados. Essa atividade também requer o estabelecimento de ações corretivas, metas e objetivos, avaliando o desempenho da qualidade, tendo em vista os resultados esperados. Por meio deste estudo de caso, desenvolvido em uma empresa, foi possível introduzir o modelo de custeio ABC para medir seus custos de qualidade, identificando e definindo sua principal classificação de custos. Fontes relevantes de materiais e resíduos operacionais gerados, planos de ação corretivos e preventivos foram identificados e implementados, reduzindo em 76% os custos de qualidade em 12 meses. Concluiu-se que o gerenciamento de custos de qualidade em uma pequena empresa semelhante ao analisado é um método vantajoso para a tomada de decisões, adequado para alavancar finanças e minimizar desvios de conformidade. Após 36 meses, os custos de qualidade diminuíram ainda mais, em torno de 92%.

KEYWORDS: Custeio Baseado em Atividade (ABC). Finanças. Custos de qualidade.

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