THE IMPROVEMENT OF A CERAMIC PRODUCT QUALITY IN A PORCELAIN FACTORY

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Abstract: *Nowadays, the quality of the products plays an important role in ensuring competitive advantages and improving, in the same time, the performance of the organization. Product defects are considered sources of nonconformities, which involve financial and image damage to the organization. Therefore, companies show an increased interest in the improvement of product quality. Thus, the main objective of this research is to improve the quality of one of the products manufactured in a porcelain factory, named S.C. APULUM. S.A. The applied methodology involves first of all a diagnosis of the quality management processes through quality functions to identify the most important problem facing the organization, respectively the quality of the products, followed by the use of quality tools to detect improvement opportunities. Also, the PDCA cycle is used for continuous improvement. The conclusions show that after applying the established measures, the situation considered registered a slight improvement.*

Keywords: product quality, improvement, porcelain factory

JEL Classification: L00, L15

Introduction

In recent years, modern-oriented companies are subjected to numerous economic, political, technological and social changes. Increasing competitive struggle, the appearance of new knowledge and technology, information and communication capabilities, constantly increasing needs and demands of consumers and the new regulations influenced the emergence of a new philosophy of business companies. During the `80s, in the business world, appeared a new management concept-quality management (QM). It involves the implementation of total quality management (TQM) that is used to integrate business operations to create products/services with maximum quality (Topalović, 2015), that are getting greater attention by the consumers. Moreover, in some industries, after the price of the product, the quality has become the second most important factor influencing consumers' purchasing decisions. Hence, many industries are now adopting product quality improvement as a powerful competitive tool (He et al., 2016) in fulfilling consumers' expectation level (Chakraborty et al., 2019).

This paper consists of three chapters: first chapter presents a literature review regarding the definition of the quality concept and evolution of the quality concept; the second chapter

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consists in a case study, where applying different quality tools, the quality of one of the ceramic products manufactured in a porcelain factory is improved and the third chapter presents the final conclusions which emphasize that after applying the established measures the quality of the considered product has been improved.

Literature review

Definition of the concept of quality

Quality is usually an imperative issue to any company survival in the competitive market. During time, the worldwide experts have postulated different definitions for quality (table no.1).

Table 1. Definitions of quality

Definition	Author
Suitability to use	Juran
Predictable degrees of uniformity and dependence at a low cost and appropriate to the market	Deming
Compliance with requirements	Crosby
Customer satisfaction	Ishikawa

Source: (Neves et al., 2018)

A reference moment in the evolution of the quality concept is the emergence in 1986 of the international standard ISO 8402, through which is reached the international consensus regarding the terms, definitions and applicable concepts of quality. In accordance with ISO 8402 (revised 1994), quality represents ”the set of properties and characteristics of an entity that gives it the ability to meet the expressed and implicit needs” (Oprean et al., 2012).

The ISO 9000 standard brings a new vision to the specific concepts of quality. In the latest version of this standard, respectively in the version released in 2015, quality represents ”the degree to which a set of inherent characteristics of an object fulfills the requirements”. The characteristic is ”a distinctive feature of physical, sensory, behavioral, temporal, ergonomic and functional nature”. The object can be ”an entity, an article or whatever is perceptible or imaginable”. The requirement is ”a need or an expectation that is stated, generally implied or obligatory” (SR EN ISO 9000:2015).

Evolution of the concept of quality

Over time, the concept of quality has undergone four important stages, namely: inspection, quality control, quality assurance and total quality management (Oprean and Kifor, 2002), all these being presented below.

a. Systems for inspection or conformity assessment

Inspection - assessment of conformity by observation and judgment accompanied, as the case, by measurement, test or comparison with the gauge. In a simple system, based on inspection, one or more features of the product, service or activity are measured, examined, tested or evaluated and compared to specific requirements in order to assess the compliance with a specification or a performance standard. This system is not oriented on prevention and it does not allow the identification of the causes that led to the occurence of non-conformities (Oprean et al., 2012).

b. Quality control systems

Quality control - part of quality management focused on fulfilling the quality requirements. This type of system involves the existence of detailed specifications of the

products and processes, activities of verification of the raw material and of the product in different stages of processing, but also feed-back based on the information from processes. In addition to the inspection-based systems, there is the self-control of the products made by the operators, the use of various techniques and tools, as well as the basic statistical techniques. It ensures a greater control of the processes and a lower incidence of non-conformities (Oprean, 2005).

c. Quality assurance systems

Quality assurance - part of quality management focused on providing confidence that the quality requirements will be met. In parallel with the individual concerns of the quality gurus and with the large scale application of the quality control systems, quality systems, whose sphere of influence gradually extends from quality verification to other activities of the organization directly involved in the production of the products (analysis of the client's requirements, manufacturing planning, manufacturing, acquisitions, storage and delivery, service and then even on the constructive and technological design) start to become functional in different organizations (Oprean and Kifor, 2006).

Based on the experience gained gradually from these organizations and taking into account the practical results of the organizations that have succeeded in their implementation of the principles and concepts of the quality gurus, under their direct guidance, national regulations for planning the quality systems appear, which were subsequently adopted by the international standardization bodies (Oprean and Kifor, 2002).

d. Quality management systems

Quality management system (QMS) - integrated set of activities for establishing and controlling work processes, managing resources, carrying out evaluations and continuous improvement (Carey, 2018). It suppose the systematic use of the ensemble, of the resources (especially human resources) in the organization during the entire life of the product/service provided by it, in order to fully satisfy the clients' requirements simultaneously with improving the economic results of the company (Baba, 2019).

Research methodology

The methodology (fig. no.1) used in the study case presented in this paper consists of three steps, namely:

1. Assessment of quality management processes – implies an evaluation of the company`s quality management processes to diagnose possible problems and limitations in these processes leading to the identification of improvement opportunities.
2. General quality data analysis – aims to analyze the historical records of occurance of non-conformities in the entire production process in order to prioritize actions to resolve the problems.
3. PDCA cycle – used in order to solve a specific problem that was considered a priority in the previous step (Fernandes et al., 2013).

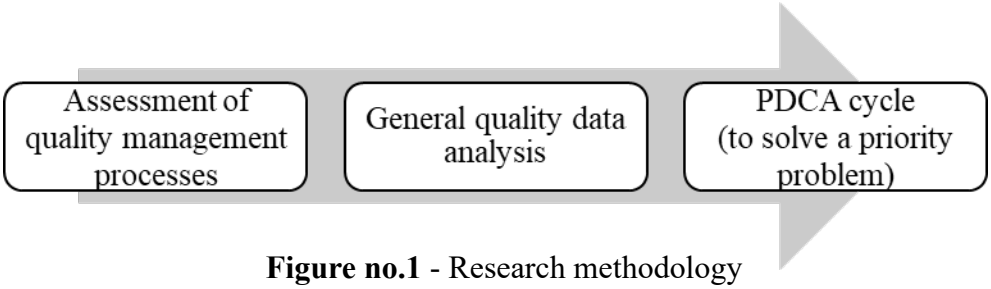

Figure no.1 - Research methodology
Source: Fernandes et al., 2013

Case study

Study area

The company considered in the case study is S.C. APULUM S.A., it was founded in 1970 in the city of Alba Iulia. It is the largest porcelain manufacturer in Romania and also in South-East of Europe, with a variety of production: household and HoReCa articles on porcelain, decorative objects (Sârb et al., 2018).

Credibility of the ”Apulum” results from the main strengths of the company, such as: quality of raw materials, modern technology used to manufacture different products, staff structure, the price-quality ratio perfectly adapted to the customer's requirements, modern and dynamic management, adaptable to the changes that may occur in the internal and external business environment (Sârb et al., 2019[a]).

Application of the research methodology

Assessment of quality management processes

S.C. Apulum S.A. implemented, certified and maintained up to now a QMS since 1998 according to ISO 9001:1994. In 2017, the company was recertified in accordance to ISO 9001:2008 and in 2018 took place the surveillance audit with transition on ISO 9001:2015 (Sârb et al., 2019[b]).

The quality policy is defined by the top management and it is based on the following management principles and behaviors:

- creating a mutually beneficial relationship with the clients of the company, to ensure long-term success, by understanding their needs and their clients needs;
- continuous improvement and innovation based on efficient business processes, well-defined measures, best practices and customer questionnaires;
- improving systematic research and the use of best practices at all levels and ensuring reliable risk management;
- developing skills, creativity and empowering staff through adequate development programs and the involvement and strong commitment of the management.

Also, within the organization the following five quality objectives have been set:

- maintaining the certification of the QMS;
- continuous improvement of the QMS;
- harmonizing the creative potential of the organization with the market requirements;
- investments to improve and optimize processes;
- decrease of expenses (S.C. APULUM S.A., 2020).

The quality assessment was performed through the quality functions, taking into account the specific processes of the QMS that are carried out within the organization.

Table 2. Quality functions. Processes for QMS assessment

Quality function	Process
Quality planning	Suppliers qualification
	Definition and communication of the raw materials/components or subcontracted services requirements to the supplier
	Definition of the specifications/acceptance criteria and critical features of the product
	Customer requirements survey and product features validation to meet customer requirements
	Survey and verification of the compliance with the statutory and regulatory requirements applicable to the product
	Preliminary studies on the processes capability (products) or skill (services) and operating
	Ensure that who is involved in the processes have the necessary capabilities and knowledge to the products realization
	Identification of potential problems (that may arise in the product realization) and solutions
Quality Control	Planning of inspection and testing in the production
	Inspection and testing of raw materials/components and control of subcontracted services
	Calibration/verification of measurement, inspection and testing equipment
	Identification and treatment of nonconforming product
	Corrective actions to sporadic problems
	Verification of the process capability
Quality Improvement	Identification of improvement opportunities
	Priorities definition
	Analysis of opportunities for improvement
	Definition and planning of improvement actions
	Verification/monitoring of the effectiveness of improvement actions

Source: Fernandes et al., 2013

Upon completation the evaluation of the considered quality management processes the following was established:

- there are documented procedures of quality planning for all the processes existing in the factory;
- regarding quality control, it was concluded that sampling or 100% inspection are performed in all stages of the production flow;
- all non-conformities are registred and treated by corrective actions;
- taking into account the quality improvement, there is a methodology established in this regard, which suppose the usage of different quality tools.

Also, it was concluded that the most important problem the factory is facing is the quality of some of the products. Thus, in this paper, it was considered one of the most problematic products in terms of quality, named Serving Plate ϕ 27.5.

General quality data analysis

In order to detect improvement opportunities regarding the product quality, the first step was to analyze the quality of the choosen product. The analysis was performed taking into account the records made between January-March by the quality control inspectors. Thus, performed analysis aims to understand which is the quality level of the product considered and which are the defects that need to be diminished.

To accomplish the stated goal, three charts were built considering: the percentage of first quality class of the considered product (fig. no. 2), the percentage of the defects that appear in case of the product together with the average of each defect per every month (fig. no. 3) and the Pareto chart for the characteristic defects (fig. no. 4).

Figure no. 2 - The percentage of the First Quality class of the product (January-March)
Source: own source

Although, the percentage of first quality class established for the products manufactured within the organization is at least 90%, in figure no. 2, it can be observed that in case of the product considered this percentage was not reached in any of the months taken into account.

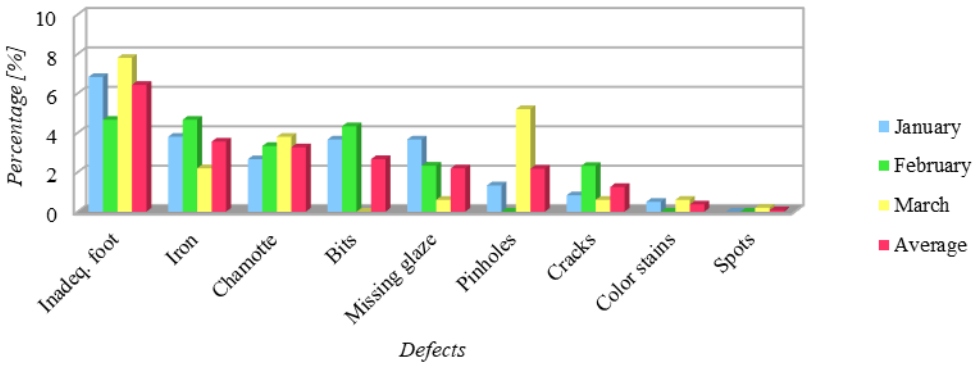

Figure no. 3 - Defects of the considered product (January-March)
Source: own source

Figure no. 3 illustrates that nine different defects contribute to reducing the percentage of first quality class for the product under consideration. In order to identify the weight of each defect in influencing the quality of the product considered a Pareto chart was elaborated (fig. no. 4).

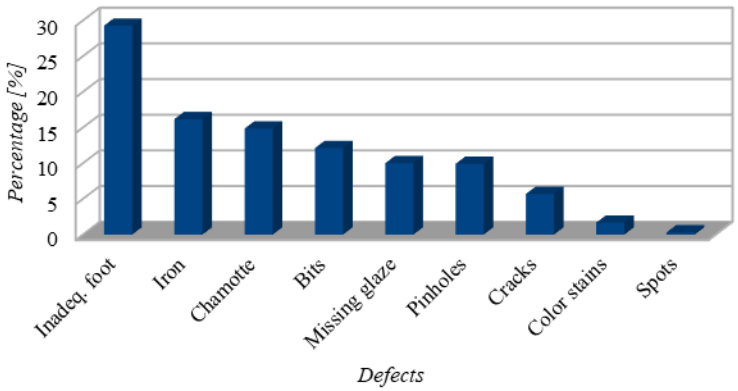

Figure no. 4 - Pareto chart for the characteristic defects (Janury-March)
Source: own source

Figure no. 4 illustrates that five of the nine defects contribute significantly to the total percentage of the first quality class. Thus, the following defects – inadequate finishing foot ring (29.3%), iron (16.2%), chamotte (14.9%), bits (12.1%) and missing glaze (10.0%) – represent 82.5% of the total percentage of the defects. So, all these defects will be studied following the methodology PDCA.

PDCA cycle

Plan

In this stage the cause of the problem was analyzed, using a Ishikawa diagram (fig. no. 5), during a meeting attended by the Executive manager, Production responsible, Quality manager, Firing manager, Shaping manager and workers from the departments involved.

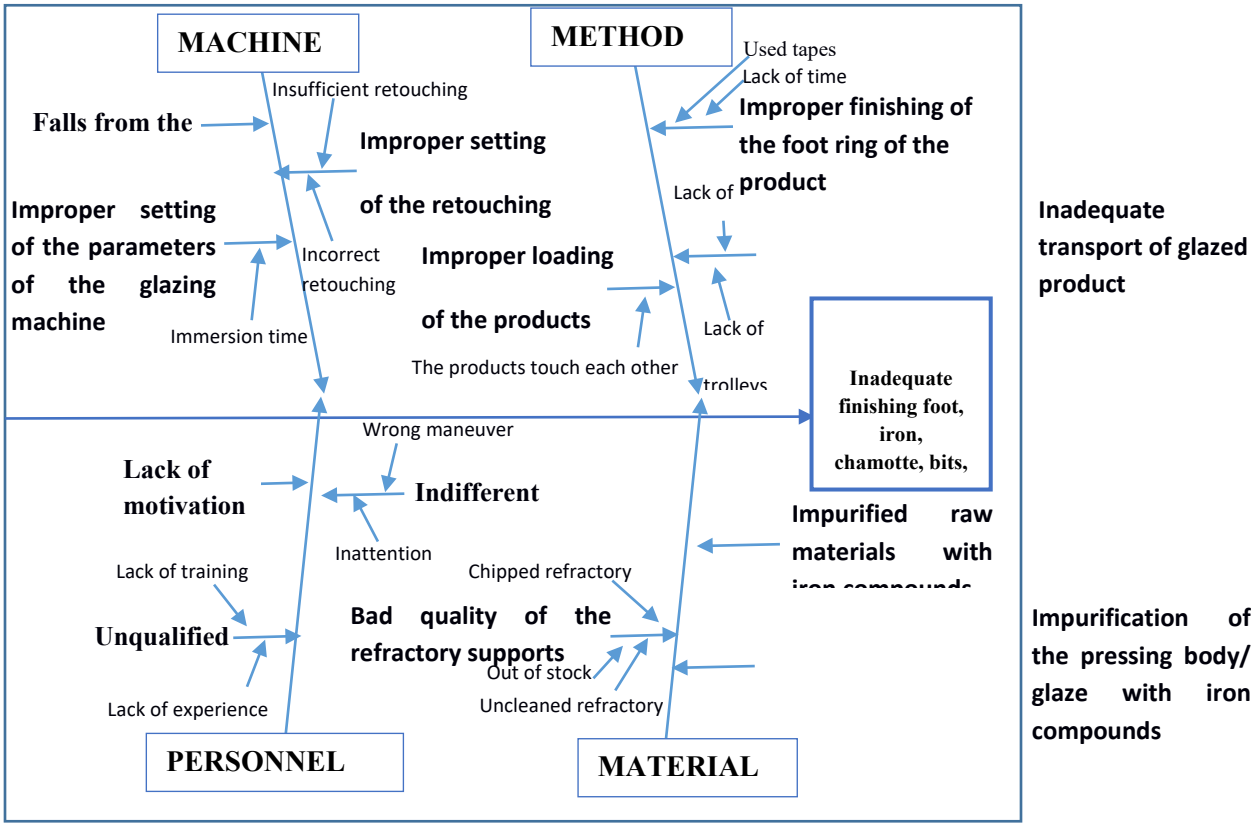

Figure no. 5 – Ishikawa diagram used to identify the root cause of the considered defects
Source: own source

The data provided by Ishikawa diagram were analyzed during another meeting attended by the same people. The method used in order to generate ideas about the improvement of the quality of the product considered was Brainstorming.

Do

The action plan established in the previous stage involves the implementation of the following corrective actions presented in table no. 3.

Table 3. Types of defects, causes and established corrective actions

Defects	**Type of cause**	**Cause**	**Corrective action**
Inadequate finishing foot ring	Method	Improper finishing of the foot ring of the product	Training personnel regarding correct way of finishing of the foot ring of the product
	Material	Bad quality of the refractory supports	Replacement of the improper refractory supports
	Personnel	Indifferent	Offering bonuses based on individual performance
Missing glaze	Machine	Improper setting of the parameters of the glazing machine	Proper setting of the parameters of the glazing machine
	Method	Improper loading of the products	Training of the employees regarding the

		inside the kiln	correct way of loading
		Improper transport of the glazed products	Avoid touching the products with each other during transport by increasing the number of trolleys.
Iron	Material	Impurified raw material with iron compounds	Increasing the severity of reception for raw materials
		Impurification of the pressing body/glaze with iron compounds	Removal of the impurification sources
Chamotte	Machine	Falls from the kiln	Ensuring the periodic maintenance of the kiln masonry
	Personnel	Unqualified	Training of the personnel
Bits	Machine	Improper setting of retouching machine	Adequate setting of the retouching machine
	Personnel	Lack of motivation	Implementation of personnel motivation methods

Source: own source

Check

In order to study the evolution of quality, as a result of the implementation of corrective actions presented in table no. 4, the data from another three months (April-June) were analyzed. Thus, the percentage of the first quality class of the product, the defects of the considered product together with the average of each defect per every month and the Pareto chart for the characteristic defects are shown again (fig. no. 6,7,8).

Figure no. 6 - The percentage of the First Quality class of the product(April-June)
Source: Own source

It can be observed that after applying the corrective actions, the percentage of the first quality class has registered an increase in all three months considered, but without reaching the established limit of 90%. If in the first three months, the lowest percentage was 79.5% in January and the highest percentage was 81.0% in February, now the lowest percentage was 82.0% in June and the highest percentage was 85.5% in May.

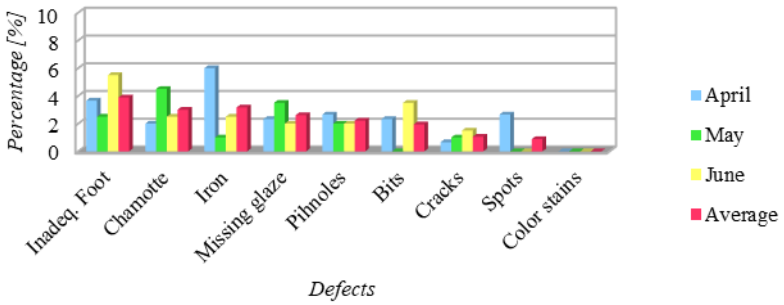

Figure no. 7 - Defects of the considered product (April-June)
Source: Own source

Figure no. 7 compared to figure no. 3 illustrates that the average of defects during the April-June period decreased for the following defects: inadequate finishing foot, chamotte, iron, bits, cracks and color stains, but in case of missing glaze, pinholes and sports it registered a slight increase.

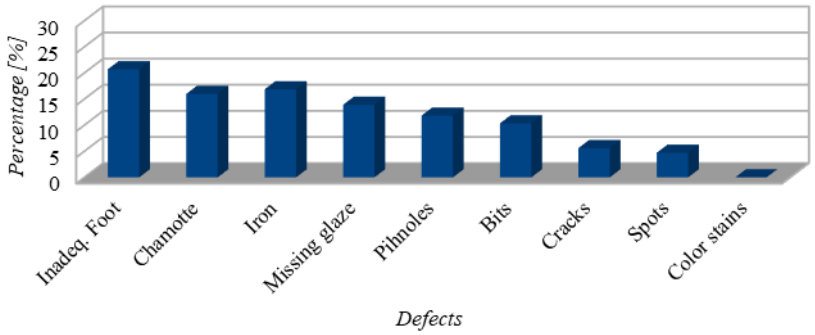

Figure no. 8 - Pareto chart for the characteristic defects (April-June)
Source: own source

Figure no. 8 illustrates that after applying the established corrective actions, the considered defects represent 77.9% of the total percentage of the defects, with the following weights: inadequate finishing foot ring (20.7%), iron (16.9%), chamotte (16.0%), bits (10.4%), and missing glaze (13.9%). It can be observed that the highest improvement is registered for inadequate finishing foot, which decreased with 29.4%.

Act

The corrective actions established within the Do stage were standardized in order to maintain, in the future, the optimal results. Therefore, it was decided to maintain the following actions: proper finishing of the foot ring of the products, replacement of the improper refractory supports, offering bonuses based on individual performance, proper setting of the parameteres of the glazing machine, avoid touching the products with each other during transport by increasing the number of trolleys, increasing the severity of reception for raw materials, ensuring the periodic maintenance of the kiln masonry, establishing a regular training personnel program, adequate setting of the retouching machine, implementation of personnel motivation methods.

Conclusions

In order to survive in the market, organizations need to continually improve their business. One of the most important aspects regarding the company's activity is the quality of the products/services. Thus, as a result of the analysis performed on the quality management processes existing in the porcelain factory, the quality of some of the products is one of the major problems of the organization. Due to the large number of products manufactured within the company, one of the most problematic products was considered, it is named Serving Plate ϕ 27.5. Thereby, records regarding its quality were analyzed using different quality tools.

The analyzed data emphasize that after applying the established corrective actions, the percentage of first quality class is higher for the second period than the first period. Also, regarding the average for each defect, in six cases, respectively, inadequate finishing foot, iron, chamotte, bits, cracks and color stains it decreased, while in the following cases missing glaze, pinhole and spots it suffered a slight increase. After applying the Pareto chart it was concluded that if in January – March the five defects that most influence the percentage of I Quality represented 82.5%, in April – June, the same defects represented 77.9%, with a decrease of 5.6%.

Even if the established percentage of first quality class for the product manufactured within the organization was not reached, it is expected, that in the future, through the continuous application of PDCA cycle, it will be exceed.

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