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Development of a Environmental Methodology for Solid Wastes Management in Higher Education Institutions

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Abstract

This work aimed to present a critical analysis about the development of a methodology for solid wastes management in Higher Education Institutions (HEI). Researches were undertaken on technical rules and on the specialized literature on Environment over the last ten years. In a comparative study between methodologies ISO 14001 and Cleaner Production (CP), it was verified convergent and complementary points to its implantation in a HEI. It was done a case study at UTFPR-PG, where factors like environmental aspects and impacts, initial environmental diagnostic, purposes and targets and the way the campus fits with CP were surveyed and analyzed. It was possible to conclude that the application of ISO 14001 altogether with CP can effectively contribute for an improvement in the competitivity of HEI´s and magnify the vision about the environmental tools application in this sector.

Keywords: Higher Education Institution, Cleaner Production, ISO 14001.

1 Introduction

Environmental question has been theme of discussion in recent years, with the concerning about natural resources conservation and the environment degradation that mankind has done (DRUZZIAN et SANTOS, 2006). Due to the population growing, waste accumulation and environmental degradation increased in a very fast way (ALENCAR, 2005; DRUZZIAN and SANTOS,2006). So, mankind realized that the solution is to decrease the waste generation, developing techniques to reduce waste, and contribute to the sustainable development (DRUZZIAN and SANTOS, 2006).

According to Tauchen and Brandli (2006), environmental management has more

and more importance among the entrepreneurs. The development of ecological conscience in different layers and sectors of the world society also reaches the education area. It organizes human activities in order to generate the lower possible impact on environment, from the choice of better techniques to the right allocation of human and finance resources. Then, the uncontrolled use of natural resources and environment degradation demand huge corrective actions (TAUCHEN and BRANDLI, 2006).

Every human activity generates waste as byproduct. The waste generation does not happen just at chemical industries, although they are first at volume and danger. (DRUZZIAN and SANTOS, 2006). Also at Higher Education Institutions (HEI), laboratories of high school and graduation, technical schools and research institutes generates great diversity of liquid and solid waste, a potential pollutant, although in a reduced quantity. According to Rodrigues, Oliveira and Pilatti (2007), Brazilian universities still face several obstacles to incorporate the environmental dimension to the human resources formation due to factors like: environmental subject approach in a multidisciplinary and sectorial way and technical studies without considering epistemological and methodological aspects.

Furiam and Gunther (2006) say that solid waste generated at universities range, besides the ones classified as urban solid wastes, some wastes classified as industrial and health services wastes. There are also, according to the same authors, Environmental Education activities that are important to define the segregation, the collect, the treatment and final destination of solid wastes generated in these spaces, as they demand a special treatment. So, this article aimed to present a critical analysis on the development of a new methodology for waste management in Higher Education Institutions (HEI), using tools ISSO 14001 and Cleaner Production, in order to contribute at environmental impacts control and at fitting to the actual laws.

2 Theoretical Reference

2.1 Higher Education Institution

Education Institution can be defined according to the Minas Gerais University glossary (2008), as:

> College: Higher education institution that offers one or more graduation courses, and can also offer one or more post-graduation courses, or even master degree or PhD courses.
>
> University: Multidisciplinary Institution that graduates higher-level professionals, and is characterized by the non-division of teaching, research and extension activities and has financial, administrative and academic autonomy.

According to Education Ministry (2008), HEI´s can be classified, considering their juridical nature, in: Private (with or without profit purpose) or Public. Tripolone and Alegre (2006, p. 34) point out that “a university is a privilege place, where the ones who take part in the educational process interact, developing and acquiring knowledge and skills, in order to understand and act on the reality that surround them”.

2.2 Environmental Methodologies

2.2.1 Industrial Ecology

Industrial Ecology contributes with the environmental sustainability of the industrial organizations by changing the view about the waste concept, considering it as a byproduct, because in the nature the waste of a cycle end is also the raw material

for the beginning of another cycle. Agner (2006) makes an analogy between the natural ecological systems and the industrial systems, and the application of this concept can improve the sustainability of the organizations by orienting the entrepreneur strategies in order to help the organizations integration, adopting as a model the systems found in the nature environment.

2.2.2 ISO 14001

ISO 14001 standard was developed since 1993 by Technical Commission (TC) 207 ISO with the purpose of giving to the companies and organizations around the world a common approach to the environment management (NASCIMENTO and POLEDNA, 2002). Nowadays, a fundamental demanding for companies that want to take part in the global market through the improvement of their environmental performance is to get the certification of an Environmental Management System by IS0 14001, according to Seifert (2006). It aims to determine the competitivity for any sector companies, medium or big ones. Rule 14001 is applied to companies of industrial activities, agro industrial and services, certifying installations, production lines and products that meet the environmental quality standards (SOLEDADE et al., 2007).

2.2.3 Ecological Economy

In his book *The Entropy Law and the Economic Process,* Rumanian economist Nicolas Georgescu-Roeden spread the Ecological Economy. When it is put in the economic study the Entropy Law (second law of thermodynamic that shows the existence of energy that is not able to be used in productive processes, being thrown in the environment and resulting in pollution and natural resources degradation), the economic thought is hardly changed, as there is the insertion of irreversibility and limits idea in economic theory (SANTOS, 2008). Georgescu-Reogen analysis are considered classical for this economy discussion that is based the energy flows or the entropy principles (SOUZA-LIMA, 2004). For ecological economy, physics laws explain the limits of the economic system. In an ecological focus, economy is part of a wider ecosystem, as part of a whole where other variables, not necessarily economic ones, are also fundamental (SANTOS, 2008). It proposes an approach against imminent environment disasters and spreads the idea of natural resources conservation for sustainable development (MATTOS and FERRETTI FILHO, 1999).

2.2.4 Clean Production

Clean Production (CP), that ranges industrial management strategies (SILVA, 2004), was proposed by non-governmental organization *Greenpeace*, says Furtado *et al.* (1998), to represent the industrial productive system that considered: Self-sustainability of raw materials renewable resources; Water and energy consume reduction; Prevention of toxic and danger waste generation at production; Reuse of materials by recycling in a non-toxic way and efficient-energy (efficient and effective energy consume); Generation of long lifetime, safe and non-toxic products, in a way that their wastes (including packages) have non-toxic reuse and efficient-energy; Recycling (in the industry or out of it) in a non-toxic way and efficient-energy, as replacement for options of environmental handling represented by incinerations and dumping.

CP is an industrial production system that demands resources like: materials (that products are made from); energy (to transport and process materials); water and air (GREENPEACE, 1997). Thorpe (1999) says that CP tries to understand the flow of materials in the society, particularly analyzing the products chain: where the raw

materials come from, how and where are they processed, what kind of wastes are generated throughout the productive chain, what products are made from the materials and what happen to them during their use and the end of the shelf life. According to Greenpeace (1997), CP aims to meet the demands of products in a sustainable way, using renewable non-hazard materials and energy, protecting the biodiversity.

2.2.5 Cleaner Production

The concept of Cleaner Production (CP) refers to the production integrated to environmental protection in a wider way, considering all the steps of the productive process and the life cycle of the final product, according to PNUMA (1993). CRP appeared in 1991, in a program of UNIDO/UNEP in an intermediary approach between Greenpeace Clean Production and the decreasing of waste from *Environmental Protection Agency – EPA* (CNTL, 2003).

According to the National Center of Clean Technology - NCCT (2003), CRP is the continuous advantage taking of an economical, environmental and technological strategy related to products and processes, in order to increase the effectiveness at the raw materials, water and energy use, by not generating, decreasing or recycling of waste generated in all productive sectors. CRP applies a preventive approach at Environmental Management that allows the company works in a social and environmentally responsive way, resulting in economical and technological improvement, in order to maximize the efficiency at the use of raw-materials, water and energy, applied to services and production, aiming to diminish the risks for people and to the environment (CNTL, 2001; SILVA FILHO e SICSÚ, 2003; PIMENTA and GOUVINHAS, 2007).

CRP aims to strength economically the industry by pollution prevention, improving the environmental situation of a certain region. It explores the productive process and other activities of a company and assess the use of materials and energy. From this, products, technologies and materials are checked in order to diminish the waste, the emissions and effluents, and to find ways of reusing the unavoidable wastes. For CNTL (2002), CPR is a complete tool to determinate the choices for productive process optimization and process continuous improvement, because join questions that aim this target, like: quality, planning, safety, environment, design, occupational health and efficiency.

2.2.6 Life Cycle Analysis

Life Cycle Analysis (LCA) is an indispensable tool for a better following up of the production cycles and to identify interaction alternatives among the processes. It is a method used to assess the environmental impact of goods and services (RIBEIRO; GIANNETI e ALMEIDA, 2008). LCA of a product, process or activity is a systemic assessment that quantifies the energy and materials flows in the life cycle of a product, following the main flow of material and energy that take part of a product formation. LCA is a technique for assessment of environmental aspects and of possible impacts related to a product, comprehending steps since the taken from the nature of raw materials until the disposition of the final product, ranging ISO, 2008): Product from energy; Processes that comprehend the manufacture; Questions related to package; Transportation; Non-renewable energy consume; Impacts related to use or reuse; Reuse of the product or even questions related to trash or recycling. LCA is recommended by ISO 14040, according to Ribeiro (2003) that describes the principles and the structure to take and report LCA studies.

2.2.7 Ecodesign

Costa (2008) defines Ecodesign as interactions with environmental questions at industrial design related to what is technically possible with what it ecologically necessary and socially acceptable; face to the perception of growing necessity of protecting the environment it is in the context of sustainable growing. The word ecodesign is used to describe a increasing trend at architecture, engineering and design, where the main purpose is to project places, products and services that reduce the use of non-renewable resources or minimize the environmental impact (BRUAN and GOMEZ, 2007). According to Regis (2004), ecodesign consists in a method of projecting that eliminates or diminishes the environmental impacts. It is not just "cleaning", but mainly "not dirty", considering all the phases of the project. Oliveira (1998) considers ecodesign as a conceptual approach of the production demanding that all the phases of a product or a process must be leaded to preservation or minimization of long or short term risks to human health and to environment.

2.2.8 Eco-efficiency

Eco-efficiency definition was established according to Toledo and Demajorovic (2006) as how efficient human resources are applied to meet human needs, and its result is obtained from the value of products and services generated by a company. Eco-efficiency means to generate more products and services with less use of resources and decreasing of waste and pollutants generations, says Holidday et al. (2002), and it aims a more efficient growing using a business approach that reduces environmental impact at organizations. According to D´Agosto and Ribeiro (2008), ecoefficiency is a set of key elements to improve the eco efficiency of an activity and principles that assure the recommended indicators and the way to get them are scientifically justifiable, relevant for environment, sharp and useful.

Companies that adopt eco-efficiency can generate higher added-value products and services, and assures the resources consume reduction and the less generation of pollution (LEHNI, 2000). Eco-efficiency has three fundaments: economic, environmental and social. If a company or process wants to enter in the market and stay in it, it must be economically profitable, environmentally compatible and socially fair. In this way, it will be eco-efficient and will create basic conditions to be introduced in the actual concepts (CNTL, 2002).

3 Methodology

Considering the cited environmental methodologies, the study adopted ISO 14001 because it is a global tool that joins systemic elements to the purpose of environmental damage reduce in managerial aspects. And Cleaner Production by analyzing the management of waste and generate performance indicators for decision taking, besides interacting with other tools like Product Life Cycle Assessment, technical and economic studies. By the revision of literature was undertaken a comparison between ISO 14001 and Cleaner Production methodologies, verifying their similar and complementary points for implantation in a Higher Education Institution, as these methodologies aims the realization of the social-environmental responsibility in the entrepreneurial area.

The study undertaken by Vaz (2008) about the management of solid waste in the Technological University of Paraná (UTFPR), Campus Ponta Grossa, showed subsidies that helped this research results and data interpretation. The referred study was a UTFPR-PG mapping, identifying wastes generated at each department: academic ones, laboratories, medical office and university restaurant; it was also

searched the practices adopted by the institution for final destination of the wastes, from solid ones to chemical effluents and it was analyzed the students conceptions about environmental problems. This way, in this study were analyzed environmental aspects and impacts, presenting an environmental policy for the Institution and an environmental management program with purposes and targets, and its fitting at Cleaner Production, according to the survey realized by Vaz (2008).

4 Results and Discussion

4.1 Analysis of ISSO 14001 and Cleaner Production at HEI´s

To implant an Environmental Management System (EMS) in a Higher Education Institution is necessary to use ISO 14001 rules (it determines the elements that must be present in the EMS like, environmental policy, planning, implementation, corrective actions and revision) and the 14004 (a guide for EMS implementation). This work focused on ISO 14001. In order to make easier the understanding about the main elements for an EMS implementation, they are described as follow according to NBR ISO 14001 (1997): Environmental Policy. Planning: Environmental Aspects and Impacts; Legal Requirements; Purposes and Targets; Environmental Management Programs. Implementation and operation: Structure and Responsibility; Training; Communication; EMS Documents; Operational Controls; Preparation and emergency attend. Checking and corrective action: Monitoring and measurement; Non-conformity and corrective action; Registers. Critical analysis: Management Critical Analysis. According to the National Center for Clean Technology - CNTL (2003), implantation steps of Cleaner Production do not follow a sequence, but can be followed as shown in Table 1

Table 1 – CP implantation stages

Stage	Activities
Planning and organization	- To get the commitiment of high administration; - To set the project team; - To set the CP range; - To identify barriers and solutions
Pré-assessment and diagnosis	- To develop the process flow; - To assess the inputs and outputs; - To select the assess focus of CP.
CP assessment	- To make a material and energy balance; - To generate CP options; - To select CP options.
Study of Technical, Ecomic, and Environmental viability	- Technical assessment - Economic assessment - Environmental assessment - Select options to be implanted
Implementation of the option plan and continuity plan	- To prepare the CP implementation plan; - Implementation of the CP options; - To monitor and assess - To keep the CP activities

Source: CNTL, 2003

4.1.1 Analysis of similar points between ISO 14001 and CP

CP and ISO 14001 have similar points for their implantation in an organization, that altogether can be complementary tools, because join systemic elements to the objectives of waste reduction; ISO 14001 acts on managerial aspects and CP on inputs and outputs of raw material, input, energy, water, and so on. The authors suggest a complementation for implantation of these two tools together. For their implantation is necessary the high direction commitment; Eco-team formation; survey of the initial diagnosis in all the organization, process, product or service;

determination of an environmental policy; structured planning of the integrated assessment matrix, for analysis of emission and generation of waste for technical, economic and environmental feasibility, and the program made of targets and objectives for raw material optimization and emission reduction (based on ISO 14001).

Implementation and operation, assessing the inputs and outputs of raw material, input, energy, water, and defining the participation and responsibilities, training and communication of the organization as a whole. CP assessment, resulting in a balance of materials and energy, generating and selecting options for CP. Technical feasibility study, in order to implement each level; environmental assessment to evaluate the environmental benefits that can be obtained and the economic assessment evaluating the economic feasibility of each elaborated level.

Checking and corrective action, monitoring activities and foreseeing environmental impacts. Continuity plan, basing the activities. And the critical analysis by high direction, in order to review the implantation, aiming the continuous improvement. For assessment, wastes must be continually treated in the system or sub-system inside ISO 14001, being strongly meant their gas emissions and chemical residues.

4.2 Case Study at UTFPR-PG

4.2.1 ISO 14001 analysis

ISO 14001 is not implanted at UTFPR. According to ISO 14001 stages implantation and based on the Institutional mission, relevant environmental aspects and impacts were assessed, it was made the environmental diagnosis and targets and objectives were outlined based on the management of solid waste at UTFPR-PG. Environmental aspects are defined according to Viterbo Junior (1998) as any element of activities, products or services that can interact with the environment; and the environmental impacts are defined as any beneficial or adverse environment change, that represents part or all the activities of the organization. When data are allocated, it results in Tab. 2 with environmental aspects and impacts to be assessed by matrix of aspects and impacts at Tab. 3.

Tab. 2 – Environmental Aspects and improvement suggestions

ENVIRONMENTAL ASPECT	IMIPROVEMENT SUGGESTION
Use of chemical substances	Reuse of the substances
Use of Metals	Metals Recycling
Consume of water, energy and paper	Consume Reduction and reuse of paper
Work Conditions	Use of PPE, equipments adaptation to the activities considering ergonomic aspects
Chemical substances storage	Training for proper storage of the substances
Laboratories equipments maintenance	Training for equipments maintenance

Source: Authors

To identify and assess the important environmental impacts at UTFPR-PG it was used the matrix of environmental aspects and impacts, according to ISO 14001. Table 3 shows the requirements for this assessment, that is the identification of aspects and impacts, happen probability, severity, probability of transgression the legislation and the significance filter.

Tab. 3 – Matrix of environmental aspects and impacts

IDENTIFICATION		CARACTERIZATION							SIGNIFICANCE FILTER	
Aspects	Impacts	CL	INC	TEM	SEV	FRE	PRO	IMP	REG	PI

Use of chemical substances	Soil contamination	A	D	F	3	3	2	8	X	X
Use of metals	Soil contamination and decreasing of natural resources	A	D	F	3	3	3	9		X
Consume of water, energy and paper	Consume of natural resources	A	I	A	2	3	3	8		X
Work conditions	Risk of accidents	A	I	F	1	1	1	3		X
Maintenance of laboratory equipments	Gas emission, soil and effluents contamination, consume of fuel (energy)	A	D	A	3	3	1	7	X	x
Chemical substances storage	Soil and effluents contamination	A	D	F	3	3	1	7	X	x

Source: Authors

Tab. 4 shows the goals and purposes for a Waste Management Program. Goals must follow the environmental legislation on those points that eventually company could not attended yet. And purposes must be monitored by indexes.

Tab. 4 – Environmental Management Program

ENVIROMENTAL MANAGEMENT PROGRAM	
GOALS	**PURPOSES**
To reduce the waste generation at laboratories	To reduce the mensal amount in 10%
To reduce the amount of energy in the institution	To reduce the mensal KWH consume in 5%
To reduce the water consume in the institution	To reduce 10% of treated water
	To implant a rain water capture system, to be use in the bathrooms
To improve the danger products conformity	Training for teachers, students and workers to correctly destine the waste

Source: Authors

4.2.2 CP analysis

According to the level of opportunities and priorities of production management from CNTL (2003), UTFPR-PG is on level 2 of internal recycling. The institution has a selective collect program on several departments, it is done the reuse of wastes like papers generated in academic and administrative sectors. However, some wastes like computers and furniture cannot be sold, because it is a public institution. Recently, in chemical laboratories there is a control of generated solutions, which is not disposed as waste, but kept properly to be correctly destined. There is, in the institution, a separation system of recyclable waste (paper in blue containers, plastic in red ones, metal in the yellow and organic in the Black ones). It was also surveyed several chemical waste such as sulfuric acid and solvents.

By CP in its levels like the following can be taken: a) Level 1: reduction and continuous improvement of chemic waste; b) Level 2: try to recycle chemic solutions and solvents. For decision taking must be elaborated technical and economic feasibility plan, at same time generating indexes of environmental performance, the goals and purposes surveyed previously in ISO 14001 are factors to be reached.

5 Conclusion

From this bibliographic research can be concluded that, besides economic aspects, the bases of CP like prevention, continuous improvement, good practices, search for innovation in products and processes, application/assessment of internal and external recycling, make this tool totally integrated to other management systems.ISO 14001 is a tool used by organizations to be according the rules and/or

environmental legislation, required for an environmental quality standard. ISO 14001 apply altogether with CP can contribute effectively for competitivity improvement of HEI, because both have benefits, for example, productivity growing, quality improvement, environmental resources optimization, input and energy, important factors to the search for entrepreneurial and educational excellence in the world nowadays. It is necessary, when implanting an EMS in a HEI, that there is a compromised and motivated direction. At the UTFPR case, it is not possible to conclude the benefits that EMS brought to the institution, because the analysis was undertaken just at the initial stages of EMS and on what level it was in the management of solid waste at CP, to show that is possible to implant an environmental methodology as in industries as in Teaching and Research Institutions.

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