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Review

Guidelines for improving the adoption of cleaner production in companies through attention to non-technical factors: A literature review

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The success of Cleaner Production programmes is an essential part of the search for more sustainable societies, because Cleaner Production emerges as one of the main activities of the companies committed to effective environmental management. However, it is believed that Cleaner Production proves to be unrealistic without the support of human resources. Thus, the main purpose of this article is to present some guidelines for improving the adoption of Cleaner Production in companies through attention to non-technical factors (human resource practices and factors). In this article we present a literature review about cleaner production and the role of non-technical factors in the greening of companies. Then, we propose some guidelines for improving the adoption of cleaner production based on non-technical and human resources factors (organizational culture, training, and others).

Key words: Cleaner production, human resources factors, non-technical factors, literature review.

INTRODUCTION

Considering that business activities and planetary environmental conditions are related (Dunn, 2002), companies are responsible for changing their behaviour to bring about environmental sustainability in their activities (Hunt and Auster, 1990). This movement occurs through the adoption of proactive environmental management, made possible by the development of a set of actions oriented at the launching of products, productive processes and strategies that avoid or minimise environmental impacts (Richards and Frosch, 1997). Yet, various challenges related to the effectiveness of the environmental management practices of companies exist. One of the most relevant is the integration between environmental management and so-called human factors (non-technical or organisational) (Daily and Huang, 2001; Govindarajuru and Daily, 2004) as well as the lack of support of environmental management practices by human resources (Stone, 2000). This absence is even more evident when the area of Cleaner Production is analysed. The success of Cleaner Production programmes is an essential part of the search for more sustainable societies, because Cleaner Production emerges as one of the main activities of the companies committed to effective environmental management (Fresner, 2004). However, it is believed that Cleaner Production proves to be unrealistic without the support of human resources (Stone, 2000). Thus, the main objectives of this article are:

1. Highlight the main contributions of human resource aspects to Cleaner Production;
2. Draw up some guidelines to improve Cleaner Production based on human aspects.

ENVIRONMENTAL MANAGEMENT AND CLEANER PRODUCTION

The destruction of the environment and the relationship of such destruction to business activities began to be appropriately discussed in the mid-1970s, culminating in the perception of the relevance of the engagement of organisations in the search for sustainable development. In response, a number of organisations transformed their

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approaches in relation to environmental concerns. These transformations led to various environmental positions, which tend to range between two extremes, on the one hand, the reactivity, typical of firms that only implement only the minimum mandatory requirements to comply with regulatory standards (González-Benito and González-Benito, 2006) and on the other hand, environmental pro-activity that seeks to control environmental questions and transform them into competitive opportunities (Berry and Rondinelli, 1998). The insertion of the environmental question into the business world has been termed 'environmental management' (Backer, 2002), the specific literature related to environmental management burgeoned in the 1990s, leading to various definitions of the term. The more widespread definitions of environmental management embrace the following factors:

1. Adjustments and structural planning of systems and activities of the company, targeting a certain type of position in relation to the environmental aspect (Mccloskey and Maddock, 1994);
2. The fulfilment of a continuous improvement programme to treat environmental problems, which demands the acquisition and development of instruments and methodologies to deal with environmental complexity (Borri and Boccaletti, 1995)
3. Revision of aspects of the organisation's management, including planning necessary to develop and maintain the environmental policy and objectives of the organisation (Nahuz, 1995);
4. Activities that target the design of products, productive processes and strategies that avoid the emergence of environmental problems (Richards and Frosch, 1997);
5. Administrative and operational guidelines and activities, such as planning, direction, control, resource allocation and other activities performed with the objective of obtaining positive effects in the environment, either by reducing or by eliminating the damage or problems caused by human actions or avoiding their emergence (Barbieri, 2004);
6. Reflection of an adaptive and dynamic process through which organisations define and redefine their expectations related to environmental protection, identifying strategies and means to reach these objectives within a determined period by means of constant evaluation of their interactions with the external environment (Seiffert, 2005); and
7. Evaluation and redefinition of organisational operations, seeking environmentally legitimate actions (Rowland-Jones et al., 2005).

The proposals of these authors do not present significant conceptual differences, therefore, in this work, environmental management is taken to represent the set of isolated practices or actions in the organisational context that change the structure, responsibilities, administrative and operational practices of a company in order to cope with the complexity of including environmental variables in the institutional objectives through mitigation of the negative effects generated by business activities (Jabbour et al., 2010). Since the integration of environmental sustainability into business strategies became a strategic imperative for all businesses in the 21st century, various factors have led companies to develop strategic environmental management policies (Preston, 2001). One of the main impulses for environmental management is the pressure exerted by stakeholders (Berry and Rondinelli, 1998; González-Benito and González-Benito, 2006). Environmental movements, communities, consumers and investors are the main parties responsible for the pressure exerted over the organisations that monitor pollution and for the consolidation of environmental policies and the perception of the organisation in relation to environmental questions (González-Benito and González-Benito, 2006). It is this pressure that will cause organisations to adopt more conscious attitudes with respect to the environment, that is, this pressure will determine the policies adopted by individual companies. The literature has documented numerous examples that demonstrate that the perception of organisations changes from reactive to proactive with the resolution of environmental questions (Berry and Rondinelli, 1998; Henriques and Sadorsky, 1999; Zutshi and Sohal, 2004). Because it is responsible for regulatory standards and structures, the government also plays an important role in the search for environmental sustainability (Wilkinson et al., 2001), which should translate into the constant development of environmental legislation. In relation to market aspects, the environmentally responsible consumer is considered one of the main driving forces of environmental management (Hunt and Auster, 1990; Donaire, 1999; Sanches, 2000; Preston, 2001; Seiffert, 2005) because the environmental question, generally evidenced by a logo, emerges as a differentiating factor when consumers make purchases. This instrument distinguishes products produced in companies that minimise their environmental impacts from those that do not (Maimon, 1996), which is categorised as green marketing. The exploration of marketing strategies directed at the environment may improve a company's public image, increasing earnings and share value of the company (Hart and Milstein, 2004). In addition, due to consideration of the risks associated with environmental disasters, the insurance sector has exercised pressure on companies to improve their environmental performance. However, any attempt at environmental management strategy needs the support of various management areas, among which the production function emerges as essential for the environmental management of a company to achieve success (Florida, 1996).

Despite the fact that common factors influence companies' environmental management strategies, the treatment of the environmental dimension by companies is not homogenous (Buysse and Verbeke, 2003). This

has led the literature to present various classifications and taxonomies for environmental business management standards, each composed of evolutionary stages. Thus, various authors (Hunt and Auster, 1990; Hart, 1995; Azzone et al., 1997; Maimon, 1996; Sanches, 2000; Corazza, 2003; Rohrich and Cunha, 2004; Seiffert, 2005) propose either reactive stages of environmental management, in which the company merely responds to legal pressure and environmental fines, or proactive stages, in which environmental management becomes a source of opportunities for the company. In the proactive stage, environmental management tends to offer various tangible and intangible benefits to the company (Zutshi and Sohal, 2004), such as:

1. A reduction in operational costs resulting from improvements in productive processes, reduction of waste and greater efficiency (Berry and Rondinelli, 1998; Kitazawa and Sarkis, 2000);
2. A reduction of fines linked to environmental matters (Hunt and Auster, 1990; Berry and Rondinelli, 1998);
3. Access to external markets through insertion into countries with stricter environmental legislation (Seiffert, 2005; González-Benito and González-Benito, 2006);
4. Access to environmentally-conscious consumer markets (Ginsberg and Bloom, 2004);
5. An improvement of the organisation's image (Donaire, 1999; Miles and Covin, 2000; González-Benito and González-Benito, 2006);
6. A reduction of financial risks and costs (Fresner, 1998);
7. The creation of innovations in products and processes, stemming from internalisation of the environmental question (Porter and Linde, 1995; Azzone et al., 1997);
8. More valuable stocks, as investors increasingly take environmental performance into account (Preston, 2001);
9. Opportunities for new business and markets (Berry and Rondinelli, 1998);
10. Motivation for staff (Fresner, 1998); and
11. Perfection of productive processes (Zutshi and Sohal, 2004).

Thus, companies that seek to explore the advantages of strategic environmental management need to develop new proposals for their productive processes so that they can be environmentally sustainable. Among the various instruments that seek to boost environmental management in the company, Cleaner Production is one of the most relevant because it promotes environmental management through the continuous improvement of processes (Fresner, 1998) and the direct reduction of environmental impacts at their greatest source (Angell and Klassen, 1999). Cleaner Production could be considered part of the corporate environmental management movement (Figure 1). The term "Cleaner Production" was coined in 1989 by the United Nations Environmental Programme (UNEP), which states that:

"Cleaner Production is the continuous application of an integrated preventative environmental strategy applied to processes, products and services to increase eco-efficiency and reduce risks to humans and the environment" (Fresner, 2004); such production requires "changing attitudes, responsible environmental management and evaluation of technology options" (UNEP, 2001).

Cleaner Production also tends to incorporate certain technological components and training (Hilson and Nayee, 2002). This approach is considered to be an organised, innovative and creative way to improve production processes, products and services, reducing their environmental impact through preventative measures (Fresner, 2004). Cleaner Production is also defined as a greater level of environmental performance that can only be achieved through strategic improvement in a way that minimises risks to the environment and to human health with the use of sound control, layout optimisation and the implementation of efficient management techniques (Hilson and Nayee, 2002).

The essential factor for a methodology to implement Cleaner Production is the identification of good options, mainly based on a systematic description of the company's material and energy flows and on an evaluation of its efficiency in the use of materials, water and energy (Fresner, 2004). In this process, the environmental variable is considered a new performance objective of the production function because it strongly overlaps with manufacturing questions and generates various competitive advantages (Jimenez and Lorente, 2001). Thus, Hilson and Nayee (2002) argue that the effective implementation of well-structured environmental management is key to achieving Cleaner Production because such implementation presents elements that support environmental improvement and help coordinate individual technological processes and management, both of which can contribute to advances in environmental performance.

Notwithstanding this argument, there are several barriers associated with the internalisation of the environmental issue that may vary substantially due to the specific characteristics of the company, the nature of the sector in which it operates (Donaire, 1994) and the form of integration of the environmental variable into the organisational structure. Such integration can take place in an exact way in which environmental concerns and activities relating to them are relegated to a specific department or office, or in a matrix pattern within which environmental aspects permeate the entire company (Corazza, 2003). There is also uncertainty related to lack of financial resources (Azzone and Noci, 1998; Mccloskey and Maddock, 1994), economic benefits and the rewards of the market (Mccloskey and Maddock, 1994; Hillary, 2004) and organisational structure (Brío and Junquera, 2003). Thus, various challenges related to

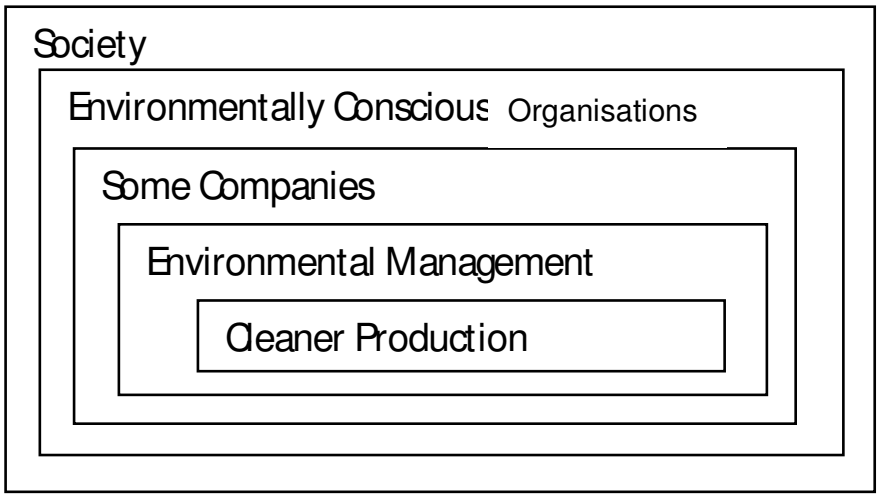

Figure 1. Relationship between environmental management and cleaner production.

the effectiveness of companies' environmental management practices exist; because such effectiveness is considered to be a determinant of Cleaner Production, environmental management involves the participation and cooperation of all of the members of the company, with the communication and motivation of each employee being critical (Hilson and Nayee, 2002). Therefore, one of the most critical challenges, and the one that is least studied in the literature, is the integration of human resource practices (or organisational practices) into the environmental management strategy of the company (Daily and Huang, 2001; Govindarajuru and Daily, 2004), existing evidences in the literature of the strong association between human resources factors and success of Cleaner Production programmes (Zwetsloot and Gayer, 1996; Stone, 2006a, 2006b), supported by concepts such organizational learning, collective commitment (Zwetsloot and Gayer, 1996) and more effective adoption and implementation of advanced technologies (Chung, 1996; Co et al., 1998), toward an improvement of organization's environmental performance.

THE HUMAN SIDE OF CLEANER PRODUCTION AND CORPORATE ENVIRONMENTAL MANAGEMENT

There is no uniform definition for the concept of human resource management; existing definitions range between operational and strategic approaches. In this context, the conceptualisations of authors such as Davel and Vergara (2001) stand out. These authors define human resource management as the use of management over the behaviour of people in search of organisational efficiency. For Fischer (2002), human resource management is the establishment of organisational policies and practices that direct human behaviour at work. Bohlander et al. (2003) define this type of management as the understanding of human behaviour and the application of practices for the construction of a motivated and capable labour force. Storey (2001) defines human resource management as a search for competitive advantages through the development and training of workers. For Vergara (2005), it is an organisational pact that creates opportunities for the development of employees in search of organisational objectives. According to Milkovich and Boudreau (2000), human resource management is the integrated set of decisions that form work relations and influence the capacity of the organisation to reach its objectives.

Ivancevich (1995) defines human resource management as the organisational area that deals with the effective use of people in the search of organisational objectives. In this definition, there is strong emphasis on human resource management as the way to achieve organisational objectives. Because the environmental issue has emerged as a new organisational objective, it consequently interacts with human resource management. Despite the fact that engagement of the field of human resources has been traditionally indicated as fundamental to achieving proactive environmental management, the bibliography that integrates a company's human resource management and its environmental management is presented to researchers and organisational leaders as scarce. In fact, it is rare to find researches that develop integrated constructs between human resource management and actions related to environmental management in companies (Govindarajulu and Daily, 2004). If companies are to take advantage of the business opportunities that may emerge from a greener world, then new forms of organizations, products and processes must to be created (Charter, 1999), like Cleaner Production. This will mean the need of new expertise and skills (Charter, 1999) and this way, the development of appropriate human resource management

management policies is seen as fundamental for Cleaner Production programmes, due to need of development of new abilities and because, employees are the ones who possess knowledge of their own activities and who can create better solutions for the improvement of the environmental performance of individual companies (May and Flannery, 1995). More broadly, even if it is determined that only now is the bibliographical gap related to contributions of human resource for environmental management receiving attention, the gap related to the debate on the human side of Cleaner Production is still present (Stone, 2000). The integration of human resource management and Cleaner Production has been addressed through the alignment of the following human and organisational dimensions:

1. Environmental training (Zwetsloot and Gayer, 1996; Fresner, 1998; Stone, 2006a; 2000b; Hilson and Nayee, 2002; Kjaerheim, 2005; Unnikrishnan and Hegde, 2007);
2. Top management support (Zwetsloot and Gayer, 1996; Fresner, 1998; Hilson and Nayee, 2002; Kjaerheim, 2005; Unnikrishnan and Hegde, 2007; Stone, 2006a; 2006b);
3. Green teams (Zwetsloot and Gayer, 1996; Fresner, 1998; Stone, 2006a; 2000b);
4. Organisational culture (Stone, 2000; 2006a; 2006b; Unnikrishnan and Hegde, 2007).

In addition to these four modes of interaction between human resource management and the Cleaner Production process, the participation of human resources in the activities of employee empowerment and performance evaluation and rewards is proposed as an integral part of the effort to achieve Cleaner Production. According to Fresner (1998) the greatest focus of Cleaner Production is always to create consciousness of the prevention of pollution by searching for sources of waste and for practices that reduce emissions. With the interdisciplinary approach of Cleaner Production, a range of options can be adopted (Fresner, 1998) including management of materials and energy, improvement of logistics activities, improvement of communication and data availability among departments, substitution of primary materials with less harmful materials or with materials that can be more efficiently used or that can be partially or completely recycled, modifications of products to eliminate production stages with a large environmental impact, changes in processes to minimise waste and emissions, internal recycling, and the sending of waste to external recycling networks. In addition, employee training stands out as one of the practices of greatest relevance. Cleaner Production requires a commitment, new attitudes, knowledge and abilities for all professionals so as to guarantee that each company's environmental prevention strategies are integrated with the planning and development activities of the entire company (Unnikrishnan and Hegde, 2007). In order for these practices to develop sustainably, all organisations must have access to education and training in the use of cleaner and more efficient technologies for natural resources (Martin and Rigola, 2001). Environmental training is thus of fundamental importance for Cleaner Production, which is understood as the systematic process by which the behaviour of workers is directed towards carrying out the set of organisational objectives (Ivancevich, 1995) related to the environmental issue. Corresponding to the claim that environmental training increases environmental consciousness, this training also informs the team of the goals of Cleaner Production and provides the work force with the ability and motivation to implement the new processes (Hilson and Nayee, 2002). It is evident that the business community is beginning to recognise the need for people who can effectively deal with environmental issues such as pollution, compliance with legislation and sustainability (Unnikrishnan and Hegde, 2007).

Researchers suggest that individual training of employees is essential for the effective use of new production technologies, due to the new demands placed on workers in terms of new abilities and related requirements (Chung, 1996). From this same perspective, Fernández et al. (2003) claim that environmental training programmes, in general, seek to promote employee motivation in this area, to integrate and internalise the best environmental practices and to ensure the collaboration of all parts of the company. Thus, all employees of a company, not only those linked to specific departments whose workers require training in relation to environmental issues, are considered as a main factor for the success of environmental management practices (Zutshi and Sohal, 2004; Govindarajulu and Daily, 2004; Unnikrishnan and Hegde, 2007). For this, it is necessary to identify training needs involving various organisational areas of the company, including those responsible for environmental management programmes (Fernández et al., 2003) and including the umbrella organisation (Mccloskey and Maddock, 1994). Because environmental training is recognised as the essential factor for the preparation and maintenance of environmental management practices such as Cleaner Production, it is imperative that there exist a systematic formulation of training programmes that qualify employees to identify specific environmental problems and the best practice to deal with them (Denton, 1999), (Madsen and Ulhøi, 2001). According to Wehrmeyer (1996) there are several key elements for such an environmental training programme; these include maintaining simple and relevant environmental messages, conducting short and informal sessions with small groups, involving employees in the subject through open sessions, identifying possible leaders for environmental management among the employees of the session, treating the environmental issue as a new part of the organisational culture, highlighting the results achieved by the employees of other

companies and evaluating the effects of training on the employees' routines.

According to Zutshi and Sohal (2004), such initiatives and training programmes should minimally include topics related to the environmental impact of the company's operations and individual actions, the importance of environmental issues for the profitability and survival of the company, the contribution that the company's management and employees can make to reducing their impact on the environment and the legal implications of the company's environmental impact for the company and employees. Thus, by means of environmental education and training, employees become more conscious of the need to improve environmental quality and begin to present a more receptive behaviour towards changes resulting from the internalisation of the environmental dimension in work practices and the implementation of technologies. Employees consequently come to understand the importance of proactive behaviour.

According to Castrillon and Cantorna (2005), based on the results of a study conducted in 90 companies in industries with advanced technology in production processes, the managerial decision to develop training is not determined by or directly correlated with investment in new technologies or production techniques. Thus, one of the main driving forces for environmental training programmes, as well as for the implementation of Cleaner Production, is the support and commitment of top management (Zwetsloot and Gayer, 1996; Unnikrishnan and Hegde, 2007). The involvement of top management in environmental management topics translates into the diffusion of an environmental policy supported by the members of the highest hierarchical level of an organisation (Brío et al., 2007). To a large extent, Stone (2000) argues that the commitment of top management is equivalent to limiting business activities to those that are coherent with sustainability (Stone, 2000). Recent literature on Cleaner Production identifies commitment and support from top management as essential for the success of the programmes (Stone, 2000; 2006a). This support is also highlighted in the literature on environmental management (Daily and Huang, 2001; Govindarajulu and Daily, 2004; Pujari et al., 2004; Zutshi and Sohal, 2004; Wee and Quazi, 2005; Brío et al., 2007; Daily et al., 2007). This emphasis may be partly the result of the rational authority invested with high-level managers and the expectation of their significant role in bringing about change within organisations (Stone, 2006a).

However, even emphasising the importance of top management commitment, Cleaner Production manuals and pollution prevention guides pay little attention to the process of actually mandating or reinforcing such commitment (Stone, 2006a). According to Hilson and Nayee (2002), when a company possesses environmental management, it reflects the commitment of top-level management to comply with legislation and continuous environmental improvement (Zutshi and Sohal, 2004). Without that commitment, the potential benefits of such environmental management could not be completely realised. This support also provides orientation regarding best practices and Cleaner Production for all levels of the organisation through the establishment of precise goals and objectives that facilitate the improvement of the environment.

Because it involves technological and organisational changes, the implementation of Cleaner Production is a long-term process. Therefore, it is not enough to locate the best technological options; there should also be a process in which changes in attitudes and organisation, with the latter receiving support from top management, are considered a conditioning factor or catalyst. The leadership of top management is a prerequisite for successful pollution prevention projects (Fresner, 1998), and such projects are vital to ensure awareness and understanding of environmental issues and the implementation of Cleaner Production programmes by the entire organisation (Zutshi and Sohal, 2004). Without a solid structure of this nature, it is almost impossible to motivate employees to take effective measures for environmental improvement (Govindarajulu and Daily, 2004). Furthermore, such a structure is even more critical in the implementation phase of Cleaner Production programmes (Kjaerheim, 2005). It can be said that for the successful implementation of Cleaner Production programmes, top management should address the following issues (Hilson and Nayee, 2002):

1. Identify appropriate procedures, reports and meetings that form the skeleton structure of the programmes. The tasks involved in doing this should first be assigned to various individuals, and groups and each process in the system should be identified.
2. Provide workers and managers with immediate training. Implementation of Cleaner Production requires the participation of employees at all operational levels. Each employee should be educated and trained in the important procedures of environmental management of the system, such as auditing and reports.
3. Familiarise employees with the system; in this regard, it is important to explain why Cleaner Production has been adopted and the merits of its implementation. Deep understanding of the applications and benefits of clean production is the key to motivating employees to use the system.
4. Assure that problems related to the Cleaner Production Programme are quickly resolved. All systems have problems at one point or another. Contingency plans should be designed to be used in case of dysfunctionality of the programme. It is essential that management identify the priority problems and provide a list of strategies to correct them.
5. Guarantee that people have sufficient time and resources to implement the programme. The key is to provide simple systems that can be maintained with relative ease. Basic education is essential because employees are "green" and should be trained incrementally.

The system may become more complex with time, with complementary formation of employees.

Top management should also identify a vision for the organisation that includes environmental issues. This should be done in such a way that the company's established global strategy guides its efforts to achieve the vision, and management should ensure that there are enough resources allocated to implement environmental projects, thus developing a foundation to perpetuate the programmes (Zutshi and Sohal, 2004). According to Daily and Huang (2001), the support of top management involves the following factors: (a) communication of the policy, plan and other pertinent information to employees, which is considered essential to motivate employees to take action (Govindarajulu and Daily, 2004); (b) compensation and empowerment of workers for corrective actions and improvements; (c) review of the progress of the programmes and support of cultural change for the implementation and operation of the projects. Thus, to promote and maintain Cleaner Production, a certain amount of time should be allocated, first for understanding the system in detail and then for communicating and disseminating the information and the changes necessary for its implementation throughout the entire organisation (Zutshi and Sohal, 2004). Because rigid, bureaucratic structures often face great difficulties in the implementation of changes, top management should understand the importance of cultural organisation so as to permit the effective implementation of environmental management programmes and should take measures to change the organisational culture and make it more flexible and responsive to changes (Daily and Huang, 2001).

Cleaner Production is not simply a change in primary materials, processes and products but also a change in the organisational culture of a company and in people's attitudes within the company (Stone, 2000). For this reason, organisational culture and human resource management become critical elements for the successful mastery of higher environmental standards (Fernández et al., 2003). Govindarajulu and Daily (2004) claim that promoting or hindering employees implementing environmental management is related to organisational culture and that organisational culture is also a factor determining change and innovation of the organisation's basic assumptions with respect to Cleaner Production.

According to Schein (1990), 'organisational culture' refers to the set of basic assumptions that a given group has invented, discovered or developed in its learning process in order to deal with problems of external adaptation and internal integration. When these assumptions are considered valid, they are taught to other members of the organisation as the correct way to perceive, think and feel in relation to those issues. Thus, environmental organisational culture may be understood as an organisational philosophy that covers the set of organisational assumptions, values, symbols and artefacts that reflect the desire or need of the company to operate in an environmentally friendly manner (Harris and Crane, 2002). Based on the above, the effective implementation of Cleaner Production, an approach with advanced environmental demands, requires a culture based on environmental values along with a deep consciousness of the workers. Otherwise, investments and efforts could lose some of their value (Fernández et al., 2003). In the integration of the environmental dimension into the organisational culture, five steps can be followed (Johnson and Walck, 2004):

1. The umbrella organisation spreads and supports the environmental dimension as a new company value;
2. Top management recognises and spreads the ways in which environmental practices influence the practices, strategies and core business values of the company;
3. The umbrella organisation demonstrates how the environmental values support environmental management and organisational practices;
4. Training, communication, performance evaluation and compensation systems directed at the environmental performance of employees are developed;
5. And the environmental dimension is incorporated as a new organisational value by employees. Organisational culture has been identified as a major factor determining employee participation in projects of environmental management improvement in the company, such as Cleaner Production (Rothenberg, 2003). Such participation demands clear communication of the values and alignment of the reward and punishment systems that are in effect within a company. In addition, business leaders should provide environmental performance feedback for employees so as to reinforce correct behaviour, where this is further improved by means of education and training (Fernández et al., 2003), with the goal of perpetuating correct values. Organisations that possess consolidated environmental management supported by the organisational culture tend to attract workers with similar concerns and who are highly motivated. As such, pro-environmental organisational culture tends to be more robust when a company is formed by environmentally conscious people (Fernández et al., 2003). Thus, a Cleaner Production programme should be supported by an environmental culture in such a way that the assumptions of pollution prevention are part of the organisation and the programmes have an order (Fresner, 1998).

In Leitch et al. (1995), empowerment of employees is described as the importance of giving workers the capacity and the responsibility to take active measures to identify problems in the work environment that affect the quality or service to the client and to effectively deal with them. The traditional top-down organisation inhibits the emancipation of workers. On the other hand, a flat and horizontal organisation motivates the empowerment of

workers (Govindarajulu and Daily, 2004). Thus, the expansion of the concept of empowerment is tied to modern organisational assumptions and to flexible companies and horizontal structures that allow the decision-making process, the ability to resolve problems, individual thinking and self-control, which should be developed at all hierarchical levels of an organisation, including the operational level (Daily et al., 2007). In general, empowerment requires employees to be managed more freely and flexibly and with trust and commitment, removing the control and hierarchical rigidity that often plague companies (Dainty et al., 2002). In the context of environmental management practices, empowered employees, i.e., those who have autonomy and decision-making power, are more prone to be involved in the improvement of the environment (Govindarajulu and Daily, 2004). As the main results of their research on the implementation process of ISO 14001, Kitazawa and Sarkis (2000) report the direct impact of human resource dimensions on the implementation and maintenance of environmental business practices, the indispensability of empowerment of employees for the reduction of environmental impacts and the need for appropriate human resource management practices in making the empowerment process effective with respect to environmental practices. In this context, Ogden et al. (2006) assert that empowerment has been treated as a practice of manage-ment excellence emerging from contingencies that oblige companies to reduce their operational costs and to increase the quality of their manufacturing processes and of their products; in this process, they act flexibly and with high productivity according to the concept of Cleaner Production. Thus, Cleaner Production does not refer merely to the substitution of some prime materials for less polluting congeners, nor is it a simple change in the development of products and processes; it also refers to changes in organisational culture and in the pattern of employee attitudes (Stone, 2000). In the wake of this finding, empowerment of employees highlights a dimension of human resources that is fundamental for the achievement of Cleaner Production and that is extremely useful in the generation of ideas by teams of workers who aim for the reduction of the environmental impact of a given business activity. In this context, Fernández et al. (2003) also argue that environmental initiatives should arise from creative ideas originating with all employees. They also state that the mechanisms that need to be created to involve employees include giving the employees independence to generate creative solu-tions to solve problems and to make the best use of their abilities. Examples of the results that can be achieved through empowerment and participation of employees has been observed since 1975 with the initiatives of 3M, which encouraged its employees to propose changes to generate revenues and reduce pollution through its Pollution Prevention Pays (3P) programme. At present, 3M claims that its initiative has produced more than 2,500 solutions to pollution, reduced waste emissions by half and saved around US $ 300 million (Renwick et al., 2008). Similarly, estimates indicate that the 3P programme has led employees to propose more than 4,750 projects worldwide, preventing 1.7 billion pounds of pollution (Reed, 2002). Other similar programmes that stand out are Dow Chemical's Waste Reduction Always Pays (WRAP) programme, which was created as a contest in which all employees were invited to participate and which Dow Chemical claims has obtained a 173 percent return on investment (ROI) in the first year of operation (Denton, 1999), and the projects of Chrysler and AT&T, which have intense employee participation and aim to produce environmental improvements (Hanna et al., 2000). Thus, the concept of empowerment consists of the involvement of employees in defining specific environmental objectives through which to achieve a cooperative environmental vision and the creation of "green" teams to implement environmental projects, such as Cleaner Production (Wee and Quazi, 2005). While individual contributions to the environmental efforts of an organisation are important, working in teams is necessary for the implementation of an effective environmental management system (Daily et al., 2007). Accordingly, Zwetsloot and Gayer (1996) classify team environmental programmes as successful elements of Cleaner Production projects. Fresner (1998) also points to the formation of such teams as the basis of Cleaner Production programmes. This is because the majority of environmental problems cannot be equated with individual projects; the complexity of these problems demands green teams (Daily et al., 2007). The team refers to a small group of people with complementary knowledge who seek to achieve shared goals and objectives (Katzenbach and Smith, 1993) with the purpose of solving environmental problems.

Teamwork requires meetings of people who possess common beliefs and values (Casado, 2002). In this case, teamwork requires people who share respect for the environment. Another important aspect of the teamwork issue is that environmental challenges require a diverse set of competencies. In this context, according to Rothenberg (2003), a large proportion of environmental management projects demand a conglomeration of various types of individual competencies. Thus, the constitution of multifunctional teams has proven to be an appropriate trend in approaching environmental problems (Denton, 1999), especially those that are concerned with the reduction of waste and are considered to be complex and interdisciplinary, such as Cleaner Production (May and Flannery, 1995). Eliminating problems and enacting environmental improvements at the source demand changes and improvements in all areas of the organi-sation, including planning, purchasing and production (Kitazawa and Sarkis, 2000). Therefore, teamwork has proven to be very useful in achieving environmental

improvements across departments (Govindarajulu and Daily, 2004).

In summary, teamwork for successful environmental projects requires that team members accept responsibility for making efforts to achieve both individual and team objectives because the objectives of the team often mean going beyond one's own job and operating with a sense of empowerment (Daily et al., 2007). Thus, teamwork offers an opportunity for individuals to meet and find solutions for complex environmental problems (Daily et al., 2007). In truth, the benefit of such teams lies in the demand for collective knowledge to develop complete solutions, avoid duplication of effort and perform many tasks at the same time (Cai et al., 1999; Leitch, et al., 1995). The use of teamwork to address problems pertinent to environmental management is becoming particularly popular in manufacturing companies, in which the dynamics of production strategy, competitive pressure and the use of advanced technologies require a greater commitment of the workers on the factory floor to the environmental dimension (Govindarajulu and Daily, 2004). Thus, the most developed approaches are intensive work strategies that depend on the development of tacit competencies through the development of workers who work in "green" teams (Fernández et al., 2003). These environmental management groups are defined in the international literature as *green teams*, which can be understood as teams of workers that are established to try to solve environmental problems or to implement programmes to improve environmental performance (Laabs, 1992). As Beard and Rees (2000) observe, green teams are used to generate ideas, to upgrade experiences, to foster organisational learning, to identify sources of conflicts and to direct attention towards their resolution, increasing understanding and pursuing the best options for environmental management practices.

Organisations based on teams are an ideal format for effective environmental management because companies that possess processes capable of incorporating the knowledge of employees and of articulating that knowledge in work teams are likely to exhibit superior environmental performance (Griffths and Petrick, 2001). Some examples can be observed, such as in the work of Rothenberg (2003), which analysed environmental management projects undertaken by an automobile assembly plant in the USA, with the goal of investigating the main contributions of the workers to the success of these projects. One of the author's main conclusions is that the majority of environmental management projects were undertaken through teams that included employees in environmental management, engineering, supply and operational areas. Other companies that have emphasised teamwork as a human resource practice to improve environmental performance are Kodak Company, Xerox, Apple Computer, Volkswagen and Audi (Strachan, 1996). Organisational architectures based on team networks require the support of organisational systems such as remuneration and the distribution of resources for value-adding activities (Griffths and Petrick, 2001); through such systems, employees are recognized for their contributions to improving the environmental performance of the company, with performance evaluation and the compensation policy intimately linked to meeting environmental objectives (Wee and Quazi, 2005). This occurs because performance evaluation and recognition, through compensation, act as reinforcement for desired practices and values to continually motivate and increase the commitment of the workers to perform in an environmentally responsible way (Govindarajulu and Daily, 2004).

According to Ivancevich (1995), performance evaluation is a dimension of human resources used to analyse the performance of employees with respect to their duties, by means of comparing tasks and achievements. Many companies have established environmental objectives for their employees, whose environmental role is evaluated as one of the criteria of organisational evaluation programmes of individual performance. Such evaluations may affect the variable fraction of the amount of rewards and remuneration accruing to the employee, as in the case of Xerox, which has compensation programmes such that employees achieve high levels of innovation in waste reduction, reuse and recycling (Fernández et al., 2003). Perfor-mance evaluation seeks to deal with the challenge of measuring environmental performance standards through various business units (Renwick, 2008) and can become an important source of information for organisational managers. Performance evaluation programmes are necessary to ensure the effectiveness of environmental management activities over time, because they allow constant adjustment of the performance of an employee to the environmental performance desired by the organisation (Govindarajulu and Daily, 2004). In this way, the maintenance and effectiveness of Cleaner Production practices are promoted. In this context, compensation practices are also changing to incorporate the environmental dimension.

The policy of rewards has the goal of attracting, retaining and motivating the best employees and of encouraging the development of knowledge, attitudes and abilities that lead to the achievement of company objectives (Gómez et al., 2005). When used systematically, reward systems not only motivate employees to perform desired behaviours in relation to environmental management, reinforcing environmental performance, but also make them more aware of the importance of environmental programmes in the organisation (Daily and Huang, 2001; Daily et al., 2007). That is, such reward systems are a way of recognising the importance of Cleaner Production programmes and of emphasising the role of each individual in their success. The alignment of human resources with environmental strategy is already a reality for companies such as Du Pont and Neste Oy

(Renwick et al., 2008). In these companies, the awards and rewards are financial and linked to the achievement of environmental performance goals (Renwick et al., 2008). However, some employees may feel more motivated by recognition and praise than by financial incentives. As demonstrated by Ramus (2001), employees value both verbal feedback from superiors and formal compensation. Informal verbal feedback, in addition to formal written feedback, may help motivate employees for environmental improvement (Govindarajulu and Daily, 2004). Some companies have also used systems of public recognition to achieve specific objectives in the environmental area. Examples of this type of system include meeting with employees who participate in successful environmental projects (Handfield et al., 2001) and rewarding the environmental performance of employees with commemorative plaques offered during formal ceremonies.

These formats of recognition coexist with the recognition that financial incentive policies are potentially divisive and that, as such, they may impede the maintenance of a sense of organisational fairness. In addition, an improvement of environmental performance should be understood by employees as a constant and not as the result of episodic actions that deserve differentiated compensation (Denton, 1999). Therefore, a programme of performance evaluation and rewards may support Cleaner Production and serve as reinforcement to continually motivate and increase the commitment of workers to environmental responsibility, thus promoting their loyalty to and internalisation of the precepts of the Cleaner Production Programme (Govindarajulu and Daily, 2004). In addition, this type of programme motivates innovations in productive processes that are aimed at the environmental improvement of those processes.

GUIDELINES FOR IMPROVING THE ADOPTION OF CLEANER PRODUCTION IN COMPANIES THROUGH ATTENTION TO HR FACTORS

Some guidelines may be delineated to facilitate the integration between the technical and human/non-technical aspects of Cleaner Production. The contributions of human resources for Cleaner Production involve elements such as:

(1) The definition of a vision through the identification of critical capacities: Defining the vision is composed of two elements: first, a clear vision with realistic objectives and goals that positions the organisation in the future, where the role of top management is fundamental, and second, good corporate and developed programme strategies that have been constructed in an interactive and integrated manner for the entire organisation, with special attention to the areas of human resource management, production and environmental management (Wee and Quazi, 2005).
(2) The creation of a project for organisational excellence through the insertion of human resource management into the formulation of the environmental policy of the organisation and action in the area of human resource management as a strategic partner (Jamrog and Overholt, 2004) for Cleaner Production. If organisational efficiency is measured by how well organisations reach their objectives through their strategies, then with the increasing insertion of the environmental dimension into the organisational objectives, so that human resources become a real strategic partner, processes should develop for the insertion of human resource management into the planning and execution of the strategic priorities of the company (Jamrog and Overholt, 2004). Due to the increasing rhythm of changes and competitiveness, the need for this type of measure has grown; this is especially true because organisational effectiveness requires management of three interlinked and interdependent components: people, strategy and operations (Jamrog and Overholt, 2004).

Usually, a great deal of time, resources and energy is devoted to developing a good strategy, and often a good job is done in aligning operations to support that strategy, yet the most common set of problems that occurs results from the failure of leaders to align their human resources processes with the strategic priorities of the company (Jamrog and Overholt, 2004). In this sense, unfortunately, many environmental programmes fail because human resources do not accompany the projects (Milliman and Clair, 1996). Design for excellence involves ways of aligning the processes of organisation, structure and resources to implement the vision. Thus, the alignment of human resource management in the definition of the environmental strategies of the organisation may more completely assimilate the contributions of the interaction of human resource management practices and Cleaner Production processes. This integration emerges as a potential way to increase the success of programmes to reduce the environmental impacts of companies and as a significant source of improvement in their environmental performances.
(3) The creation of processes to achieve continuous improvement. Finally, processes such as performance evaluation, rewards and recognition, training, the development of organisational culture and strategic management of the programme should be created to facilitate continuous improvement towards the vision (Wee and Quazi, 2005). Some of these actions may be outlined as:

1. Fostering an appropriate environmental organisational culture (Fernández et al., 2003; Daily and Huang, 2001; Govindarajulu and Daily, 2004; Stone, 2006a; 2006b);
2. The development of systematic environmental training programmes with the goal of providing the competencies necessary for the Cleaner Production Programme (Perron et al., 2006). This training should be extended to all employees of the company and especially to those

directly linked to Cleaner Production programmes;
3. Promoting the formation of green teams to debate environmental problems (Backer, 1995; Beard and Rees, 2000; Strachan, 1996);
4. The development of performance evaluation systems aimed at global performance improvement and at improvement in people's productivity over time; such performance evaluations systems should provide a useful instrument for measuring the performance of employees in Cleaner Production programmes and for providing feedback that fosters the improvement of individual participation and the participation of teams in the programme (Denton, 1999);
5. The implementation of reward programmes that seek to reinforce or inhibit behaviours during the processes of Cleaner Production programmes (Govindarajulu and Daily, 2004);
All of the above instruments for the development of capacities to generate new processes and improve current processes are directly related to human resource practices and may be explored more deeply by means of:

1. Direct solicitation of the workers' opinions on the initiatives for environmental improvement in the current processes and innovations in the systems;
2. Empowerment of workers to make suggestions on environmental improvements in productive processes;
3. Constant investigation of new competencies related to the aspects demanded during the course of the Cleaner Production Programme; and
4. Documentation and knowledge retention, with the aim of allowing the transfer and retention of useful information for future programmes.

It is hoped that in this manner the contribution of human resources to the area of environmental management can be strengthened, with human resource management also concerning itself with the strategic objectives related to environmental issues.

CONCLUSIONS

Environmental management has been widespread within the organisational sphere as a tool capable of leading the company to continuous improvement of its activities and of encouraging consideration of environmental aspects.

Because it is a complex process, environmental management demands the engagement of various organisational areas in the identification of the best alternatives for the development of productive forms aligned with the assumptions of sustainability. However, even with this recognition of the necessity of the participation of the entire organisation, the literature shows that interaction between human resource management and environmental management is lacking in most companies, both in theoretical and empirical terms. This gap proves to be even more accentuated when the perspective involves the contributions of human resource management to Cleaner Production programmes. Given the above, one of the greatest challenges in the consolidation of Cleaner Production programmes is to ensure the engagement of employees in this process, which has direct implications for human management activities. In this sense, it is essential that human resource management develop strategies that foster proactive environmental management and that entail the improvement of Cleaner Production programmes. The alignment of human resources with the environmental practices of the organisation, considered here as the integration of human resources with Cleaner Production processes, can be brought about through the development of training programmes, the empowerment of employees and the creation of performance evaluation and reward systems and is fundamental for the effectiveness of Cleaner Production.

On the other hand, both management of an environmental organisational culture and teamwork are essential for the improvement and maintenance of Cleaner Production in companies. Thus, only when employees and top management are committed to the environmental dimension and to the environmental cause of the organisation will Cleaner Production become a reality. Therefore, human resources should assume responsebility for the spread and consolidation of environmental management practices in the company, thereby fostering and supporting the development of Cleaner Production. As a limitation, this paper is theoretical in nature. We therefore recommend that future researchers to test empirically the relationship between cleaner production and human resources.

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