CHEMICAL ENGINEERING TRANSACTIONS
VOL. 86, 2021
A publication of AIDIC
The Italian Association of Chemical Engineering
Online at www.cetjournal.it
Guest Editors: Sauro Pierucci, Jiří Jaromír Klemeš

**ISBN** 978-88-95608-84-6; **ISSN** 2283-9216

# Design of a Strategy for the Quality Management System in a Bricks Manufacturing Company in Colombia

Laura Carrero[a], Brayan Gomez[a], Pablo Velásquez[a], Angélica Santis[a,*]

[a]Universidad Cooperativa de Colombia, Avenida Caracas 37-63, Bogotá, Colombia
*angelica.santisn@ucc.edu.co

Globalization makes us find ourselves in a world where markets are increasingly competitive, and therefore companies are concerned about having higher quality products and processes. Adopting quality, environmental, and social practices could become strategies for success and recognition in the market. The quality management systems appear to control and improve the activities within the manufacturing and services organizations. To help organizations manage their improvements, the international standard ISO 9001: 2015 is used, which is a crucial tool in implementing quality management systems. This standard is supported by the Deming cycle or, in other words, the PDCA (plan-do-check-act), which is characterized by promoting continuous improvement, and makes that all the company's tasks can be executed in an organized and efficient way. Companies dedicated to the manufacture of goods are in a continuous task so that their systems and processes operate adequately. The companies' objectives are to comply with their production plans, where quality and minimization of resources prevail. When considering the construction sector, it stands out that bricks appear as one of the most essential and used materials. Likewise, within the materials used in this sector, the bricks have an excessive demand, and all this is associated with the increase in population growth rates. Given this demand scenario, companies try during the production process to reduce the percentage of defectives products and thus become more competitive in the market. Also, companies pretend to be able to satisfy the needs of customers and market requests. All of this supported by the commitment and direct participation of both management and employees. Based on the above, this work focuses on designing a strategy for the quality management system in a brick manufacturing company in Colombia based on the international standard ISO 9001: 2015. The proposed strategy aims to increase productivity using its resources (human, technological, and raw materials) most efficiently. This strategy will translate into an increase in customer and employee satisfaction and generate greater confidence, producing improvements in the corporate image and therefore increased sales.

## 1. Introduction

In the 1980s, with the impact both on a technological and informational level, there has been growth in the markets, which has allowed consumers to demand more in terms of processes and products. This scenario has increased with the rise of globalization (Cardenas et al., 2018). Based on the above, the need for quality standards has become a determining factor to companies worldwide when offering products and services. The need to establish these standards has been reflected in approaches such as Deming's, which says, "transformation can only be carried out by man, not hardware (computers, devices, automation, new machinery), a company cannot buy the road to quality" (Deming, 1989). Ideas established by William E. Deming broaden the vision to the world about the reality of the processes and how they were carried out in the East. Thanks to this, it establishes 14 principles for quality assurance. These principles provided large Western companies with administrative techniques that allowed them to improve each of their processes. In organizations worldwide, it is essential to establish mechanisms that allow the provision of goods and services with high-quality standards to establish a competitive advantage in the market. Consequently, Quality Management Systems arise based on the philosophy that seeks to ensure customer satisfaction through continuous improvement and management of the organization as a single system. Within this unique system, each of its parts must be cohesive to achieve

a functioning that allows consolidating a whole system. Now, through economic and industrial growth, it has been detected that Quality Management Systems must be directed towards teamwork, customer focus, cost reduction, commitment, leadership, and training. This implies an appropriate work culture, which aims to design an appropriate strategy that positively impacts the company and becomes the philosophy to apply to achieve excellent results (Malik et al., 2012).

High levels of competition have induced cycles of continuous improvement in companies, which affect their power to grow, develop, and survive. This way was how Deming in the 1950s proposed a strategy that he called PDCA. This cycle was designed to solve problems and implement solutions. It was so versatile that 80% of the companies that used it showed that their reduced costs between 20% and 30% in the initial stage of its development. (Jagusiak-Kocik, 2017). Currently, different methodologies base their improvement models on the PDCA cycle, since its use is appropriate when an error is detected early or immediately after a failure occurs (Lovrenčić et al., 2017). The interest shown by the Orient to implement these methodologies was so astonishing that industries focused on applying it and making impressive improvements in quality development. Thus, during World War II, Japan focused its efforts on stopping making copies and starting to manufacture original products, and in 1966 the Quality Function Deployment (QFD) methodology emerged. Initially this technique was immersed in Total Quality Control. The QFD allowed the management structure to recognize the importance of quality and generated a decrease in manufacturing costs. Since, in the previous methods, the control was carried out from graphics generated in post-production (Akao, 1997). Simultaneously, they focused on the value engineering of products and services whose success lies in optimizing each of the elements involved in manufacturing and their focus on customer satisfaction. This involves reducing the product cycle, and minimizing design problems, making products and services more competitive (Cristiano et al., 2001).

When the construction sector is considered, it is characterized by having a more significant impact on an economic level, mostly because it is the pillar of the world's necessary infrastructure. One of the most important companies in this sector refers to brick manufacturing plants. It is relevant to consider that the development of this industry has occurred in an artisanal way and that over time it has evolved towards a cutting-edge commercial production (Oral & Mıstıkoglu, 2007). Like other industries worldwide have adapted to changes resulting from globalization, the brick industry has had to adjust to the modes of production used. At this point where ensuring quality takes tremendous importance, the reason for which it is necessary to implement methods for quality assurance that are comprehensive and with which the different fronts that organizations must cover and implement to achieve high levels of competitiveness can be evaluated. Consequently, this study aims to design a strategy for the quality management system in a brick manufacturing company in Colombia based on the international standard ISO 9001: 2015. The strategy aims to increase productivity in a brick company, optimize human, technological, and raw material resources, satisfy customers and employees, generating improvements in the corporate image, and increased sales.

## 2. Materials and methods

To correctly establish the client's wishes, the lean manufacturing methodology 5's is used; this allows to be carried out a study considering the following fundamental pillars: Sort, straighten, sweep, standardize, and sustain. This working method allows the problems of reprocessing, waste, and industrial safety in the plant to decrease significantly, and the productivity has an improvement rate from 30% to 50% (Hernandez et al., 2015). The company studied is in Bogotá (Colombia) and is part of the construction sector, specifically brickyards. To establish the correct development of the study, the strategy that was implemented is based on the ISO 9001 standard, which is based on the dynamic PDCA cycle (Figure 1), which allows the processes to be executed through a logical and organized sequence to facilitate monitoring and continuous improvement in the organization.

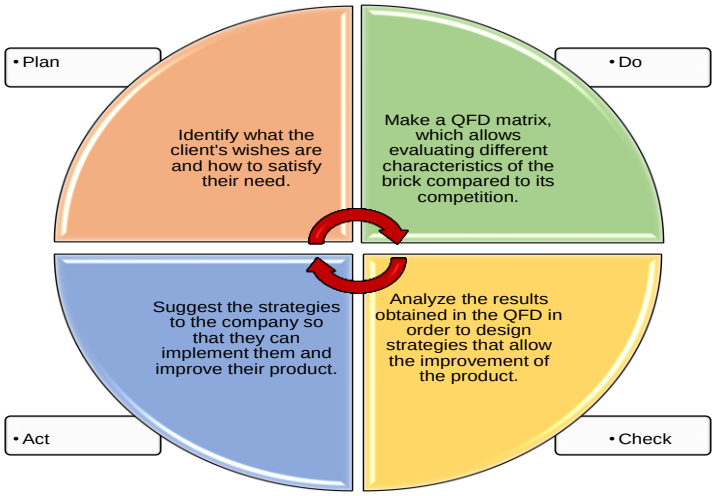


*Figure 1: PDCA cycle*

## 3. Results and discussion

Knowledge of the customer's requirements when buying a brick is fundamental because it permits that analyze the importance of the specifications that the end customer expects from the product.
To realize the QFD, a survey was conducted to customers on the main characteristics they expected of the brick. The survey implemented the weighting levels shown in Table 1. In this case, a weighting was given 1 to 5, where 1 is of low importance and 5 is of high importance.

*Table 1: Weight and level of importance*

| Types of weights used for levels of importance | Qualification by weight type at the level of importance |
|---|---|
| High importance level | 5 |
| Average importance level - high | 4 |
| Medium importance level | 3 |
| Medium importance level - low | 2 |
| Low importance level | 1 |

The information recorded in the table was provided thanks to brickwork used as support to design the study using the QFD method (Table 2).

*Table 2: Expectations of costumers*

| General Feature | Specific Features | What Does the Customer Want? | Level of Importance |
|---|---|---|---|
| Technical details | Compression-resistant | That the brick has high levels of compressor resistance | 5 |
| | Varied dimensional levels | Let the product have a standard dimensional level. | 4 |
| | Water absorption | Let the water absorption levels in the brick be high. | 4 |
| Processing characteristics | Use of raw materials for processing | That the inputs selected for brick production are of the best quality | 5 |
| | Color present in bricks | May the color present in the bricks be mainly terracotta in tone. | 2 |
| Features of the service offered | Delivery service | Have the product delivered directly to construction sites. | 3 |
| | Final price of the product | Let the product be offered at a reasonable price in the market. | 4 |

For the preparation of the QFD, the five "What's" of greatest importance to customers are selected, these being:

•That the brick has high levels of compressor resistance
•Let the product have a standard dimensional level.
•Let the water absorption levels in the brick be high.
•That the inputs selected for brick production are of the best quality
•Let the product be offered at a reasonable price in the market

Once what customers expect from the product has been recognized, a competitive study was carried out to determine at what level they are reaching customers' needs. Competitors are indicated as A, B, C, since it is sensitive information for the company that is being studied. The same weighting system applied in the case of the "What's" that people expected when obtaining the product was used. This information is shown in Table 3.

*Table 3: Degrees of satisfaction of the competition*

| Types of weights used for levels of importance | Competition behavior | | |
|---|---|---|---|
| | A | B | C |
| That the brick has high levels of compressor resistance | 5 | 3 | 4 |
| Let the product present a standard dimensional level | 4 | 2 | 5 |
| That the water absorption levels in the brick be high | 4 | 5 | 5 |
| The inputs selected to produce the brick are of the best quality. | 4 | 3 | 4 |
| Let the product be offered at a reasonable price in the market. | 4 | 4 | 4 |

Once the requirements that the customer expects against the product "What's" have been established, it seeks to propose the strategy that the organization will implement to meet those needs, thus establishing the matrix corresponding to the "How's," this information is recorded through the Table 4.

*Table 4: How's requirements*

| What does the customer want? | How will the organization meet that need? |
|---|---|
| That the brick has high levels of compressor resistance | Generate systems where brick cooking is done evenly |
| Let the product present a standard dimensional level | Mold the brick in default proportions to get a size according to specifications |
| That the water absorption levels in the brick be high | Perform kneading systems using machines to generate a more generous and better mixing of materials |
| The inputs selected to produce the brick are of the best quality. | Use clay soil that is neither very lean nor very oily. |
| Let the product be offered at a reasonable price in the market. | The product will be in the average price compared to the market. |

Based on the information collected, the weights by which the relationships to be applied to the structural system of the QFD matrix will be established as shown on Table 5.

*Table 5: Relationship in QFD*

| Relationship plot | Relationship rating |
|---|---|
| High ratio ● | Quantified with 5 |
| Average ratio – high ◌ | Quantified with 4 |
| Average ratio Δ | Quantified with 3 |
| Average ratio – low ■ | Quantified with 2 |
| Low ratio □ | Quantified with 1 |

In figure 2, the QFD built using the Excel application is presented.

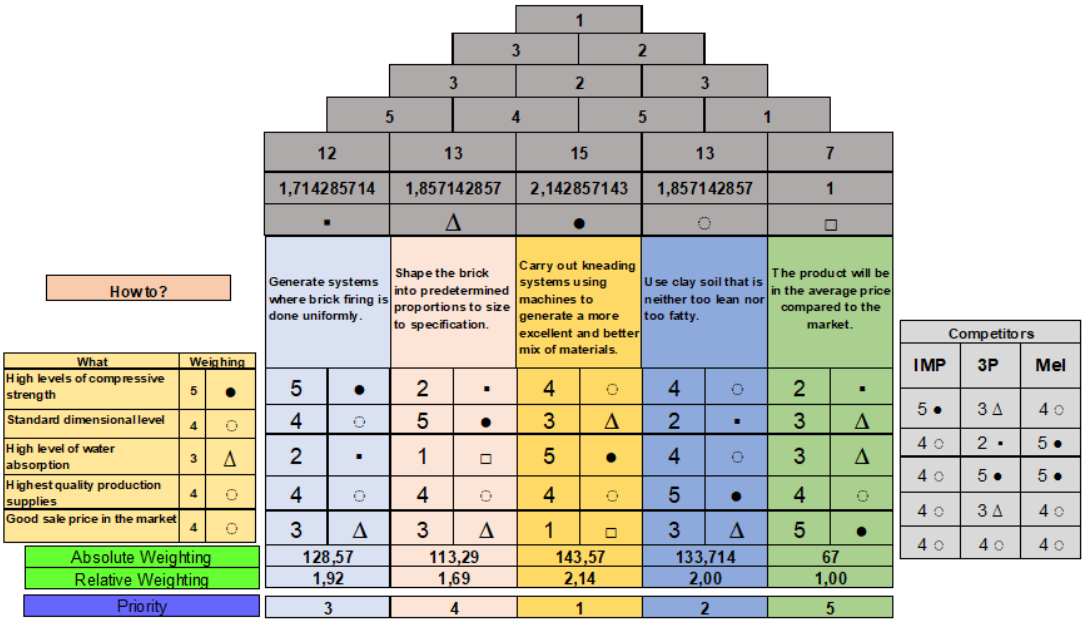


*Figure 2: QFD matrix*

## 4. Discussion

After obtaining the results of the QFD matrix, a complete analysis of the identified improvement opportunities was carried out and an action plan to implement was suggested to the company. A priority level was established for each one to define what would be the first need that customers hope to satisfy and thus have a positive impact on the market (Table 6).

*Table 6: Action plan*

| | **Priority 1** | **Short Term Objective** | **Strategies** | **Plans** | **Policys** |
|---|---|---|---|---|---|
| 1 | Design brick blocks with high levels of compressive strength | Apply a dough cook evenly so that a better mix of materials is obtained | Carry out automated kneading systems to generate a more generous and better mix of materials. | Design a tactical plan to generate a dough cooking system that improves and, in turn, increases production. | Design brick blocks with resistance to compression by mixing and firing the material according to the structural masonry standard to apply to the final product. |
| | **Priority 2** | **Short Term Objective** | **Strategies** | **Plans** | **Policys** |
| 2 | Use inputs to produce with the best quality. | Make use of high-quality red clay and river silt. | Use clay soil that is neither very lean nor very fatty. | Design a strategic plan to acquire the best quality materials and thereby increase production. | Use the best quality materials to obtain brick blocks that comply with the standard regulations, according to non-structural masonry. |
| | **Priority 3** | **Short Term Objective** | **Strategies** | **Plans** | **Policys** |
| 3 | Produce bricks with a standard dimensional level. | Inspect brick molds for a standard measurement. | Generate systems where brick firing is done uniformly. | Design a strategic plan to produce dimensionally standardized bricks | Produce bricks that retain predetermined dimensional levels following the |

| | | |
|---|---|---|
| | and thus reduce defective items from total production. | standard for facade masonry to obtain equal dimensions for marketing. |

## 5. Conclusions

The importance of achieving the company's objectives in the time horizon makes it put itself in drawing up strategies and using methods that identify all those points that need improvement. All this to ensure that the products have the quality to satisfy the customers. On the other hand, the QFD method turns out to be valuable now for displaying the quality of the product offered by the brickyard. For the brick-producing company to remain in the market, it must initially study the available budget to determine the possible investments to be made and the costs required.

As a fundamental tool to stay in the market, the company must focus its efforts on making kneading systems through machines to generate an excellent and better mixture of materials.

It is recommended to implement methodologies such as the PDCA cycle periodically, which will allow it to identify possible problems early, execute the respective corrections and monitor the progress made.

It must focus the attention while using clay soil that is neither too lean nor too fatty. For customers, it is also imperative that the bricks have a high level of resistance to compression. For this reason, the company must implement firing systems where the brick is heated uniformly. Also, it must be carried out a kneading using machines so that the materials have a better consistency and are optimal for production.

Finally, the organization should consider launching products at an affordable price for customers. This will allow it to impact the market and generate higher levels of profit compared to the competition.

### References


Akao Y., 1997, QFD: Past, present, and future, In International Symposium on QFD, 97, 2, 1-12.

Cardenas Escorcia Y., Valencia-Ochoa G., Acevedo Penaloza C. H., 2018, A Systematic Procedure to Combine the Integral Management Systems in a Services Sector Company, Chemical Engineering Transactions, 67, 373-378.

Cristiano J.J., Liker J.K., White C.C., 2001, Key factors in the successful application of quality function deployment (QFD), IEEE Transactions on Engineering Management, Portland, United States, 81-95.

Deming, W. E. 1989, Out of the Crisis. Quality, productivity and competitive position, Massachusetts Institute of Technology, Cambridge, MA, 81, 82.

Hernandez Lamprea E. J., Camargo Carreño Z. M., Martínez Sanchez P. M. T., 2015, Impact of 5S on productivity, quality, organizational climate and industrial safety in Caucho Metal Ltda, Revista chilena de ingeniería, 23,1, 107-117

Jagusiak-Kocik M., 2017, PDCA cycle as a part of continuous improvement in the production company - a case study, Production Engineering Archives, 14, 14, 19-22.

Lovrenčić, V., Brezavscek, A., Pantos, M., Gomiscek, B., 2017, Contribution of live working to the quality, safety, efectiveness and efficiency of the maintenance processes, Tehnicki Vjesnik, 24, 5, 1619-1626.

Malik A., Blumenfeld S., 2012, Six sigma, quality management systems and the development of organisational learning capability, The International Journal of Quality & Reliability Management, 29,1, 71-91.

Oral, E. L., Mıstıkoglu, G 2007, Competitive analysis of the Turkish brick industry—a case study for developing countries, Building and Environment, Oxford, UK.