Restrictive factors in implementation of clean technologies in red ceramic industries

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ABSTRACT

The objective of the present work is to identify a set of restrictive factors that impede the implementation of clean technologies in the red ceramic industries of the southeast region of Brazil. Despite the significant number of these industries and their importance in Brazilian civil construction, there has been no analysis of many of these factors, which leads to a lack of investment in clean technologies, limiting their development and modernization. Some clean technologies in this area are as follows: replacement of fossil fuels by biomass in the product sintering process, implementation of energy efficiency, reduction of raw material consumption, among others. For the structure of this study, a bibliographical review was performed to map the restrictive factors for the introduction of clean technologies in several industrial regions of the world. In total, 28 possible restrictive factors were identified and grouped into one of four categories: Institutional, Financial/Economic, Technological, and Social/Cultural. Based on this literature review, a field survey was carried out with 37 managers in the ceramic industry in the southeast region of Brazil to map their perception of these 28 identified factors. As a result, 19 restrictive factors were considered, among which the following stand out: a lack of incentive policies in the Institutional Group, which determines necessary interventions with the public power; an absence of financial incentives in the Financial/Economic Group demonstrates that other sources of financing should be explored; there is minimal infrastructure available for teaching and research in the Technological Group, suggesting that a greater interaction with research and development institutions is necessary to increase innovation in this area; and a lack of knowledge of administrative issues on the part of managers in the Social/Cultural Group underlines the need for improved management training. These results can be used to contribute to the body of knowledge on the ceramic industry in Brazil, and can be used to support decision-making and management.

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1. Introduction

The last annual meeting of the World Economic Forum, held in January 2017 in Davos, Switzerland, was attended by 3000 participants from most countries, who participated in 400 sessions on the official program. This forum focused on five challenges: strengthening global collaboration, revitalizing economic growth, reforming capitalism, preparing for the Fourth Industrial Revolution, and restoring a sense of shared identity to the world (WEF, 2017).

Revitalizing economic growth, especially in the civil construction sector, has been identified as a major goal in several countries, including Brazil, according to a study by the National Confederation of Industries (CNI, 2015). Among the main problems related to the management of the construction industry are issues related to the tax burden, high interest rates, and insufficient domestic demand.

The civil construction chain represents 5% of the GDP — Gross Domestic Product — of Brazil. This chain is composed of diverse protagonists, including the construction materials industries. The red ceramic industries, with more than 6000 factories distributed throughout all states in Brazil (ANICER, 2015), stand out in this research.

The red ceramic industry has ceramic bricks as its main product, and bricks with dimensions $0.9 \times 19 \times 19$ cm are the standard dimension of the whole production segment and are used to identify the size of factories. Tiles and pipes used for basic sanitation, known as clay pipes (pipes that have not gone through the vitrification process), are also produced by this sector, which suffers...
from the current economic crisis and is searching for alternatives to maintain business (ANICER, 2015).

Among the alternatives are the implementation of clean technologies in production processes with the aim of improving the quality of its products, its productivity and its market competitiveness, highlighting the following: the replacement of fossil fuels by biomass in the product sintering process, implementation of energy efficiency to reduce the consumption of electric energy, preparation of the clay mass to reduce the consumption of raw material, among others.

Moreover, the absence of such technologies or hindrance in their implementation has been identified in other countries, including the United States (Ervin et al., 2013; Gliedt and Hoicka, 2015), Greece (Sardianou, 2008), China (Wang et al., 2008), Sweden (Thollander and Ottosson, 2007), and India (Nagesha and Balachandra, 2006).

Despite the significant number of red ceramic industries in the southeast region of Brazil and their importance in construction, little is known about the restrictive factors for the introduction of clean technologies in these industries, which determines the research gap of this article.

Additionally, because there has been no determination of these factors, most of the ceramic industries cannot invest in clean technologies, limiting their development and delaying their modernization, which demonstrates here the problem of this research to which these industries are vulnerable and needy, being of paramount importance the identification of such factors.

Thus, this region is used as a data collection base for this research, aiming to identify a set of restrictive factors present in several industrial segments and to propose a set of factors that prevent the introduction of clean technologies in the red ceramic industries in the southeast region of Brazil, the region that has the largest concentration of factories—approximately 39% of the total factories in the country.

After this introduction, in Section 2 the concepts of clean technologies in the red ceramic industries are presented; the method used in this survey is described in Section 3; Section 4 presents a bibliographic review; Section 5 describes the results and discusses the Restrictive Factors; the conclusion and ideas for new research are presented in Section 6; and the bibliographic references are provided last.

2. Clean technologies for the red ceramic industry

The red ceramic industry is an industrial segment of the civil construction product chain. It is found throughout the national territory according to data from ANICER — Associação Nacional da Indústria Cerâmica (ANICER, 2015), varying between small size and large size factories. ANICER is an institution that represents the ceramic industries in Brazil.

Of the total number of 6903 ceramic factories, 4346 factories produce ceramic bricks; 2547 factories produce tiles; and 10 factories produce clay pipes for basic sanitation. The estimated monthly production of ceramic bricks is four billion units. The estimated production of tiles is one billion three hundred thousand units per month. The production of clay pipes for basic sanitation reaches 325.5 km per month (ANICER, 2015), as can be seen in Table 1.

To provide this production, the sector offers 293,000 direct jobs and generates approximately 900,000 indirect jobs. The monthly revenue is R$ 1.500.000.000,00 (one billion and five hundred million Reals). The ceramic sector represents 4.8% of civil construction (ANICER, 2015).

ANICER (2015), as show in Table 1, analyzes relationship between the total number of companies and ceramic products, identifying that 63% of these companies manufacture bricks, 36% manufacture tiles and 0.10% manufacture pipes for basic sanitation.

The raw material used in the factories to manufacture products is clay. The red ceramic industry is responsible for the transformation of clay through a specific industrial process and gives it shape and mechanical resistance, as well as low water absorption.

These industries are typically managed by members of the same family, and there are also industrial groups. The industry counts on various technologies, from processes with large concentrations of manpower to robotized production lines for processing clay (Facincani, 2002).

In the case of the Brazilian ceramic industries, the conventional technologies used are those that do not reduce the consumption of thermal or electric energy nor clay consumption, such as the use of electric motors that are not self-generating or have their consumption controlled by capacitors, consumption of fossil fuels in the sintering of products, and use of clay without any selection process or preparation of mass before being sent to production.

However, the companies in this sector can implement clean technologies or cleaner production lines, following the concept created by UNEP—United Nations Environment Programme—in 1989, which considered a preventive environmental strategy that influences products, processes and services, with a proposal to increase eco-efficiency and reduce risks for mankind and the environment (PNUMA, 2004) to achieve sustainable development.

Although this concept was established almost three decades ago, its understanding, uses and practices are still used today. According to the UNEP Office in Brazil (INSTITUTO BRASIL PNUMA, 2015), to reach this level of development, it is necessary that the organizations go through the three following phases: First Phase—improvement of the production processes; Second Phase—improvement of the project and development of products; and Third Phase—determination of the socio-environmental responsibility of the companies.

These technologies, regarding the ceramic industries, embody the acquisition of equipment, technical changes, changes in production and adjustments of management processes. Their main inputs are electric energy, thermal energy (fuels for synthesis), clay and water, in addition to manpower. Thermal energy varies according to the availability of fuels in the region where the factory is installed (ANICER, 2014).

The reduction of the consumption of electric and thermal energy can be performed through the efficient use of energy, which depends on a technical analysis performed by a qualified professional or person with at least a minimum amount of knowledge of the issue.

Henriques Junior et al. (2013) define energy efficiency as the

<table>
<thead>
<tr>
<th>Approximate Number of Companies</th>
<th>Approximate Percentage per Area</th>
<th>Monthly Production (Number of Items)</th>
<th>Clay Consumed Monthly (Tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bricks 4346</td>
<td>63%</td>
<td>4,000,000.00</td>
<td>7,800,000</td>
</tr>
<tr>
<td>Tiles 2547</td>
<td>36%</td>
<td>1,300,000.00</td>
<td>2,500,000</td>
</tr>
<tr>
<td>Pipes 10</td>
<td>0.10%</td>
<td>325.5 km</td>
<td>~</td>
</tr>
</tbody>
</table>

Source: ANICER (2015)
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