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## **HOSPITAL ACTIVITIES: ENVIRONMENTAL IMPACT AND ECOEFFICIENCY STRATEGIES**

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### **ABSTRACT**

The service sector presents a variety of environmental aspects that, depending on the activity, may have a significant impact on the environment. Its users are consuming resources such as energy and water on a daily basis and generating a great deal of solid waste and effluents. However, the number of studies that have been published that allow us to adequately quantify the environmental impact of service activities is still small. Even so, for some sectors these data are beginning to be made available in such a way as to allow us to build up a more realistic picture of the potential environmental impact of these organizations. The hotel industry, banking sector and hospitals are examples of some of the sectors that provide us with more information on this issue. This work discusses the main environmental impacts generated by the hospital sector and highlights the possible ecoefficiency strategies that can lead to improvements in environmental management in this particular activity. In the final part of the article we look at three case studies that were developed in hospitals located in the Greater Metropolitan Region of Sao Paulo. The results of this research revealed some of the main environmental performance indicators relating to water, solid waste and energy and also highlighted some of the main challenges to the effective introduction of an ecoefficiency strategy for the sector.

**Key words:** Hospitals; ecoefficiency; environmental impact; environmental management.

## INTRODUCTION

Ecoefficiency has been playing an increasingly important role in the environmental management strategies of organizations. Pressured by restrictive legislation and because of an increase in the costs of natural resources, a growing number of companies have overcome the paradigm that prevailed until the 80s that the environment and competitiveness are antagonistic variables. This tool, however, which until the mid-90s was, for all practical purposes, restricted to the business sector, is beginning to be increasingly employed in the service sector, also.

In the current stage in which the world economy finds itself recognition of this tool in the service sector is fundamental for mitigating the impacts on the business sector as a whole. At the end of the day, a large part of the wealth generated in the economy originates from this sector. In the United States, for example, the service sector, which includes a huge range of activities, such as restaurants, hospitals, banking institutions and others, represented 75% of GDP in 1997, nearly US\$ 3.8 trillion, and accounted for 80% of all employment (GUILLE et al. 1997, mentioned by DAVIES et al., 2000). In Brazil, which is going in the same direction, the service sector already responds for nearly 60% of national GDP (Dias, 2002).

These numbers, showing the economic relevance of the service sector, do not, however, account for the increase in the environmental impact associated with expansion of these activities. To a greater or lesser extent, every activity in the service sector generates environmental impacts in its day to day operations; these include energy and water consumption, the generation of solid waste and effluents, air pollution and alterations in ecosystems and natural environments. Many of these impacts could be avoided, or restricted, if these activities incorporated measures for rationalizing natural resources.

Hospital activities are among the countless types of service industry that can play a central role in mitigating, or expanding, the socio-environmental impacts associated with the sector. of all service activities, hospitals are one of the main consumers of electrical energy, in addition to generating a significant quantity of waste. in this context

ecoefficiency constitutes an essential tool, so that hospital activities may also reconcile greater economic efficiency with reduced environmental impact. this article analyses the main environmental impacts associated with hospital activities, by highlighting how ecoefficiency is being incorporated into these undertakings. in the final part we present a case study that includes three hospitals located in the municipality of santo andré and debate the prospects for incorporating an ecoefficiency strategy into the decision making process in the management of hospital units.

## **ECOEFFICIENCY**

Over the last twenty years, or so, in parallel with the debate on sustainable development, a series of tools, aimed at making socio-environmental responsibility a reality within the business sphere have been discussed, such as clean production, pollution prevention and ecoefficiency. Of all of them, ecoefficiency is the one that has been receiving special attention over the last few years. It is interesting to note that this is not such a recent debate since, according to Lehni (2000), the term ecoefficiency was used for the first time by the researchers, Schaltegger and Sturm in 1990.

In this process an important contribution was made with the publication of the book, *Changing Course*, by Stephan Schmidheiny. The author, founder of the World Business Council for Sustainable Development, defended a change of perception on the part of the business sector with regard to the socio-environmental variable. Instead of placing itself exclusively in the position of agent of the degradation process, the business sector could perform a crucial role in solving the challenges of global sustainability (LEHNI, 2000). This would only occur, however, if it was possible to base business strategies on alternatives that would reconcile environmental and economic improvements. In this sense the search for ecoefficiency would allow the business sector to turn such objectives into a reality.

Since the publication of *Changing Course*, the concept of ecoefficiency has been continuously remodeled. In the book an ecoefficient company is one that manages to generate products and services with greater added value, while at the same time ensuring a reduction in the consumption of resources and less pollution generation (LEHNI, 2000). For the OECD ecoefficiency was defined as the efficiency with which ecological resources are used to meet human needs, its results being obtained from the value of the products

and services generated by a company, economic sector, or even a country, divided by the sum of the environmental pressures generated by the companies and sectors. For the European Environmental Agency (EEA), on the other hand, which intends to use it as an indicator to quantify the progress of a country towards sustainable development, ecoefficiency is “*more welfare from less nature*”(LEHNI, 2000).

In other words, ecoefficiency means generating more products and services with less use of resources and a decrease in the generation of waste and pollutants. Considered in this way, ecoefficiency has managed to be accepted in a big way in the business environment, although more recently we have also seen the publication of various works pointing out the limitations of this particular tool. One of the main reasons explaining its popularity with the business sector is the fact that ecoefficiency imposes no limits on growth and does not involve restrictions as to the type of industrial activity. As Holliday et al. (2002) state, its objective is more efficient growth from an approach to business that minimizes environmental impacts. In practice this approach makes it possible for an organization to be considered ecoefficient when it manages to reduce its pollution emissions in relative terms, even though in absolute terms they have increased.

Such flexibility has proved to be compatible with current ways of doing business, based on incremental changes in process efficiency, thereby making companies more interested in introducing ecoefficiency strategies into their management practices. In fact, countless studies have shown that both in the industrial sector, as well as in the service sector ecoefficiency strategies have led to significant reductions in spending on raw materials and energy. However, to its critics, ecoefficiency cannot be credited with the potential for turning sustainable development into a reality. According to the OECD, in order for ecoefficiency to achieve this objective, the average productivity of resources in industrialized countries would need to increase more than tenfold over the next 30 years, in such a way as to ensure an expansion of production, while using increasingly fewer natural resources (DAY, 2004).

Day (ibid.) himself questions this optimistic vision, by pointing out that the gains obtained over the last few decades in process efficiency were not enough to compensate for the increase in absolute terms of resource consumption. According to the author, highly industrialized economies, such as the United States, Germany and Japan, have managed to obtain considerable increases in resource productivity, which over the last 20 years has

avored a reduction by nearly 20% in materials intensity in relation to GDP. However, total consumption of resources in these countries increased 27.7% in the same period. The same reasoning is valid for energy consumption. While in the United States it is planned that energy consumption will increase by 20% over the next 20 years, in Asia growth of more than 40% is estimated for the same period.

For Day (ibid.) incremental changes brought about by ecoefficiency gains would be an important step, but not sufficient to achieve sustainable development. The real challenge lies in the continuous incorporation of an innovation process based on the radical transformation of technology, thereby guaranteeing new processes and products, instead of concentrating only on improving current processes. Also according to the author, the problem is not in the concept of ecoefficiency, but in its application. In his opinion, the current concept of ecoefficiency is sufficiently broad to incorporate the challenges of sustainability, since it includes process change and product innovation.

According to the World Business Council for Sustainable Development, ecoefficiency comprises seven elements: a reduction in materials intensity; a reduction in energy intensity; a reduction in the emission of toxic substances; an increase in recyclability; maximization of the use of renewable sources; an increase in product durability; and an increase in service intensity (HOLLIDAY et al., 2002).

These elements clearly show that ecoefficiency is not limited to incremental changes in the use of resources. In many cases this means selling services in place of products, which makes it possible for the consumer to have his needs met with less use of resources.

Such is the case of the partnership of the Swiss company, Mobility, with the Swiss Federal Railway. To the user Mobility offers an automobile sharing system that allows the registered person to use an automobile parked in predefined places for a certain period of time, and via its partnership with the Swiss railway company it makes reduced fares available on the trains for those who are interested. The result of this initiative is a change in the behavior of users of the transport system, who now use the rail services much more than their automobiles. Furthermore, frequent users of this service consume on average less than half the fuel per year when compared to the owners of automobiles. For the rail company the main advantage is an increase in the use of their services because of those who use this system (LEHNI, 2000).

For Day (2004), however, what prevails in the majority of business organizations is an emphasis on process efficiency, as a synonym of ecoefficiency, while the development of new products and new services continues to occupy a secondary position. In this sense a partial application of the concept of ecoefficiency cannot be confused with sustainable development. Furthermore, it is important to underline that ecoefficiency does not work with all the variables that are present in the current debate about corporate socio-environmental sustainability. This is a concept that brings together only two dimensions: economic and environmental. The social variable, a fundamental element of the triple bottom line, is not included. Despite these limits ecoefficiency is a fundamental tool when it comes to organizational strategy, particularly in those service activities that present a considerable potential for generating an environmental impact, as is the case with hospitals.

## **HOSPITAL SERVICES AND ENVIRONMENTAL IMPACTS**

The hospital sector has a growing economic importance in developed countries. Research presented by Davies and Lowe (1999) in the United States showed that the sector is responsible for employing one in every nine employees and accounts for one in every seven dollars that is spent in the economy. Furthermore, this activity employs nearly 10 million people, and includes 200,000 medical consulting rooms, 100,000 odontological consulting rooms, 20,000 laboratories, 10,000 hospitals and 8,000 clinics.

Besides their economic importance the particular way that hospitals function involves a range of activities that present great potential for causing an environmental impact. These organizations operate 24 hours a day, 365 days a year, have various pieces of equipment for producing food, consume fuel oil for generating energy and also demand a variety of other common resources in considerable quantities, including rubber, plastics and paper products. In this context hospitals carry out functions that are often similar to those found in industry, such as laundry, transport, cleaning, food, photographic processing, and others. What is different from other activities, however, be they in the industrial or service sectors, is that hospitals consume great quantities of disposable medical products that are used to prevent the transmission of diseases to their doctors, patients and employees.

Because of these characteristics, in their operations hospitals generate, on the one hand, a great quantity of waste, and on the other demand a great quantity of resources, such as electrical energy and water. Davies and Lowe (ibid.) mention that the generation of waste by the sector is significant and constant throughout the year. According to Velez (2004) while 85% of the waste from a hospital can be recycled the remaining 15% is made up of infectious and dangerous material that demands special care when handling and disposing of. Such is the case, among other things, of used syringes, anesthetics, disinfectants, reagents and radioactive waste.

For the major part of the waste considered to be dangerous the main alternative has been incineration, resulting in atmospheric emissions that issue from the equipment used for burning it. Data from EWG (1997, after DAVIES and LOWE, 1999), show that the USA has 2,400 hospital incinerators, of which 2/3<sup>rds</sup> (1600) use no type of device for controlling pollution.

Data available from the Ecoefficiency Guide for Hospitals also indicate the potential environmental impact of this activity as far as the consumption of energy and water is concerned. Velez (2004) points out that the consumption of energy is fairly diversified, including lighting, air conditioning, boilers and kitchen activities, which means that in the absence of any plan for its rationalization this resource may account for between 15-30% of the organization's revenue. Likewise, Davies et al. (1999), report that the high energy consumption of North American hospitals contributes to the fact that these units present the second highest consumption of all commercial buildings, with available indicators revealing that their average electricity consumption is 240 kWh/m<sup>2</sup>/per year.

The use of water is also varied and includes sanitary installations, both for patients as well as for their visitors, laundry, the cleaning of installations and restaurants and the watering of gardens. The available indicators show that total consumption is very variable and depends on the degree of development of the country. In Denmark, for example, the consumption of cold water per bed/day is almost 600 liters, while in Austria this figure is 200 l/bed/day. When we come to compare the consumption of hot water in hospitals in the United States and countries in Eastern Europe the difference varies from 340 to 110 l/bed/day (VELEZ, 2004).

If there is already a concern in many countries with building up the indicators of environmental performance, in Brazil there is still a long way to go before we correctly quantify the environmental impact associated with hospital activities. In fact, until the beginning of 1990 there was no great concern with hospital waste, compared to waste in general, even though its potential for causing socio-environmental damage is a great deal higher. It was handled and packed in any way whatsoever, generally in water-proof sacks, but also in other types of container, and local temporary storage was in the open air, exposed to the elements and subject to animals that often scattered the waste around the external areas of the hospitals (DIAS, 2004, p. 25).

According to Dias (ibid.), this concern with a different way of handling hospital waste only arose when the patient came to be seen as a consumer who demanded differentiated treatment and started to actively participate in everything that was done to set him or her back on the road to full health. Also, according to the author, the rise of Acquired Immune Deficiency Syndrome – AIDS - obliged health professionals to review their procedures with regard to waste and its contribution to the disease transmission chain. Perforating and cutting materials acquired an enormous importance in this context, demanding special care when it came to disposing of them.

Currently, Brazilian legislation, by means of a resolution from the National Environmental Commission - CONAMA (283/2001), demands that all units that carry out activities of a human or animal medical assistance nature have a Plan for Managing Solid Waste in the Health Area (RSS), in the same way as Resolution 33/2003 of ANVISA [National Sanitary Vigilance Agency].

According to Dias (ibid.), however, there is a conflict between the CONAMA and ANVISA resolutions, although the merit of establishing the first directives on the handling of RSS and of provoking discussion of the subject is undeniable. Even so, this lack of agreement between the two resolutions shows that there is no single solution to the problem. In order to fulfill what the legislation lays down, hospitals normally delegate this particular management activity to a hygiene and cleaning service, which in itself is a questionable move, in view of the need for involving all employees. Souza (2003, after DIAS, 2004) says that the professionals who are actively involved in this process have no



environmental aspect to their training, which is technical and specific and does not provide them with the necessary preparation that makes it possible to guarantee minimization of internal and external environmental risks.

With regard to the management of water, both as far as the consumption of this resource is concerned, as well as the treatment of the effluents that are generated, there are few initiatives directed at the introduction of actions for its rational use and suitable treatment before it is discarded. In this context, based on the information obtained from the bibliography existing on this subject and the development of the case studies, a Figure was constructed that summarizes some of the examples from different sectors and activities, their main aspects and the impact hospitals have. We also must emphasize that sectors that are common in other economic activities, such as reception, car parking, green area, restaurant and kitchen, administration, convenience store, maintenance, laundry, utilities, fire prevention system, and others, were not the subject of the study in the figure below.

SECTOR/AREA	ACTIVITIES	ASPECTS	IMPACTS
General hospital (outpatients department); Emergency room; Laboratory; Image diagnosis; Hemotherapy; General and obstetric surgical centers; Sterilization and cleaning; Nursing; Private rooms and wards; General intensive care and semi-intensive care area.	Handling patients with health problems and in emergency situations, internment, specialist examinations.	<ul style="list-style-type: none"> <li>• Various types of controlled and non-controlled medicines.</li> <li>• Infectious waste from disposable materials, dressings, cleaning materials, contaminated IPE, syringes and needles, feces and urine, packaging used for blood, plasma and platelets, anesthetics, antiseptics, digitalics, serum, anti-convulsants.</li> <li>• Fused light bulbs.</li> <li>• X-ray films.</li> <li>• Various non-infectious waste products (paper, cardboard, plastic, ferrous and non-ferrous metals, wood, cloth material, packaging, office materials, food and others).</li> <li>• Consumption of electrical energy.</li> <li>• Water consumption.</li> <li>• Generation of effluents.</li> <li>• Atmospheric emissions.</li> </ul>	<ul style="list-style-type: none"> <li>• Treatment and subsequent disposal in sanitary landfill sites/incineration.</li> <li>• Treatment/recycling.</li> <li>• Occupation of sanitary landfill site.</li> <li>• Use of renewable and non-renewable natural resources.</li> <li>• Alteration in water quality.</li> <li>• Alteration in air quality.</li> </ul>

Figure 1 - Demonstration of aspects and impacts generated by hospital activities  
 Source: adapted from Dias (2002)

From the data presented we identified that there is a need to improve environmental management actions in organizations. It is important to highlight that some of the current initiatives in hospitals indicate that there is a potential for applying ecoefficiency in these organizations. As a result of more rigorous legislation and persuaded by an increase in operating costs with resources such as water and energy, some hospitals are introducing actions that manage to reconcile economic benefits with improvements in environmental performance. Examples of this are the Pablo Tobón Uribe Hospital and the Noel Child Clinical Hospital, both in Colombia, and the Sao Paulo Clinical Hospital Complex, among others.

As recorded by the Medellin National Center for Cleaner Production and Environmental Technologies (2001), Colombia, and the report of the Basic Sanitation Company of the State of Sao Paulo [CETESB] (2002), Brazil, these hospitals succeeded in reducing the amount of total and infectious waste they generated by means of ecoefficiency initiatives, preventive actions and educational programs. Furthermore, they recorded a significant decrease in the consumption of water and energy per patient handled.

Authors like Neto (2001), Novaes (1994) and Azevedo (1993) report on the possible measures that may be adopted by hospital organizations to reconcile economic gains with environmental gains. The following stand out as being the most recommended and most significant measures:

- Modernize elevators: in hospital services elevators consume an extremely high amount of energy;
- Switch off air conditioning when its use is unnecessary;
- Use gas in boilers to pre-heat the water: economize gas for heating water and identify if there is excess oxygen in the boilers for combustion purposes;
- Use only one chiller (water cooling system). Normally two chillers are used to cool the water in the air conditioning system. Every time it is switched on it is recommended that only one chiller be used when the system is not working at full capacity;
- Isolate circuits and install switches in such a way that the lights in different areas may be switched off when they are unnecessary; the installation of movement sensors and/or time switches for controlling lighting is also recommended;
- Substitute standard lighting for highly efficient lights in public areas and install high performance lamps. In working areas, redesign the lighting systems according to the needs of each specific area and prepare an energy economy program;
- Regulate the flow of water by installing economy systems in wash-rooms, showers, cleaning areas and rest-rooms. Substitute conventional valves for economy valves

to reduce the volume of water when flushing the toilet, and substitute 12 liter cisterns for 6 liter ones;

- Introduce a policy of non-acceptance of products packaged in non-recyclable materials and continuously improve the handling of solid waste. Avoid mixing dangerous waste with contaminated waste.

The examples mentioned show some of the things that hospitals can do to guarantee they have both economic and environmental gains. Even so, in Brazil this debate is just beginning and the majority of the managers of these undertakings are fairly insensitive to the need to adopt ecoefficiency practices in their activities. It is within this context that, with the aim of discussing the challenges and prospects for ecoefficiency in hospitals, we present the following three case studies.

## **CASE STUDIES**

The organizations we researched comprise one public and two private hospitals and they present, at least theoretically, a high risk of environmental impacts. We had contact with them by telephone and we visited them personally in order to collect the data. In this study the names of the organizations that took part in the research and their respondents are not revealed, thus respecting their identity and providing the necessary secrecy. It must be emphasized that because this research is exploratory and has its limitations, it is necessary to be cautious when it comes to making any generalizations about the results; the research merits complementary studies and a more detailed analysis of the results.

The research was done in the city of Santo André, which is located in the Metropolitan Region of Sao Paulo, Brazil. Economically Santo André is going through a transitional period. Today, its strong industrial past is giving way to a situation where the remaining industries that are modernizing, and thus economizing labor, coexist alongside a tertiary sector that is expanding. As happened in the ABC Region, the economic data and indicators reveal a great industrial deconcentration in the municipality, where a strongly growing service sector, a sector that is assuming a strategic role in the process of production restructuring that is today under discussion in the region, is prevailing.

According to data from the Economic Development Agency for the ABC Region (1999), industry in the area is responsible for 23% of the formally employed labor force, while the service sector, including civil construction, commerce and public administration activities, is responsible for 77%, thus indicating its importance within the local economy and strengthening its position.

With regard to the number of hospitals in the region, nascimento (2002) mentions that the creation of the single health system (sus) in 1989 and the municipalization of health services have meant that the metropolitan region of sao paulo, along with other regions in brazil, has been facing new challenges when it comes to managing its health system. the major investments necessary in this area, as far as high technology equipment and sophisticated examinations are concerned, are a great challenge for municipal finances.

In this context we need to mention that the three organizations studied present different realities, and therefore different solutions when it comes to dealing with the theme of ecoefficiency, because they are at different levels of management development. They are, however, all subject to the same legislation and obligations as far as the management of dangerous waste is concerned. We also need to emphasis that the three hospitals present the same characteristics and have similar activities and are therefore considered to be general hospitals.

Even so, of the three hospitals, only the two private ones are at a level that allows them to offer their patients hotel hospital services. According to Torres (2001) this type of service is conceived of as bringing together all the support services, in association with specific services, and which together offer comfort, security and well-being to both internal and external customers during their period of internment/activity. The hotel hospital concept arrived on the scene in Brazil a little more than ten years ago, when some factors occurred that forced this emergent need. The public hospital, on the other hand, does not fit into this classification because it does not offer the same services. It does, however, have a characteristic that differentiates it from the other organizations; it is a hospital/school, used for medical residency by the ABC Faculty of Medicine, which leads to some discrepancies in the data analyzed when compared to the other cases we studied.

In order to measure the comparison between the environmental performance evaluations of the hospitals we used the indicators proposed by the *Sector Guide for Cleaner Production: Hospitals, Clinics and Health Centers* (Medelin, 2001), because of a lack of studies in this country on environmental performance in hospitals. As a result we defined the following indicators: solid waste (kg/bed/day), infectious solid waste (kg/bed/day), total consumption of hot and cold water (m<sup>3</sup>/bed/day) and consumption of electrical energy (kwh/bed/day). The following figure gives the results of the indicators selected for different countries and regions:

INDICATOR	TYPICAL VALUE	COUNTRY
Total solid waste (kg/bed/day)	4,8 7,5 0,14 - 3,5 8,46 1,0 - 4,5	Australia USA Middle East, Asia and Africa USA Latin America
Dangerous solid waste (kg/bed/day)	1,5 - 2 1,1 0,01 - 0,2 0,25-1,13	France, Belgium and England USA Middle East, Asia and Africa Latin America
Total consumption of water (m <sup>3</sup> /bed/day)	0,2	Eastern Europe
Consumption of electrical energy (kwh/bed/day)	6,6 maximum	Austria

**Figure 2 -** Indicators of hospital performance

Source: Sector Guide for Cleaner Production: Hospitals, Clinics and Health Centers (2001)

The data mentioned in the table below summarize the results obtained from the research into the three hospitals. this is followed by an individual analysis of each of the indicators we selected.

Hospitals	Electrical energy kw/h / bed / day (annual average)	Water m3 / bed / day (annual average)	Total waste kg / bed / day (annual average)	Infectious waste kg / bed / day (annual average)
A	35,83	0,5	5,5	1,0
B	21,86	0,4	6,5	2,5
C	16,80	0,85	64,07	50,32

**Table 1 -** Results obtained from data collection in the organizations (2003)

## Electrical energy

To obtain the indicator relating to the consumption of electrical energy we used the following formula:

$$\frac{\text{Energy consumption (kw/h) : total number of beds}}{\text{Number of days}} = \text{performance indicator}$$

The data provide us with the different performance percentages relating to energy consumption. in hospital a, energy consumption is of the order of 35.83 kw/h/bed/day, 63.9% greater than the consumption of hospital b and 113% greater than the data collected from hospital c.

According to the information we collected from the respondents the significant difference between the indicators can be explained by the hotel hospital aspects of service, which one or another organization offers to its customers. hospital a, as explained previously, has a larger number of items of electro-electronic equipment, as well as other pieces of equipment that add to the comfort of the patients, but consume more energy. the data prove that as hospitals offer greater comfort and different examination services, so energy consumption increases.

In comparison with the indicators we defined from our study of correlated international cases and the references obtained from the National Center of Cleaner

Production and Environmental Technologies, where the typical value for Figure 2 is 6.6 Kw/h/bed/day, the three cases we studied proved to have a poor performance; hospital A's value is 35.83 Kw/h/bed/day, hospital B's, 21.86 Kw/h/bed/day and hospital C's, 16.80 Kw/h/bed/day. The latter is the closest to the typical value established by the manual, although even so it is a value that is almost three times greater.

## Water

To obtain the indicator relating to water consumption we used the following formula:

$$\frac{\text{Water consumption (m}^3\text{) : total number of beds}}{\text{Number of days}} = \text{performance indicator}$$

The data provide us with performance percentages in the private hospitals (hospitals a and b), with regard to water consumption, which are very close. While in hospital a water consumption is around 0.5 m<sup>3</sup>/bed/day, hospital b's is 0.4 m<sup>3</sup>/bed/day. What stands out from these numbers is the water consumption in hospital c, the public one, the indicator of which is 0.85 m<sup>3</sup>/bed/day, or 112% greater than the consumption of hospital b. This fact may be explained by the existence of laundry activities, which, although they are outsourced, are still on hospital premises, thus consuming water.

Also when we compare these numbers with the international data available, we note that the performance of the three organizations studied is poor, because the number established by the Study Center is 0.2 m<sup>3</sup>/bed/day, while hospital A's value is 0.5 m<sup>3</sup>/bed/day, hospital B's is 0.4 m<sup>3</sup>/bed/day and hospital C's is 0.85 m<sup>3</sup>/bed/day. It is worth pointing out that, of the cases we studied, the value we recorded as having the best performance is double that established as a typical value.

## Total waste

To obtain the indicator relating to the generation of total waste we used the following formula:



$$\frac{\text{Total waste (kg): total number of beds}}{\text{Number of days}} = \text{performance indicator}$$

The data provide the different performance percentages relating to the generation of total waste. we can see that in hospital a the generation of waste is of the order of 5.5 kg/bed/day, 18% less than that generated by hospital b (6.5 kg/bed/day) and 1,164% less than data we collected from hospital c (64.07 kg/bed/day). the public hospital generates approximately twelve times more waste per bed per day than the private ones, which we have taken as the parameter.

According to the quantitative data we collected from the respondents the significant difference between the indicators can be explained by the more rigorous and complete control that any privately owned activity must have because of the costs arising from appropriate disposal of the waste and in order to comply with the legislation. as we previously explained, hospital a has a system for managing waste, as well as performance indicators that are measured on a monthly basis. in this aspect hospital a takes corrective management measures, but does not take preventive or educational measures relating to the generation of waste.

In comparative terms, with regard to the generation of total waste the lowest typical value established by the *Sector Guide* is 0.14 – 3.5 kg/bed/day, a value resulting from studies carried out in Asia, the Middle East and Africa, as shown in Figure 2. With regard to the highest typical value established by the *Sector Guide*, this is 8.46 kg/bed/day, registered in studies carried out in the United States.

The results of the research of our three cases give the following values: hospital A generates waste of the order of 5.5 kg/bed/day, hospital B, 6.5 kg/bed/day and hospital C, 64.07 kg/bed/day. The results from the private hospitals, however, are greater than the lowest typical values established by the *Guide*, albeit below the largest value. As for the public hospital the value is more than 60 times greater than the lowest value and seven times greater than the largest value shown as a typical indicator.

## Infectious waste

To obtain the indicator relating to the generation of infectious waste we used the following formula:

$$\frac{\text{Infectious waste (kg): total number of beds}}{\text{Number of days}} = \text{performance indicator}$$

With regard to the infectious waste generated by the organizations we looked at the situation is no different, with performance indicators that are the equivalent of the data obtained for the solid waste. while in hospital a the generation of waste is of the order of 1.0 kg/bed/day, 150% less than that generated by hospital b (2.5 kg/bed/day), the data collected from hospital c (50.5 kg/bed/day) are 50 times greater than for hospital a.

According to qualitative data collected from the respondents, as with total waste, the significant difference between the indicators may be justified by the more rigorous control to which private undertakings are subject and by the costs incurred in complying with the legislation and disposing of their waste adequately. hospital a, as already pointed out previously, has a system of waste management, as well as monthly measured performance indicators. so, it has corrective management measures relating to the production of waste, despite not having preventive and educational measures.

As far as the generation of infectious waste is concerned the lowest typical value established by the *Sector Guide* is 0.01 – 0.2 kg/bed/day, a value resulting from studies in the United States. With regard to the highest typical value established by the *Sector Guide*, the values found in France, Belgium and England varied from 1.5 - 2 kg/bed/day. The three cases we studied presented the following results: hospital A generates infectious waste of the order of 1.0 kg/bed/day, hospital B, 2.5 kg/bed/day and hospital C, 50.32 kg/bed/day. The private hospitals, when compared to the largest typical values, offer satisfactory results, with hospital A standing out, although the public hospital we studied has a number that is 25 times greater than the largest value established by the *Guide*.

From the data presented we can see that the performance of the hospitals we looked at in those indicators we evaluated is poor, as in the case of electrical energy and

water consumption. When it comes to total and infectious waste the performance is nearer the international data.

Even though the data collected in the public hospital may give the impression that the private hospitals have a greater concern with managing their resources in order to guarantee a better economic and environmental performance, the research revealed that, generally speaking, these hospitals do not work with management models that have effective strategies of ecoefficiency. This fact becomes more obvious when we analyze the data referring to energy and water, since these are much more recent variables in the decisions of hospital administrators.

If for waste there has been legislation in force since 1990, which has led hospitals to look for alternatives for appropriately disposing of it, we can infer that there is not the same sensitivity with regard to the issue of water and energy when it comes to the decision-making processes of hospitals in Brazil. It is therefore not surprising that in these Brazilian indicators the results are much higher than those shown in literature and in international cases, indicating that there are countless possibilities for the hospitals we analyzed to improve their environmental indicators by effectively introducing ecoefficiency strategies.

## **CONCLUSIONS**

Ecoefficiency has been occupying an increasingly larger space in the debate on how to reconcile economic performance and environmental commitment. There are various reasons that explain the increased interest in this tool. First of all, the hike in spending on natural resources makes it increasingly evident to business managers of the need for adopting strategies for rationalizing the consumption of these in-puts. Secondly, technological advance provides evidence that the introduction of actions that restrict environmental impacts may generate benefits when it comes to the competitiveness of business activities.

Finally, we must emphasize the fact that ecoefficiency is a tool that is compatible with the logic of business activity. It does not impose limits on growth, neither does it involve restrictions of any type whatsoever; it is limited to its objective of making the undertaking more competitive, while at the same time minimizing environmental impact. This latter characteristic of ecoefficiency has generated some criticism; there are those that allege that the business sector overvalues this tool as being an instrument that is in itself capable of achieving sustainable development.

Although such a criticism cannot be ignored, countless examples have shown the potential of this tool for generating economic and environmental benefits. It is important to emphasize that use of this strategy, which until the 90s was practically restricted to the business sphere, is beginning to occur also in the service sector. This is fundamental, because, in the post-industrial society, the more this sector affirms itself as the main vector for generating wealth and employment, the greater will be its contribution to the situation of worsening environmental impacts.

This is particularly true for the hospital activity, since it has a central role to play in mitigating or expanding the socio-environmental impacts associated with the service sector. the research revealed that until the beginning of the 90s the generation of waste by hospitals, and in particular its final disposal, was not the target of much concern as far as health professionals, or even public authorities, were concerned. a greater awareness arose only because of the change in behavior of users of these services and the appearance of acquired immune deficiency syndrome, which obliged all those involved to re-evaluate their procedures.

As has been mentioned throughout this work, one of the main reasons for this is the fact that the environmental issue is still little dealt with in the process of training and preparing professionals for the health area. Such a statement appears to have been confirmed, at least when we consider the information collected in the hospitals we analyzed. In this situation the incorporation of strategies of ecoefficiency may considerably improve the performance in the indicators we analyzed, which in turn will lead to economic and environmental gains and bring the value of these indicators closer to the values to be found in the international scenario.

As for the organizations we studied, we need to mention that, because they are at different levels of management development, they presented different realities and therefore require different solutions for dealing with ecoefficiency issues. We also identified that between the three hospitals we analyzed the private hospital with hotel characteristics stood out; it shows all the signs of introducing a process of ecoefficiency, although its managers have no knowledge of the subject.

Furthermore, the situation of the public hospital is negative when compared with the other hospitals in all the issues covered in this research, because it has lower performance indicators than those in the other organizations.

Although this study has not exhausted all the possibilities of this complex subject we believe that it can make a contribution, so that hospital institutions can start to consider the possibility of adopting an effective plan for environmental management and the development of an organizational culture directed at prevention, thereby resulting in benefits in the economic, environmental and social fields.

To achieve these results we consider that the development of management models in service activities, and in particular in hospitals, should increasingly value ecoefficiency as one of the pillars of its decision making processes.

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