Analysis of Waste Prevention Policies Applied at the Solid Waste Management in Belo Horizonte, Brazil.

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EXECUTIVE SUMMARY

The main aims of solid waste management are to protect the environment and human health; and, to conserve natural resources. However, increasing consumption, environmental issues and resource depletion threaten its sustainability. Solid waste management policies usually fail to reduce consumption, decrease environmental impacts, conserve raw materials and develop sustainable products. These problems have concentrated attention on solid waste management, which is now of immediate interest worldwide. Therefore, in parallel with projects towards sustainability, integrated management and the reduced disposal of solid waste in landfill have become increasingly important.

The main purpose of this study was to use quantitative instruments to analyse the environmental and economic aspects of Belo Horizonte’s integrated solid waste management system and, consequently, to evaluate how waste prevention has contributed to improve it in an improvement scenario. The findings presented here may help decision makers and agencies involved in solid waste management in developing policies that will utilize waste prevention as an important tool.

Belo Horizonte has been chosen as the area of study due to the fact that its system is known, internationally, as a good example in developing countries, based on the partnership between local government and former scavengers’ association which implements selective collection in the city. In 1993, after implementation of its integrated solid waste management system, Belo Horizonte local government initiative a partnership (currently in practice) with the former scavengers association, where the association is responsible for collecting, sorting, packing and selling the recyclable waste into the so-called Sorting Units.

Based on the methodology of life cycle assessment, the municipal solid waste management of Belo Horizonte was investigated, focused on solid waste materials from households and small shops, only. Environmental loadings were analyzed through life cycle assessment and economic costs were estimated through life cycle cost assessment.
The results showed a considerable decrease in environmental impacts. Another important fact highlighted by this study is that environmental education changed the conception and practice of the most part of Belo Horizonte’s population regarding their behavior, habits and attitudes related to the solid waste management at their houses. However, some citizens are not used to dispose their solid waste in a correct way; indicating that this concern did not usually carry over to their participation in environmental behavior.

Nevertheless, there is the issue of how to change the attitudes and behaviors of households towards environmental action. Environmental education is less well defined and poorly understood by researchers regarding social approaches. Consequently, in order to better understand attitudes and behaviors, more exploratory and experimental work is required. Researchers need to investigate the underlying factors of each behavioral category and to be based on targeted messages at identified sections of the population.

**Keywords:** Integrated Solid Waste Management, Waste Prevention, Life Cycle Assessment and Life Cycle Cost Assessment.

**INTRODUCTION**

In early times, the disposal of human and other wastes did not pose a significant problem because the population was small and the amount of land available for the assimilation of solid waste was large. However, problems with disposal of wastes can be traced from the 14th century, littering of food and other solid wastes in medieval towns led to the breeding of rats and the outbreak of the plague epidemic killed half of the Europeans and caused many subsequent epidemics and high death tolls.

Nowadays, limited space for new landfill sites and social acceptance of solid waste management policies are the major concerns related to solid waste issue. All policies in this area must be environmentally friendly, economically sound and socially acceptable to guarantee their success; since social movements and conflicts between residents and authorities sometimes lead to closure of an existing facility or to fail an applied policy. Therefore, in dealing with solid waste, there are two fundamental requirements: reduce the amount of solid waste generated and then an effective system to manage the waste still produced.

Solid waste management must be sustainable. In other words, it must consider the whole life cycle of waste from the cradle to the grave. An integrated solid waste management – ISWM system combines solid waste streams, collection, treatment, and disposal methods, within a life cycle approach. Using a range of management options in an integrated system gives the flexibility to channel waste via different treatments as economic, environmental and social conditions change.

Nevertheless, for an ISWM system to reduce solid waste effectively, waste prevention is necessary. In other words, waste prevention is an alternative to avoid solid waste generation. Waste prevention, “waste reduction” or “source reduction” refers to any change in the design, manufacture, purchase, or use of materials or products (including packaging) to reduce their amount, toxicity and fugitive emissions before they enter into solid waste stream.

Recently, new studies have been developed in order to understand how waste prevention helps to reduce solid waste generation. Most of them are based on the conventional solid waste management, which do not include all the activities in urban cleansing. Although, all these studies have presented trusty data, no absolute results have been achieved. Economic and environmental aspects must be included simultaneously to improve the decision-making tool.
Hence, this study will address the lack of comprehension about waste prevention inside ISWM system subject, based on the evaluation of environmental and economic impacts. And, to achieve this it will introduce the unique system adopted in Belo Horizonte, presenting how this system works in the local context and also as a potential model for adaptation elsewhere.

**STUDY CASE**

According to the National Survey of Basic Sanitation (IBGE, 2000), about 69% of the solid waste produced in Brazil is disposed in adequate landfills but the remaining part has being still disposed in waste dumps. The 13 biggest cities are responsible for 32% of the waste collected in urban centers and almost 100% of them has adequate final disposal.

In addition, 236 out of the 5507 Brazilian municipalities have a selective collection implemented as an alternative to resolve the environmental, economic and social problems consequents of informal solid waste collection in wastes dumps (CEMPRE, 2004).

The research was delimited to Belo Horizonte considering the previous elements and the fact that its ISWM system is internationally recognized as a good example of the municipal urban cleansing management in developing countries.

**BELO HORIZONTE CITY**

Belo Horizonte City, located in the southeast of Brazil (Fig. 1), has an area of 355 km2 and a population of approximately 2.5 million, of which all live in urban areas of the city. It has two distinct seasons, a wet and hot summer/spring (September – March) and a dry and cold autumn/winter (April – August) (See Figure 4.1.1). The average annual rainfall in the region is about 1301.1 mm, with more rain in the months of January – March. As of 2004, it has a per capita GDP of US$ 4,173 per year.

![Belo Horizonte’s location in Brazil’s Map](CIA, 2005)

Belo Horizonte is the country’s third largest city, with the best quality of life in Latin America according to United Nations and also ranked 45th among the top 100 cities of the world. Recently, Belo
Horizonte won the United Nations Public Service Award. Construction, high technology, and other industries make it one of the most economically dynamic urban areas in Brazil.

In 1990, Belo Horizonte adopted the techniques for participatory democracy, a high level of citizen involvement in allocating the municipal budget, with the objective to re-orientate public priorities through citizens’ opinions.

BELO HORIZONTE ISWM SYSTEM

The Superintendence of Urban Cleansing – SLU was created in 1973 to assist a critical situation at the open dumping site called “Boca do Lixo” (Garbage’s Mouth). At that time, eleven huts were buried at the landfill causing the death of many people who used to make a living by collecting valuable things and recyclable wastes from the solid wastes disposed.

In 1975, a solid waste treatment plant at the sanitary landfill was implemented with 1.45 km². In order to assure future disposal area, another lot in the northeast area of the city was expropriated for a future sanitary landfill.

SLU has technical and administrative autonomy. It has three management sectors: administrative, technical and operational; with a staff including engineers, architects, economists, business managers, lawyers, medical doctors, psychologists, sociologists, technicians, some specialists and operational personnel, summing up to 50.4% of employees of the Agency. All the operational services are decentralized, working together with the 10 local centers coordinated by the local government.

However, SLU is inspected and supported by the municipal council for cleansing, which has among its members: engineers from the Brazilian Association for Sanitary and Environmental Engineering and from the Engineers Society of Minas Gerais, medical doctors from Minas Gerais Medical Association and Municipal Government officers.

From the following years, fast urban growth, particularly from migration from the countryside; had been overwhelming the city’s capacity to provide a decent standard of living and environment for all residents. Some of marginalized residents earn their living through the informal economy, picking through the city’s waste for recyclable materials to sell. In Belo Horizonte, these individuals are known as street scavengers who have collected recyclable material from the waste for over 50 years.

In May 1990, their work led to the creation of the Street Scavenger’s Association – ASMARE; through it the scavengers demanded the right to work in the city, to have a proper place to sort them and a guarantee to collect recyclable materials. In 1993, the Superintendence of Urban Cleansing began a selective collection and treatment system for recyclable wastes in accordance with the “Agenda 21”, to minimize environmental impacts and maximize social and economic benefits (Fig. 2).

The SLU’s selective solid waste collection project works with scavengers as preferential partners. A coordination board was created for ASMARE, with representatives from their different executive partners. The project has created a selective waste collection system within the municipality, improving the city’s cleanliness and environmental quality.
The ISWM system in Belo Horizonte is divided in three main subprograms:

(a) household solid waste collection program: divided in two types, selective and ordinary collection is managed by the SLU through the nine Regional Managements of the SLU and executed by its own and contracted fleet; preceded of detailed planning with diagnostic elaboration. Recyclable wastes are delivered at ASMARE, which sort, bale up and sell them to recycling factories;

(b) technological consistency program: adequacy and innovation of equipment and installations, also attendance improvement of the areas excluded from the city;

(c) composting program: at the composting unit, organic wastes are transformed into compost for school’s vegetable garden, parks and squares of the city.

Belo Horizonte generates approximately 1,500 tons of household waste per day, which 25% out of that could potentially be recycled. Nowadays, the recycling efficiency reached 17.5% of the recyclable waste collect through the formal and informal selective collection (Tab. 1). According to SNIS (2004), the local government expenses in solid waste management correspondent with 5% of municipal budget. The ISWM system has 50.4% of economic self-sufficiency.

The collection of recyclable materials has increased from 15 to 900 tones per month, reducing the amount of waste delivered to landfill. The financial resources, which the city would normally spend on landfill and curbside collection, have been reduced annually. The ISWM implemented in Belo Horizonte encouraged population participation at discussions and implementation of projects and it has been decreasing unemployment by opening new positions and rationalizing all activities among solid waste management.
Table 1 – Belo Horizonte’s ISWM System Data. (SLU, 2005)

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<tbody>
<tr>
<td>Population</td>
<td>2.5 million inhabitants</td>
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<tr>
<td>Total solid waste collected</td>
<td>535,029 t/year</td>
</tr>
<tr>
<td>Local population attended</td>
<td>91%</td>
</tr>
<tr>
<td>Household solid waste production</td>
<td>0.7 Kg/inhabit. day</td>
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<tr>
<td>System’s cost</td>
<td>US$ 14,732,000/year</td>
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<tr>
<td>System’s self-sufficiency</td>
<td>50.4 %</td>
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<tr>
<td>Recycling efficiency</td>
<td>17.5 %</td>
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WASTE PREVENTION

Realizing the limits of downstream, end-of-pipe approaches, during the early 1990’s many environment administrations fully embraced “source reduction” and “pollution prevention” as general, overarching goals. This meant, among other things, that as little solid waste as possible was to be finally disposed of, and this objective was to be achieved with priorities focus on preventive efforts, generally followed by recycling.

In most of previous researches, both waste prevention – WP and waste minimization usually have the same meaning. However, according to terminological definition at OECD report (OECD, 2000), waste minimization is a broader term than WP in that it includes recycling and incineration with energy recovery. As discrete activities, both recycling and incineration are distinct from WP.

Therefore, WP is fundamentally different from the waste minimization. Recycling and disposal options all come into play after goods have been used. WP, in contrast, takes place before materials have been identified as solid waste. To implement WP, managers need to promote practices that reduce solid waste before it is generated.

The consensus understanding of WP achieved by OECD in 1998 can be broken into three types of action:

(a) Strict Avoidance, which involves the complete prevention of solid waste generation by reducing material or energy intensity in production, consumption and distribution;

(b) Reduction at Source, which involves minimizing material or energy consumption;

(c) Product Re-use, involving the multiple use of a product in its original form or purpose for an alternative with or without reconditioning.

It is important to highlight that the potential contribution of WP to overall waste minimization has not been realized. While WP will never make recycling obsolete, the application of both will generally have a greater influence on overall solid waste reduction than the singular application of one or the other. For example, there are numerous applications of source reduced packaging that is made with recycled materials that can also be recycled.
At the municipal level, WP avoids unnecessary solid waste collection, processing, storage and final disposal. It also offers significant potential for diverting materials from landfill, as well as contributes to greenhouse gas mitigation. Secondary materials market development can also be avoided and, consequently, WP saves money and conserves natural resources. However, experience at the municipal level is still limited as well as the difficult to access its contribution to solid waste diversion relative to recycling.

**METHODOLOGY**

A large number of methods, approaches and modeling tools that can be used for supporting solid waste management decisions at different levels in society have been developed in the past years. Life-cycle thinking and life cycle assessment – LCA have become important methods for solid waste management and policy, and have been successfully applied to ISWM systems in a number of case studies.

Based on the methodology of life cycle assessment, as introduced by White et.al (2002), the ISWM system of Belo Horizonte was investigated, focused on solid waste materials from households and small shops, only. Environmental loadings were analyzed through life cycle assessment and economic costs were estimated through life cycle cost assessment – LCCA. The activities of ISWM inside each process, collection, transport, treatment, recycling, landfilling were determine as well as the corresponding costs and savings.

Quantitative analysis was performed through LCA and LCCA to determine environmental and economic aspects, respectively. In both methods, two different scenarios of the system were applied, namely the current (scenario 1) and the improved (scenario 2) situations, for comparison.

Scenario 1 consisted of ordinary solid waste collection and selective collection with source separation. After selective collection, recyclable waste materials were delivered to sorting units separated into four categories (paper, glass, plastic, metal) and then sold to recycling factories. Solid waste that was collected through ordinary collection was delivered directly to a landfill site.

Based on the status quo (Scenario 1), the following scenario 2 for improving ISWM practice in Belo Horizonte was analyzed: (a) full coverage of ordinary, selective and organic waste collection; (b) composting of collected organic waste; (c) increasing of existing recycling rates; (d) implementation of waste prevention programs; and, (e) upgrading of existing disposal practice to sanitary landfill with energy recovery.

At this study, five waste prevention programs were adopted at the scenario 2. Home composting and clothing reuse are residential waste prevention programs, while office paper prevention (duplex copping initiative and reducing waste) and paper towel reduction are commercial programs.

**CONCLUSION**

The purpose of this study was to investigate on a general and approximate level, how waste prevention influences solid waste generation and its integrated management in Belo Horizonte. First, waste prevention programs were determined and applied. Next, a future scenario with the improvement of current collection, recycling, landfilling, treatment and source separation was analyzed in view of their impacts on environment and on network costs. This study’s findings provided a quantitative
understanding of waste prevention inside solid waste management and revealed consistent approaches to improve its environmental and economic performances.

Life cycle thinking are becoming the principal decision support tool of solid waste management systems and, in this study, it illustrated the benefits of different waste management methods and waste prevention programs applied in the improved scenario, mainly with the reduction of solid waste disposed at the landfill and with the production of new raw materials that could replace production from virgin materials.

Here, waste prevention has been showed to have considerable environmental impacts, particularly decreasing greenhouse gas emissions and, water and soil contamination. However, no single solid waste management process or technology produced the overall lowest environmental impacts. Tradeoffs among management options were needed in both scenarios, indicating that society will have to make choices regarding the type of environmental impact that is least desirable in a certain place.

Applying waste prevention as a part of integrated solid waste management system in Belo Horizonte has led to a reduction in the quantity of solid waste at the landfill and has also decreased unnecessary collection, processing, storage and final disposal.

Another important fact identified by this study concerned the relationship between industry and the former scavengers’ association in Belo Horizonte. Nowadays, the association’s employees only earn enough to maintain their own survival but not to improve their living conditions; usually middlemen and industry receives most profit. A well-organized market for the recyclable waste trade is needed to structure this relationship in a fair manner for all parties. Increasing prices do not mean decreases in industry savings; in fact it might increase the availability of recyclable waste in the market.

The main objectives of solid waste management are to protect human health and the environment, and to conserve resources. In Belo Horizonte, this study presented that direct impacts of solid wastes on human and the environment may be eliminated by introducing extended recycling strategies and waste prevention policies such as reuse.

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