

Full Length Research Paper

Cleaner production: Cases of the metal-mechanic automotive cluster of Serra Gaúcha, Brazil

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Accepted 22 May, 2012

Industrial production, allied to a vertiginous economic improvement for the last decades, has provoked negative impacts to the planet's natural resources, which reflects on the quality of life of any society and its environmental health. Currently, humanity is facing extremely complex environmental problems, whose solution seems to be in applying a preventive environmental strategy, instead of implementing corrective actions. Undertaken and recognized strategies, such as organizational competitiveness, efficiency and profitability, create concerns about environmental realities, and provoke, then, necessities to re-think these vital actions and their impact on the productive process. Organizations started to adopt new technological strategies, by means of implanting environmental management systems. Facing an environmental decadency, these systems are seen as a competitive difference, as well as a factor of organizational improvement, in order to rationalize the consumption of natural resources. The expectation of environmental management strategies, besides decreasing the environmental impacts, may generate more profit, increasing companies' competitiveness and efficiency. Within this context, there are different methodologies in environmental management, as well as practices of cleaner production, which consider the opportunity of reducing costs, since a polluting organization is usually an entity that wastes raw material and inputs. The objective of this study was to identify environmental innovations, cleaner production methodologies and the results of its implementation. Three companies were analyzed in the automotive metal-mechanic cluster of Serra Gaúcha (Rio Grande do Sul, Brazil). From this multi-case qualitative research, the results demonstrate that it is possible to highlight that companies, which implemented technological innovations from the implementation of cleaner production methodologies, has an impact on the improvement of its productive process, such as an increase in operational efficiency, costs reduction with raw material and energy, and an improvement with product's environmental quality; having positive effects on organizational and socio-economical impacts.

Key words: Cleaner production, environmental management, operational efficiency.

INTRODUCTION

The productive metal-mechanic automotive cluster of Serra Gaúcha (MMAC) is perceived as an important industrial pole in this region, due to the strong concentration of companies in the segment of agricultural machinery and transport vehicles (SIMECS, 2008). For the last few decades, the industrial production allied to a

strong economic growth has caused negative impacts on the natural resources of the planet, reflecting on the quality of life and the environmental health of the society (Severo et al., 2008).

In times of deep concerns with the environment, organizations of different industrial sectors are stopping to act in a reactive way, to act pro-actively about the environmental matters (Araújo, 2002). A collective construction of a strategic planning (2007 to 2008) demonstrates the intention of reinforcement of the

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companies and this cluster, looking to be a world-wide reference of competitive products. They invest and dedicate resources and efforts in technological innovation, with the integration of the public and private institutions, improvement of their management processes and generation of quality of life, with preservation of the environment.

Pressures from society aiming at an improvement in the quality of life added to environmental norms each time more rigid to combat pollution, and the pressures of the global competitive market, are now influencing changes in business strategies (North, 1992).

Actually, companies have witnessed the apparition of new roles that must be played by the organizations as a result of these alterations, through new values and ideologies, and among them, the increasing in environmental awareness. Consequently, modern organizations, beyond the productive economic considerations, start to include in their management planning, social and environmental matters questions, which involve the reduction of pollution levels, improvement in work conditions, and their corporate image, among others (Araújo, 2002).

Facing such environmental problems, the environmental management system (EMS) became to be used as a competitive differential, as well as a factor of organizational improvement. In this scenario, arise various environmental management strategies, which aim to attain upper managements, demonstrating the possibility to generate profit through environmental strategies; one of them being cleaner production (CP).

According to Programa das Nações Unidas para o Meio Ambiente (PNUMA, 2008), the practice of cleaner production, inserted as an instrument for sustainable development, aims to offer to organizations stronger competitiveness, due to savings that it generates, as well as the valorization of its trademark, due to its association with environmental matters, common goods and humanity itself.

Being thus, enterprise strategies, which until then were summarized to the economic matters such as competitiveness, efficiency, profitability, etc., started to introduce in its priorities environmental variables, becoming necessary to incorporate them in their production processes. This made necessary to modify the scope of organizational management and structure, reorienting the corporate objective and goals, aiming at the internalization of the environment elements in management models (Severo et al., 2008).

The environment matter became a factor of differentiation in organizational management, characterizing itself, instead of limitation factor, as an opportunity (Vinha, 2003; Rocha, 2001). Currently, environmental management, as well as the practice of cleaner production is immersed in organization strategies, since it cumulates the opportunity to reduce costs, and understanding that a polluting organization is, generally,

also an entity that wastes raw material and inputs.

In view of such context, this research has the objective to identify environmental innovations, cleaner production methodologies, as well as the results reached by its implementation; with the analysis of three companies from the metal-mechanic cluster of Serra Gaúcha, Brazil. After the introductory section, this article is organized as follows: the theory background; the method; the results, the discussion and the final considerations.

THEORETICAL BACKGROUND

Environmental problems

Socio-environmental responsibility is the natural response of companies for new customer, the green and ecologically correct consumer. However, how earlier the organizations perceive sustainability as their main goal and competitive opportunities, stronger the possibility will be to survive in this context, each time more competitive (Kazmierczyk, 2002). According to Araújo (2002), he is well-known that the global environmental problems are becoming more and more preoccupying, since, in a close future, the survival of humans can be put in real danger.

In accordance with Pereira and May (2003), the intensive use of the natural resources, the residues of productive processes in the environment, had resulted in the accumulation of pollutants above of the absorption capacity, generating each time higher levels of pollution, that had soon passed from a local scale (degradation of the hydro entities, ground and the quality of air), to a regional and global dimension (global warming, rise of the level of the oceans, glacier melting, changes in the path of rain and winds, etc.). In that sense, all the efforts to promote a more healthful planet are basic.

Until a few years ago, there was an understanding among the majority of entrepreneurs that the adoption of efficient environmental management was contrary to the maintenance of higher percentages of profits. This vision has been incrementally bypassed and the use of technologies with less environmental impact has gain potential, contributing to environmental improvement of the planet, the reduction of costs, through an efficient rationalization of the production processes, particularly in the improvement in the use of the inputs and the reduction of the wastefulness of materials. With this, in the decade of the 1990s, there has been a fast dissemination of environmental management based on total quality management (Rosenberg, 1982; Vegara, 1989).

Environmental innovations

The possibility to include environmental concerns, in respect to sustainable development for organizational

strategies and by means of ecologically correct practices, can become a decisive action for the maintenance of organizations in the next decades. Consequently, the innovations that aim at the improvement of productive processes, the reduction of costs and lesser energy consumption become essential for the maintenance of organizational profitability and competitiveness.

The first author who related the importance of technological innovations for the development of the economy of a country was the economist Schumpeter (1934). He attributed that the technological innovations introduced by entrepreneurs constitutes a main stimulation for the beginning of a new economic cycle. Without these audacious entrepreneurs and their proposals of innovations, the economy would remain in a constant position of static balance, in a closed economic circle of goods and services and with no growth. Even though the author had not thought specifically about the question of the environmental loss, Schumpeter had included in his theory the concern of efficient management of natural resources and the economy of energy.

In synthesis, innovation is synonymous of change. Innovative companies are those that evolve; which offer new products and put in progress new processes or services. Furthermore, because of environmental problems, organizations had started to innovate, as well in their productive procedures as in the development and the sale of new goods or services. In other words, any organization which does not innovate will be surpassed, or by the competitors, or by the pressure of the consumers, or else by any effective environmental legislation.

New environmental standards enhance the beginning of a process that allows a reduction of the total cost of a product, then, increasing its proper value in the market; the reason being that companies which adopt new productive concepts stop to use series of inputs, raw materials and sources of energy, etc., alternative ways which compensates the expenses made for the preservation of the environment (Porter and Linde, 1995).

The organizations that have taken integrated strategic decisions in relation to environmental and ecological question will gain significant competitive advantages, reduction of costs and rise in profits at medium and long term (Baas, 2007). In this context, the use of the CP tool as an environmental preservation strategy is associated with the increase in productivity of the resources used in the production chain and, consequently, generating an increase in competitiveness of the company.

Cleaner production (CP)

Cleaner production, as a strategy applied to environmental management, is indicated as a tool which makes possible the operationalization of a company in a responsible, social and environmental way; having an impact and influence on economic and technological

improvements, by using a preventive approach to environmental management (Hunt and Auster, 1990).

According to the United Nations Environmental Program (UNEP), CP constitutes a continuous application of an integrated and preventive environmental strategy, applied to organizational processes, products and/or services in order to increase the efficiency in the use of raw materials, water and energy and to reduce the risks for the men and the environment (Oliveira and Alves, 2007; PNUMA, 2008).

The National Center for Clean Technologies of Brazil (SENAI) claims that the approach proposed by CP can be used in various processes and segments of an industry, in order to increase the efficiency of the use of raw materials, water and energy, through the non-generation, minimization or recycling of residues generated in a productive process (CNTL, 2009).

It is important to stand out that the strategy of CP is a tool that aims at the improvement of the environmental behavior in the organizations, more specifically, on the reduction of production costs and the increase of efficiency and competitiveness; aiming to improve the health and security conditions of the collaborators (work environment), to improve the image of the company in the market, resulting in possible increases in the level of customers satisfaction (Valle, 1995; Medeiros et al., 2007).

The organizations that possess internal creativity and internal predispositions and conditions can transform environmental restrictions and threats into business opportunities. Among these opportunities, it is possible to cite the development of new productive processes with the use of cleaner technologies for the environment. CP considers the environmental variable at all levels of the organization, characterizing itself by actions that are implemented inside a company, mainly the ones of the productive process, with the objective to transform it in a more efficient process, through the use of its inputs and the generation of more products and less residues.

METHODS

The present work refers to a transversal study, which characterizes itself as an exploratory study, using in-depth interview techniques, by means of a multiple case study (Yin, 2002). This study characterizes itself as a qualitative research which fills out some gaps of knowledge about environmental questions with the companies of the MMAC, with the purpose to contribute, in a scientific way, in generating knowledge about this important and complex subject.

From a total of 3 key organizations of this cluster of Serra Gaúcha, were intended to identify environmental innovations; methodologies of CP, as well as the results reached by its implementation, through the analysis of three companies of the cluster of Serra Gaúcha, Brazil, through the optic of the responsible actors for environmental management in each company.

Initially, was realized an extensive bibliographical revision on the various researches and studies of the area with the object of creating a theoretical frame to be used in the development of the study (Köche, 2004). The interviews, carried through with the

managers responsible for environment matters in each company, were guided by a script elaborated from the theoretical background, contemplating open questions that made possible the exploration of elements not mentioned in the review of literature (Malhotra, 2002). Each interview was taped, which allowed an accurate transcription and study of all texts, as well as its codification. Content analysis techniques were used in order to understand and to capture the perspective of each respondent. Method of content analysis was used for the analysis and the interpretation of data (Bardin, 2004).

According to Brazilian Institute of Geography and Statistics (IBGE), in 2006, the population of Caxias do Sul was of 412.053 inhabitants, showing an index of 14 inhabitants per company in the city of Caxias do Sul, placing it close to the highest world-wide indices of entrepreneurship. From the metal-mechanic and Electric materials Union of Caxias do Sul (SIMECS, 2007), most of the 2,600 companies of the MMAC of Serra Gaúcha is composed of SMEs (95%), responsible for approximately 47,000 jobs in the city.

The MMA cluster is constitute by 17 cities of Serra Gaúcha region, Rio Grande do Sul, Brazil; where Caxias do Sul represents 60% of the gross value added of the region (GVA), hosting the most number of companies (Calandro and Campos, 2002). In the region of Caxias do Sul, are made and manufactured by the automotive chain: buses, trucks and agricultural equipment, metal parts for automotive industry, and road and agricultural equipments. The governance of the cluster is done by the main partners, which are currently the Municipal Government of Caxias do Sul through the Secretariat of Economic Development (SDE), the National Service of Industrial Learning (SENAI), through the SENAI Mechatronic and Autotronic; the Brazilian Service of Support to SMEs (SEBRAE) and the University of Caxias of Sul (UCS).

Currently, the MMAC has strategic objectives and focus clearly defined, such as: the creation of favorable business environment; the stimulation of cooperation networks; qualification in management; technological innovation; the programs in groups; and to organize regional, national and international commercial activities and to foment credit. For in such a way nine projects they are in progress, in different areas.

The environmental project coordinated by SIMECS deals with the treatment of solid residues and clean technologies. Due to the good performance of the local economy, the cluster is the object of various studies from researchers, such as the analysis of key indicators of the cluster, related to excellence or failure (Matioda, 2008).

RESULTS AND DISCUSSION

In reference to main technological investments, which were implanted in recent years, the Company A has made the acquisition of new equipments, with new technologies producing fewer leaks, residues and thus necessitating more sporadic maintenances. Company B is investing in automation of its equipments and processes, enhancing the implantation of new products in the market. Company C has done the implementation of a security, health and environmental system; where the re-use of solvent and the changes of the isolation system in the painting process; the envoy of paper for recycling; the deposit of residues class 2 not recyclable to certified deposit sites; the physical, chemical and biological treatments of industrial effluent and biological liquids; and the acquisition of new machines (presses and robot cells).

In relation to the policies of water consumption, recycling or re-use of packing, the results reached by the

implementation had been, for Company A, the establishment of goals for the reduction of water consumption, and future projects of the re-use of rain water for toilet discharges. The amount of water produced in the productive processes and by industrial effluents is very small.

In relation to policies, there are projects of exchanging wooden packing for metallic re-usable packing, considering that for some specific customers, the supply is already carried through with recyclable packing. As for Company B, it is implementing a rain water retain process of rain for the re-use of rain water for toilet discharges.

There is also recycling policies on the re-use of wooden packing (wooden boxes). As for Company C, with its policy of re-using rain water for bathrooms discharges, it had a reduction of 40% of the total water consumption of the company. In the recycling policies, there are projects related to the exchange of wooden packing for re-usable metallic packing.

The CP method used by these companies is, in the first case, the exchange of the roof material for a better exploitation of the natural light; a rain water re-use project; a recycling project for the re-use of oily emulsion of the plant main production machines; a review of the projects aiming for a better use of raw material and less scraped iron generation; and the exchange of mineral oil for vegetal oil. As for Company B, the exchange of the diesel oil boiler for electric equipment, thus diminishing the risk of accidents, as well as the emission of gases.

As for Company C, the implementation of the concept of life cycle, giving the appropriate destination for the generated residues; and finally, the creation of eco-teams, with a focus on the development of CP tools, such as the Kaizen methods.

The results reached by the implementation of the CP tool in all three cases indicate; as for Company A, the generation of technological, managerial and product innovations; an organizational competitive improvements (through costs reduction and efficiency improvements); cost reduction of its raw materials, inputs and energy; risk minimization in a regulated environmental field; the reduction of its environmental passive caused by the industrial activity; the improvement of its products environmental quality; the improvement of its public image; the increase of its ecological efficiency; the improvement of its employees work conditions; the increase of the motivation of its employees; the diversity of benefits for the company as well as for the society; the induction of the process of innovation inside the company.

As for Company B, it indicates the reduction of costs with raw materials, inputs and energy; the occurrence of short term economic improvements; the improvement of its products environmental quality; the improvement of its public image; the increase of its ecological efficiency; the improvement of the work conditions; an increase in the

motivation of its employees.

As for Company C: the generation of technological, managerial and product innovations; an organizational competitive improvements (through costs reduction and efficiency improvements); cost reduction of its raw materials, inputs and energy; reduction in the production time of labour; risk minimization in a regulated environmental field; the reduction of its environmental passive caused by the industrial activity; the improvement of its products environmental quality; improvements in the factors related to human resources, to inputs and outputs of the productive process; and product consuming safety and ergonomic improvements.

The benefits found from the implantation of the CP tool at Company A were illustrated by the generation of little residue caused by a lower necessity of available area for storage, and lower expenses for both transport and residue storage; the reduction in its raw material consumption; to be up-dated with the environmental legislation, to being able to prevent fines up to the proper interruption of its activities. As for Company B, it had a productivity increase, improved the work environment and the production flow, presented low level of wastefulness generated by the productive processes, as well as a better organization of the generated residues. As for Company C, the program of clean technologies, introduced in 1999, is efficiently implemented translated through all processes of the company, whose objective is to conserve raw materials and energy and to reduce the toxicity of all emissions of residues within the productive process.

In relation to the environmental policies adopted by the companies, the return on investment for marketing strategy was, as for Company A, the proper certification of the norm NBR ISO 14,001, as a form to improve its image. Also, its environmental policies are displayed through prizes and quality merits, such as the Brazilian program for quality and productivity (PGQP) prize, among others.

As for Company B, it does not possess any definite environmental policies, but uses the CP in its productive process. As for Company C, environmental policies are also displayed in prizes and quality merits. The company develops five social programs, where it gets involved within the community, demonstrating a definitive success base for the success of the company, either on an organizational level or for the benefit of society. It develops actions that promote the development of the society where it is inserted, improving the quality of life of the people and protecting the environment. For this, it follows the security and occupational health and environment policies. It has as principle to promote the security and the occupational health of the people in the organization, respecting the environment. Its objectives consist in activities prevention, which can effect or harm the security and occupational health of the people of the organization or, which can cause environmental impacts

and to promote a continuous improvement of the security and occupational health and the environment. These objectives also refer to its commitment to attend the requirements of the legislation on security, occupational health and the environment. Such company is recognized today as a leader in the questions of environment and social responsibility in the region.

Conclusion

Environmental conscience is developed, in part because of the current environmental problems, but also because of the more severe legislation, which has the intent to discipline the industries to develop more compatibility between its product and the environmental matters. It is important to stand out that, in the current scene more competitive each time, environmental management and CP tools constitute basic elements for the global management of a company. Therefore, with the use of its rules and resources, it is possible to foresee many problems and anticipate solutions.

To reach the objectives of this work were identified environmental innovations, CP methodologies, as well as the results of its implementation, through the analysis of three major companies of MMAC of the Serra Gaúcha.

It was observed that each company, in virtue of its particularities and segmentation, implanted technological innovations, with the intention to optimize the productive process. The environmental innovations point out the policies focused on water consumption, considering that each company is implementing it, and that one of them has already had a reduction level of 40% in the water consumption. The policies of recycling and/or re-use of packing also are present in the three companies.

The methodologies and used tools of cleaner production, as well as the results generated by means of the implementation of this concept in each company, demonstrate that the industries of the MMA cluster of Serra Gaúcha has made improvements, in relation to the organizational productive process, the increase of the operational effectiveness, the reduction of costs with raw materials, inputs and energy, and the improvement of their product environmental quality.

Consequently, such benefits are providing an edge for possible competitive advantage of the companies of such cluster. In this context, the introduction of the environmental variable in the productive process, beyond reducing the residues in terms of amounts (volumes) and particularities, brought a reduction of a harmful effect to the environment.

Finally, the relevance of the study is related to the proper contribution of this multi-case study, in a cluster improvement context, regarding environmental dimensions and matters that have a direct impact on the management of this industry and its economic results; offering to the academic community and to the professionals of the

area a better understanding on cleaner production, its organizational use, its socio-economic impact and its effects in the community.

The limits of the study as to a non-generalization capacity must be mentioned, due to the limited sample of companies involved in the research, and since the reality of three companies were explored. In addition, it is accurate to suggest further work, either in other cluster of the country, or in studies that compare regions, sectors, productive chains or even though various actors of society.

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