Evaluation of Quality Management for Strategic Decision Making in Companies in the Plastic Sector of the Colombian Caribbean Region Using the TQM Diagnostic Report and Data Analysis

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Abstract. The plastic sector is considered one of the most dynamic industries with the highest competitive projection in the country. The incidence of this sector in the national and regional economy has led to the completion of various investigations, to learn about their behavior and detect opportunities for improvement. In this regard, previous studies carried out by entities in Colombia such as the Universidad del Norte [1], corroborated the growth potential of the sector; but one of its most relevant weaknesses was also identified in the quality factor and, at the same time, it was proposed as the main strategy for making decisions associated with productivity and competitiveness. Given this precedent, an analysis of the state of the art in this area was made, and it was found that there is not enough information on the current situation of quality management in the plastics processing and production industry in the Colombian Caribbean Region. Faced with this problem, a study was conducted to visualize the behavior of companies belonging to the plastics sector regarding quality management, identifying and analyzing the most significant needs for the approach of joint strategies to improve the sector.

Keywords: Quality management · Decision making · Plastic sector
Data analysis

1   Introduction

The plastic industry is one of the productive chains of higher evolution, both in the growth in production, which reached 250 million tons in 2015 [2], with a growth rate in the consumption of plastic materials of the 4% up to 2030 [3]. In Colombia, this sector stands out as one of those that have best responded to the economic opening by establishing new markets, developing new products, improving its technological capacity and attracting foreign investment [4].

However, this growth will condition by latest trends in the manufacture and consumption of plastic, such as prices of raw materials, consumer demands, government and interest groups related to the impact of plastics on the environment and the possibility of Offer new products. Therefore, companies must implement standards and management tools to improve their products and processes continuously.

The Total Quality Management - TQM is a methodology that helps companies to be more productive and competitive in very dynamic markets but presents both endogenous and exogenous difficulties for implementation and certification [5]. Although there are some studies found in the literature, knowledge of quality management in the plastics sector is still limited, as well as the use of diagnostic methodologies.

This paper presents, in Sect. 2 a literature review on quality management. The methodology approach is explained in Sect. 3. Then, results and analyses are shown, in Sect. 4, with the description of the industrial and productive profile of the companies in the sector, and the diagnosis of enterprises taking into account the key variables of Total Quality Management, by city and company size. Finally, Sect. 5 presents the conclusions and future works.

2   Quality Management. A Literature Review

Quality Management is a management process based on quality, in which the activities, tools, and personnel involved interact in a coordinated manner towards the permanent search for satisfaction of the requirements, needs, and expectations of the clients, according to ISO 9001:2015 [6]. In this regard, we found different scientific articles that demonstrate the importance of knowledge management and quality management and their influence in companies [7]. In [8], shows the relationship between information systems quality and organizational impact. Other work shows the assessing information quality in manufacturing planning [9]. The quality management can be design using tools and methodologies. For example, in [10] shows the application of a methodology based on process management to increase the performance of processes and implementation of the Quality Management System in a Higher Education and in [11] shows the results of a similar study, but implementing an integrated approach based on the Balanced Scorecard and implementation of ISO 9001 in a service organization in Colombia.

Mainly, this research focuses on the application of quality management systems in the plastics industry. In this respect, very few studies were found in the scientific literature. In [12] explains a process for quality control of plastic injection using

machine learning algorithms. Also, in other works, [13, 14], explain how to use the Taguchi Method and six sigma method for quality control of the plastic product and in [15] explains the implementation of a quality plan in a company in the plastics industry in Peru. In [16] describes a methodology for evaluation of Total Quality Management using Corporate Social Responsibility - CSR Company Reports.

In this regard, it can conclude that studies directly focused on improving the productivity and competitiveness in the plastic industry, with the use of the total quality management, are mostly limited. Therefore, this research contributes to the scientific literature and provides a diagnostic tool for companies in the sector based on the Total Quality Management.

3   Methodology

The investigative method [17, 18] used is described as follows. The project is framed within the analytical, descriptive and prospective study; because data and information of the present were collected and analyzed, with the purpose of proposing improvements towards the future. Given that a diagnosis of the current situation had to be made to propose solutions to the problems that arose during the investigative analysis, the study classified as transversal. It is also descriptive - explanatory, because the project, through a diagnosis of variables associated with total quality management, analyzed and classified the characteristics and behavior of Quality Management in the companies of plastic sector in the cities of Barranquilla and Cartagena, and the interrelation between the different variables that affect the management capacity of the companies in this aspect, to finally propose the action strategies.

Figure 1 shows the methodological design with the stages of the project, the procedure used to perform the entire investigative process, measurement techniques and data collection used.
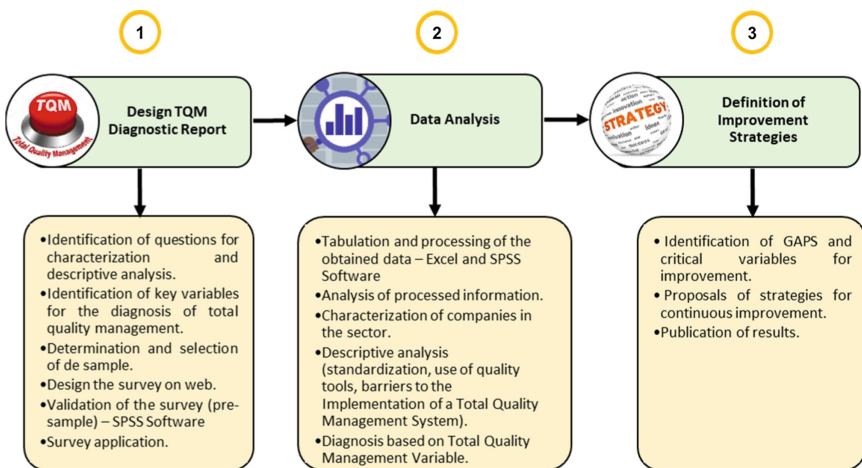

Fig. 1. Methodological design

For the data collection, a survey called TQM diagnostic report designed, which consists of three diagnostic components, as shown in Fig. 2. The TQM Diagnostic Report applied to a sample of 35 companies in the cities of Barranquilla and Cartagena using Eq. 1 for the calculation of the sample size (p = 0.5; q = 0.5; e = 0.05; k = 1.96; N = 39). The survey demonstrated a good level of reliability [19], with a Cronbach alpha of 0.96.

$$n = \frac{k^2 * p * q * N}{(e^2 * (N - 1)) + k^2 * p * q} \tag{1}$$
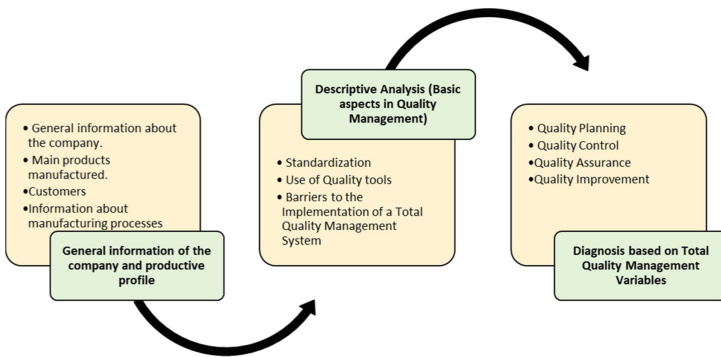

Fig. 2. Components of TQM diagnostic report

4   Results

4.1   General Information About the Companies of the Sector

In Table 1, are observed the main general characteristics found in the companies of the plastic sector are following:

Table 1. General information and productive profile

General data	Characteristics
Age of the company	34% of the companies are more than ten years old, but the creation of new companies in the last five years stands out
Size of the company	71% of the companies analyzed belong to the SME segment (Small and medium enterprises)
Foreign capital	88% of the companies are national, and only 12% have foreign capital
Economic activity	91% of companies are engaged in the transformation of plastic resins into final products
Export activity	57% of companies export their products to markets in Latin America and the US. The sectors of high demand for companies are packaging, food, and construction

4.2 Descriptive Analysis of Basic Aspects of Quality Management

In Fig. 3a–e, the primary results of the descriptive analysis are observed, taking into account essential characteristics in quality. The results show the potential that exists for companies to implement and certify their processes, use consulting services in quality management and certification and manage different tools to support quality. Likewise, the main barriers for companies in these processes are shown.
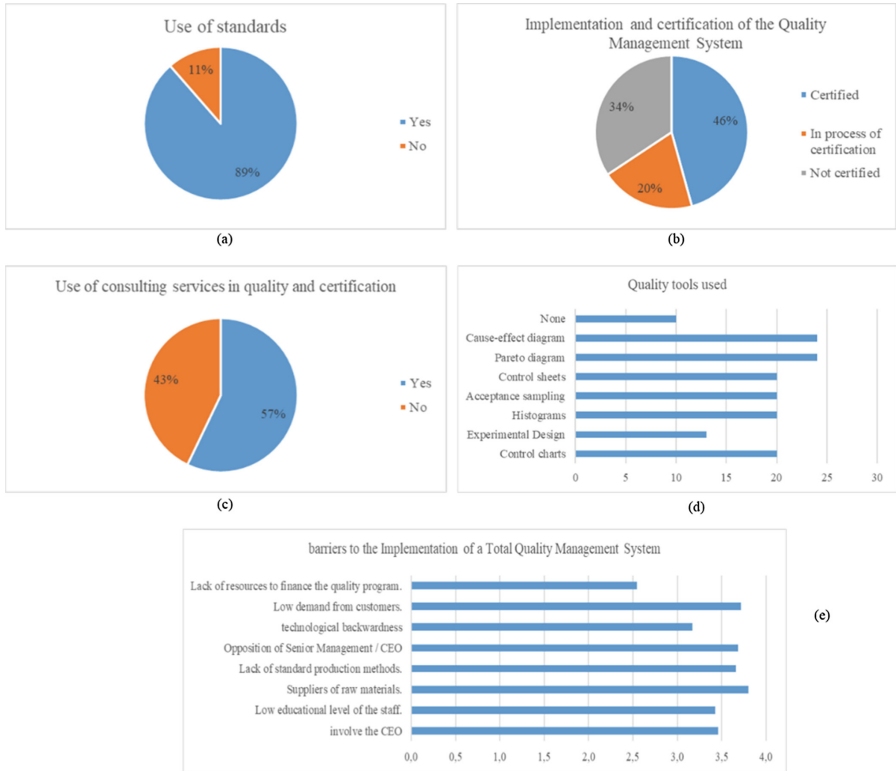

Fig. 3. Results obtained from the descriptive analysis: Use of standards (a), implementation of certification management system (b), use of consulting services in quality (c), quality tools (d) and barriers to implementation TQM system

4.3 Diagnosis Based on Total Quality Management Variables

In Table 2 shows a comparative table between the maximum scores of the TQM diagnosis for each of the critical variables (obtained from the multiplication of the number of questions by the Likert score scale) and the results obtained by the companies, according to the city and the size of the company. The results show a better performance of medium and large companies compared to small and micro companies. Likewise, companies in the city of Cartagena obtained better results than companies in the city of Barranquilla.

Table 2. Results of TQM diagnosis

	Variables				
	V1. Quality planning	V2. Quality control	V3. Quality assurance	V4. Quality improvement	Total score
Top score	65	45	140	30	280
Score obtained (average Cartagena)	60	41	123	27	250
Score obtained (average Barranquilla)	46	33	103	19	200
Score obtained (average big companies)	56	41	122	25	245
Score obtained (average medium companies)	61	40	123	27	251
Score obtained (average small companies)	46	30	99	17	192
Score obtained (average micro companies)	31	24	79	11	145

4.4 Improvement Proposals for Strengthening Total Quality Management

In an effort to underpin the Total Quality Management in the companies of the sector, a series of strategies are proposed with the aim of improving the quality management levels and, at the same time, increasing the productivity and competitiveness of this sector. The summary of the improvement proposals and the specific strategies are shown in Table 3.

Table 3. Improvement proposals

Variables	Improvement proposals	Size of company			
		Big	Medium	Small	Micro
Quality planning	Definition of the Mission, Vision and corporate values, to establish Quality Policies, objectives, and goals			✓	✓
	Incorporate strategic planning techniques (SWOT Analysis, Market Research)			✓	✓
	Development of the managerial capacity of the managers towards the Management of the Quality	✓	✓	✓	✓

(*continued*)

Table 3. (*continued*)

Variables	Improvement proposals	Size of company			
		Big	Medium	Small	Micro
Quality control	Implement statistical methods for the control of raw materials, processes, and products			✓	✓
	Encourage companies to use quality laboratories, research, and development		✓	✓	✓
Quality assurance	Sensitize Senior Management about the implementation of operational and administrative procedures		✓	✓	✓
	Encourage companies to use technical standards	✓	✓	✓	✓
Quality improvement	Development of an organizational culture suitable for quality and improvement	✓	✓	✓	✓
	Use of Management standards and indicators	✓	✓	✓	✓
	Use of statistical tools and techniques for the improvement of processes	✓	✓	✓	✓
	Training in soft management techniques	✓	✓	✓	✓

5   Conclusions and Future Works

This research constitutes a valuable contribution for the plastic sector of the Colombian Caribbean Region, by becoming a tool for analyzing the current situation of the same and for diagnosis in terms of Quality Management, achieving not only the description of the behavior of companies in the sector, but their classification taking into account their common characteristics, as well as the identification of key variables that affect their management capacity. The results of this research aim to raise the levels of productivity and competitiveness in companies in the sector, through the implementation of joint strategies with respect to Quality Management as a means for organizations to develop formal systems focused on customers, suppliers, the company and society in general, facilitating their growth and positioning in increasingly demanding markets.

As future work, the TQM diagnostic report will be applied to the selected companies to perform multivariate analysis, evaluate the levels of performance in quality management and establish correlational analyzes between variables and characteristics such as the size of the company, antiquity, and export orientation, among others.

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