



Assessment of the viability and sustainability of an integrated waste management system for the city of Campinas (Brazil), by means of ecological cost accounting



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ARTICLE INFO

Article history:

Received 25 January 2013

Received in revised form

28 August 2013

Accepted 29 August 2013

Available online 15 September 2013

Keywords:

Wastewater treatment

Ecological cost accounting

Construction building waste

Sewage

Membrane separation process

ABSTRACT

The population growth of cities increases the generation of construction building waste (CBW) and wastewater and, respectively, their environmental impacts. The present study shows a new technology to manage of the sewage and construction wastes from Campinas city, Brazil, based on the ecological cost accounting theory. In this way, the treatment of the crude sewage from Anhumas Wastewater Treatment Plant was made by decantation using the construction building waste. The organic amendment was obtained from the decanted sludge, which has been used in the recovery of a poor soil. From the supernatant liquid was obtained the reusing water, which has been tested in irrigation process. The efficiencies of the organic amendment and reusing water have been assessed by the quantity of the germinated bean seeds on the poor soil. Results show that the best condition to organic amendment production was the one in which a total soil layer of 2 cm and 100 mL/L of CBW were used, which yielded a gain in soil fertility of 11.11%. It was verified that 85% of bean seeds have been germinated on soil, when it irrigated these seeds with the reusing water, being 6% larger than control water. All parameters of lower water quality were reduced above of 90%, keeping the water in according to Brazilian standards. The cost evaluation of reusing water and organic amendment production shows a saving of US\$ 81.1 million, indicating the social, ecological and economical viabilities of the new technology developed and demonstrated in this work. In that sense, this work provided a possible environmental solver based on the ecological cost accounting theory for the city of Campinas, Brazil.

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1. Introduction

In accordance to Leonidou and Leonidou (2011), the interaction of companies with natural environment has been an issue of interest for researchers from various fields for a long time; it was not until the late 1960s that it was included in the research agendas of marketing and management scholars. Stricter environment regulations, stakeholder pollution concerns, and growing public pressure were among the forces that contributed to the emergence of a new line of academic inquiry, focusing on the effects that producing practices exercise on the environment, and how this in turn influences them.

According to Ronnenberg et al. (2011), corporate environmentalism is an essential component of corporate social responsibility

and it can take several forms: waste minimization and prevention, demand-side management, design for the environment, product stewardship, and full-cost accounting. The collaboration between different sectors companies is essential for better practices and efficiencies (Mc Donald and Young, 2012).

Boons et al. (2013) describe that any significant alteration of the dominant economic logic involves, or may be even necessarily starts from, the application of new business models by social actors seeking to promote more sustainable ideas, which may also lead to different types of practices and sustainable innovations. If our wellbeing is served by leaving the path of economic growth, then each of the dimensions of business models as identified above needs to be altered: value propositions need to reflect the true needs of citizens, and the distribution of revenues needs to be defined in categories other than purely economic ones. This will also require that the way through which firms connect to each other and wider society requires a fundamental change.

Unfortunately, in accordance with Giraçol et al. (2011), these practices are not common in Brazilian sanitation companies, which

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just implement the minimum conditions for their plants, in order to avoid the pressures of environmental regulation. However, in Brazil there are few aware companies that have a corporate environmental thinking.

In this study was conducted in one Brazil's large urban concentration with a strong water demand, causing critical conditions of sustainability due to their extremely high loads of domestic and industrial pollution, as well as the occurrence of urban flooding that contaminates fresh water sources. On the other hand, recycling of construction waste in Brazil is still incipient and few adequate techniques are employed.

The aim of the present study was to reuse of construction building waste (CBW) and sewage from Campinas city, in order to produce humus and reusing water. The CBW was used in decantation of sludge from sewage and to obtain the humus. The sewage water was filtered in a membrane of microfiltration and used in irrigation. Bean seeds were used in germination on a degraded soil mixed with CBW humus and irrigated with reusing water. In that sense, this work provided a possible environmental solution for CBW and sewage based on the theory of ecological cost accounting for the city of Campinas, Brazil.

1.1. Ecological cost accounting: paradigms and concepts

Given the current need of organizations to obtain and provide information to its stakeholders, managers have struggled to formulate and implement strategies and information systems while also addressing the environmental focus. In this sense, management systems and accounting information plays an important role for the hierarchical control of information flow within an organizational context (Cavalett and Ortega, 2010; Dillard et al., 2005).

The need for information on how environmental activities can affect the financial performance of the organization, has contributed to the further development of accounting tools for use in corporate sustainability practices (Schaltegger and Burritt, 2010).

In that sense, economic performance results from improvements in environmental performance, and therefore the managers should be aware of the importance of integrating environmental issues in management control systems, focusing in the eco-style control over financial control and strategic management methods (Henri and Journeault, 2010).

According to Burritt and Saka (2006), Giraçol et al. (2011) and Labodová (2004), the discussion regarding sustainable companies does not only relate to large companies, which are pressured by their shareholders to demonstrate that their businesses are not running the risk of being devalued due to improper social and environmental attitudes. Small businesses are also now seen by society as offering possible risks to the environment in which they operate.

Nowadays, different environmental solutions to reduce production processes impacts have been investigated in wide industrial areas, for example in the case of cleaner cars in the automotive industry (Zapata and Nieuwenhuis, 2010), companies are developing sustainable technologies to achieve feasibility of the ethanol produced from sugarcane of a large-scale production (Delivand et al., 2012; Ometto and Roma, 2010; Pereira and Ortega, 2010); the reuse of beef tallow in biodiesel production (Pereira et al., 2012) or in food industry after treatment by ultrasound (Sivakumar et al., 2012) to be used as collagen, jam and jelly products (Almeida et al., 2012a,b,c) to avoid the problem of freezer industries instead of been dispensed at unsuitable site, allowing cost reduction in packing industry by its waste reuse (da Cruz et al., 2012).

The companies, at implementing the new and efficient system of effluent treatment, show a proactive and compromised posture facing the environmental problems by measuring and eliminating

its negative externalities, not causing impacts coming from its production process becoming sustainable, reducing water consumption and discharge of polluting effluent (Fresner and Engelhardt, 2004).

The Ecological Costs Accounting (ECA) approach seeks to establish an analysis that allows integrating the internal costs with the external costs, including the environmental and social impacts of the activities, operations, products and/or services from the organization (Criado-Jimenez et al., 2008; Fernandez-Chulian and Larrinaga-Gonzalez, 2005; Burritt and Saka, 2006; Fresner and Engelhardt, 2004).

In that sense, the ECA has a different approach considering the Traditional Costs Accounting (TCA), which presents limitations regarding environmental aspects, exempting the intangible benefits and social impacts of the environmental actions. In addition, the TCA is restricted to the internal costs and environmental investments of the organization, mainly related to the prevention, mitigation and remediation of environmental impacts (Criado-Jimenez et al., 2008; Ronnenberg et al., 2011).

According to ECA approach, one of the major constraints of the TCA lies in not considering the concept of "externality", that can be understood as the social and/or environmental impact coming from the organization's activities, which can affect in a favorable or unfavorable way other activities during the organization's productive process. The externalities may be considered in a positive or negative way, being these situations one of the crucial points toward the success in the ECA implementation (Fernandez-Chulian and Larrinaga-Gonzalez, 2005; Criado-Jimenez et al., 2008; Labodová, 2004).

However, the utilization and dissemination of the ECA approach throughout the industrial organizations is still on preliminary stages, despite the discussion of this subject has begun about two decades ago (Huizing and Carel Dekker, 1992; Bennett and James, 1997).

The literatures list ECA such initiatives have proven to offer adequate quality and efficiency and help maintain a company's good image in the eyes of society.

Upon achieving self-sufficiency, such companies can be rewarded for their practices with ISO 9001, ISO 14001 and OSHAS 18001 certifications in a separated or integrated way. Therefore are accounted costs for changes in the processes so that they become sustainable and these costs are discounted with the reduction in spending on the purchase of raw material, water, energy and the reduction of costs derived from fines for discharges outside environmental standards. In addition to the environmental and economic benefits, companies gain generates social benefits, not impacting on the health of the workers and the surrounding population, improving the image, which also generates benefits as better acceptance of the products, which are viewed as environmentally friendly (Burritt and Saka, 2006; Fresner and Engelhardt, 2004; Giraçol et al., 2011; Rosa et al., 2013).

The ECA stages suggested for an eco-friendly solution for discarding wastes are presented below (Burritt and Saka, 2006; Fresner and Engelhardt, 2004; Giraçol et al., 2011; Labodová, 2004):

Stage 1 – the current unsustainable position of the company; most of the environmental impacts result from process feedstock and waste production.

Stage 2 – a more sustainable position in which a company is taking steps to reduce its impact on the environment.

Stage 3 – a position in which operations should have no impact on the environment.

Stage 4 – a position in which a company is self-sustainable, whereby the environmental accounting balance of its operations results in credits for the company.

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