Environmental advantages measured by Wuppertal method on disposal waste from the industry

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Abstract
In reason of growing concerns from the society about sustainability, the aim of this paper is to present alternatives for solid waste disposal generated by industry and show some environmental advantages according calculation method Wuppertal. This single case study from industry shows alternatives to deal with underutilized resources.

Key words: Environmental Management, Solid Waste Management, Sustainability.

Introdution

Increasingly costs with environmental issues have risen to the productive sector in different countries and this way, will be necessary considerable changes in standard production, trade and consumption. These changes meet standards and laws (national and international) associated with a new consumer profile. It is essential that companies seek a harmonious relationship with environment through the adoption of practices of control over: production processes and the use of renewable and non-renewable natural resources (CARTILHA FIESP 2003).

In 2010, Brazil finalized its National Solid Waste Policy, a cross-cutting law that aims to decrease the total volume of waste produced nationally and increase the sustainability of solid waste management from the local level to the national level. The law outlines a variety of options for producers to work together within their sectors, with reverse logistics service providers, and with municipal and state governments to manage waste flows and to recapture, recycle, and ultimately dispose of these materials (Ministry of Environment BR 2012.).

If all industrial process is characterized by use of inputs (raw materials, water, energy) that after a transformation, give rise to products, by-products and waste, the aim of this study is to present alternatives for the disposal of solid waste generated by industry and show the environmental benefits according calculation method Wuppertal.

Literature Review

In this topic will be present a brief bibliographic review about: Environmental Management System, Solid Waste, Integrated Solid Waste Management and Sustainability.

Environmental Management System (EMS)

An environmental management system could be described as a methodology by which organizations act on their operations in a structured manner to ensure the protection to environment. This metodology defines the impacts cause by activities and then propose actions to reduce them. An aim EMS is controlling and continuously reduce these impacts (Rowland-Jones & Cresser, 2005).

EMS implementation makes production process to be continuously reevaluated, reflecting the seek for procedures, mechanisms and behavioral standards less harmful to environment (Campos, 2008).

Solid Waste

According to the Brazilian Association of Technical Standards (ABNT), "Solid Waste could be waste in solid and semi-solid states, which result from industrial activities, domestic, commercial, agricultural, hospital services and sweeping. Are included in this definition the sludge from water treatment systems, those generated in equipment and plant for pollution control, as well as certain liquid whose characteristics make it impossible to launch in the public sewage system (ABNT, 1987c).

There are several ways to proper destination from solid waste , such as the open pit deposit, deposit in landfill. The deposit open pit dumps are knoshould be prohibited because of the risk that they bring to human health and the environment. Deposits in landfills according to the American Society of Civil Engineers, is the method of refuse disposal on land without creating damage or threat to public health and safety, the use of engineering principles that confine the refuse to the least volume possible, covering it with a layer of earth at the conclusion of each operating day, or more often as needed (Machado,2006).

Solid Waste Classification

For a residue has proper destination, it needs to be classified in accordance with Brazilian standards. The NBR 10004-Rating waste (ABNT, 1987c) classifies waste into three classes:
Class 1 – Hazardous Wastes: Class 1 - Hazardous Waste: those who present a risk to public health and the environment, requiring special handling and disposal due to its characteristics of ignitability, corrosivity, reactivity, toxicity and pathogenicity.
Class 2 – Non-Inert Wastes: Wastes that are not present dangerousness, but are not inert; may have properties such as flammability, biodegradability and water solubility. Are basically the waste with the characteristics from household waste.
Class 3 – Inert Wastes: are those which, when tested for solubilization (ABNT NBR-10.007), have none of their constituents solubilized out of standards for drinking water concentrations. This means that the water will remain safe when in contact with the residue. Many these wastes are recyclable. These wastes do not degrade or decompose when not arranged in the ground (degrade very slowly). Are in this classification, for example, demolition debris, stones and sand removed from excavations.

Integrated Solid Waste Management

The Integrated Solid Waste Management can be understood as the way to "design, implement and administer the solid waste systems management, considering a broad participation of society sectors and with sustainable development perspective."

This system should consider the broad participation and inter-cooperation of all stakeholders in society, the first, second and third parties sectors, as well exemplified by central government, local government, formal sector, private sector, NGOs, informal sector; scavengers; community and all generators and responsible for the waste (Mesquita, 2007).

Sustainability

Although several definitions about sustainability, we can establish that the term implied in quantitative and qualitative´s maintenance of stock of environmental resources, utilizing this resources without damaging their sources or limit the ability of future supply, so that both current needs as those of the future can also be met. (Afonso, 2006).

Research methods

The research method is a single case study from industry. Data have been collected from the internal indicators of environmental management system in an electromechanical industry researched.

The environmental advantages have been analyzed according a method developed by Wuppertal Institute called MIPS: Material Input Per Service unit which serves as an indicator of precautionary environmental protection. MIPS can be applied on several levels e.g. for products and services, enterprises, households, regions and national economies.

In the MIPS concept, the material inputs are divided into five different input categories. These five categories are:

- abiotic raw materials
- biotic raw materials
- water
- air
- earth movements in agriculture and silviculture (mechanical earth movement or erosion).

Table 1 - Material intensity of food

	Material intensity [kg/kg]			
Food	**Abiotic Material**	**Biotic Material**	**Water**	**Air**
Bread	1,10	1,40	21,00	0,15
Butter	3,42	56,87	105,75	0,79
Milk	0,15	2,46	4,42	0,04
Bean	0,67	1,07	9,09	0,13
Rice	0,03	0,31	0,27	0,01
Cheese	11,00	29,00	1,10	3,00
Beef	6,53	27,05	269,95	1,68
Pork	2,57	6,89	62,33	1,01
Chiken	8,99	6,67	344,03	2,30
Fish	1,30	5,00	19,28	3,08
Eggs	1,15	1,98	28,56	0,25
Vegetable Oil	6,47	6,09	104,53	1,38
Potatoes	0,10	1,06	0,39	0,01
Tomato	8,00	1,00	793,00	4,00
Vegetables and Fruits	1,00	1,00	7,00	0,01

The last category “earth movements in agriculture and silviculture” is documented separately and it was not considered in this research.

According Wuppertal Institute, below are table 1 (Material Intensity of food) and table 2 (material intensity of wood).

According methodology from Wuppertal institute, environmental advantages should be calculated as: MI = Amount [kg] x material intensity [kg] (table 1 and 2).

It is important to mention that studies about material intensity have been developed by Wuppertal Institute are based on the energy mix in Germany and Europe, but could be implemented this methodological tool in Brazil.

Table 2 - Material intensity of wood

	Material intensity [kg/kg]			
Name	**Abiotic Material**	**Biotic Material**	**Water**	**Air**
Wood	0,63	4,37	9,24	0,17

Case study

In this section will be present the data and results from actions taken after an internal workshop realized at the company studied aiming to improve the performance about solid waste disposal.

The company

The company studied is a family company with headquarters located in Germany. The Company's main activities include the development and manufacture of technologically advanced electronic and electromechanical (mechatronic) products to automotive industry. The Group has 39 locations world-wide, with a work-force of about 14.403 people.

In Brazil this company has an industrial unit installed in São Bernardo do Campo since 1978 with approximately 1500 employees. The main quality certificates from this company are: “ISO 9000”, “VDA 6,1”, “QS 9000”, ISO TS16949 and “ISO 14000”.

The main products provided by company are: Steering column modules, roof modules, body control units, door control units, seat control units, switch panels and switches, among others. Products from Brazil have been provided to: Europe, North America, Latin America and Asia.

Waste Management at Company

Industrial waste" is considered waste resulting from production and administrative processes. Industrial waste is considered a concern, not only for "administrators", but also by all direct or indirect employees.

The waste generated by industrial activities in the company researched is technically known as waste, and the company has a legal obligation to take care about management, transportation, treatment and these wastes disposal.

Waste food disposal

With approximately 1500 employees, the company has an outsourced restaurant for food, which provides breakfast, lunch, dinner and supper according with each three shifts. The large

number of employees, who eat in the restaurant, generates high amount of organic waste and therefore large amount of waste to landfill beyond the waste of food.

An outsourced company made this organic residue management (Rated as Class II A - not inert). After making selective collection in the company researched, this waste disposal was a landfill used by Outsourced Company duly accredited by Cetesb.

After conducting an internal workshop at the company researched with areas involved, it was decided to establish a partnership with a specialist company that recycles organic waste to animal feed.

The Outsourced Company responsible for restaurant compiles every day, and all meals mentioned, leftover food, which is placed in plastic and stored bags in a cold chamber at temperature of 10 º C, appropriately labeled "Organic Waste". The specialist company collects periodically this waste of food, leading them to a pre-selection in São Bernardo do Campo - SP.

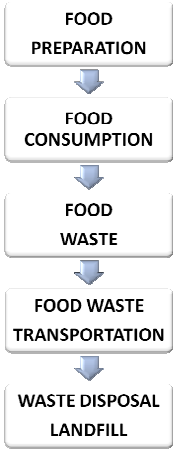

Fig 1: Food waste flow

After going through a process of high heat adding some ingredients to transform this waste into feed for livestock, the prepared food is taken to pigs and the leftovers of this feed are reused as fertilizer.

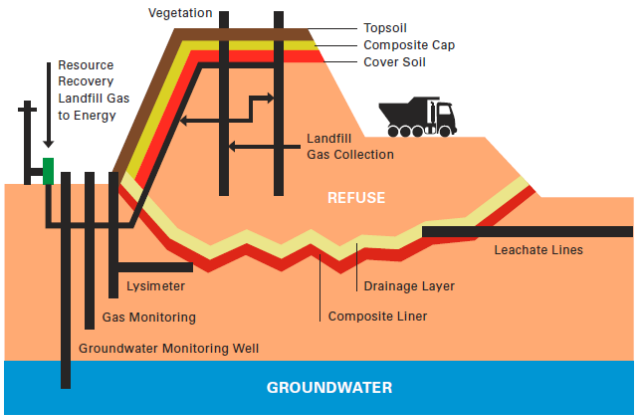

Fig. 2: Landfill scheme

Economics advantages from waste food disposal

To improve the disposal of solid waste generated by outsourced restaurant, it has been invested R $ 5,600.00 by company researched in purchasing of a cooled camera and the payback on this investment and economic advantages have been analyzed in the frame "before-and-after" as follows:

Frame 1 – Advantages (Waste Food Disposal)

Before	After
Legal responsabilities for waste disposal.	Organic waste donation.
Monitoring, compliance, tax and insurance.	
Costs from waste dumpsters rental.	There was elimination of 22 dumpsters / month Saving: R$ 740,00/month.
Environmental impact.	Pollution prevention: reducing 270 kg waste organic /month.
Costs from waste transportation and landfill.	Lower costs from waste transportation and landfill Saving: R$ 640,00/month.

Environmental advantages from waste food disposal

According information from the company responsible by restaurant, 270Kg/month food waste have been intended for swine. The quantities distribution are shown in Table 3. The intensity factor for material shows the environmental benefits according new strategy to food waste disposal generated by restaurant: abiotic raw material - 830,31 kg ; biotic material - 1538,19 kg; water - 34.578,22 kg; air - 275,80 kg.

Table 3 - MI = waste food [kg] x [kg] material intensity (table 1)

	Material intensity [kg/kg]				
Food	Abiotic Material	Biotic Material	Water	Air	Total / Food
Bread	36,30	46,20	693,00	4,95	**780,45**
Butter	6,84	113,74	211,50	1,58	**333,66**
Milk	1,80	29,52	53,04	0,48	**84,84**
Bean	12,06	19,26	163,62	2,34	**197,28**
Rice	0,81	8,37	7,29	0,27	**16,74**
Cheese	44,00	116,00	4,40	12,00	**176,40**
Beef	163,25	676,25	6748,75	42,00	**7630,25**
Pork	33,41	89,57	810,29	13,13	**946,40**
Chicken	359,60	266,68	13761,20	92,00	**14479,48**
Fish	19,50	75,00	289,20	46,20	**429,90**
Eggs	6,90	11,88	171,36	1,50	**191,64**
Vegetable Oil	12,94	12,18	209,06	2,76	**236,94**
Potatoes	0,90	9,54	3,51	0,09	**14,04**
Tomato	112,00	14,00	11102,00	56,00	**11284,00**
Vegetables and Fruits	50,00	50,00	350,00	0,50	**450,50**
Total	**860,31**	**1538,19**	**34578,22**	**275,80**	

The gains from new strategy adopted by restaurant in the company are shown in the previous table: 831 kilos of materials abiotic. This is considered as preventing the global warming, ozone layer depletion air (275,8 kilos) and water pollution (34578,22 kilos).

Waste wood disposal

Pallets are made from trees and normally it is necessary one tree to make two pallets. Currently these trees are from reforestation area. After a “Market Research” performed by studied company, it was chosen a timber industry in order to have a partnership aiming a recovery and reuse of pallets.

Economics advantages from waste wood disposal

There were not investments by the researched company to change the wood waste disposal from pallets, since they are reused by "logging company" who was also responsible for removal.

The economic benefits from reuse of pallets by respective "logging company" are shown in the table below:

Frame 2 – Advantages (Waste Food Disposal)

Before	After
Costs from waste transportation and landfill	Lower costs from waste transportation (160.000 kilos) and landfill. Saving: R$ 10.100,00/semester
Costs from waste dumpsters rental	There was a reduction of 4 dumpsters /month. Saving: R$ 10.000,00/semester
Legal responsabilities for waste disposal	Wood waste for sale with profit R$ 280,00/semester
Monitoring, compliance, tax and insurance.	

Environmental advantages from waste wood disposal

According information from the researched company, 160.000 Kilos/semester of waste wood have been discarded. The gains from partnership between studied company and chosen timber industry are shown below in the table 4: 100.800 kilos of materials abiotic. This was considered as preventing the global warming, ozone layer depletion, air (27.200 kilos) and water pollution (1478400 kilos).

Table 4 - MI = waste wood [kg] x [kg] material intensity (table 2)

	Material intensity [kg/kg]				
Name	**Abiotic Material**	**Biotic Material**	**Water**	**Air**	**Total**
Wood	100800	699200	1478400	27200	**2305600**

Conclusion

The aim of this study was to present alternatives for the disposal of solid waste generated by industry and to
show the environmental benefits according calculation method Wuppertal (2011).

After internal workshop realized at the company studied, two opportunities have been presented to improve the performance about solid waste disposal: waste wood and waste food.

As from application of Wuppertal method, it was possible to measure the environmental advantages about the two opportunities presented. This research could have been expanded to electromechanical items manufactured by the company, but for reasons of client confidentiality, the data could not be displayed. Besides environmental advantages also added

economic advantages obtained. These economic advantages have been shown in the tables "before-and-after". There were opportunities to sustainability solutions

About future actions by continuous improvement in the waste food disposal , it was suggested educate employees to reduce waste food through research. As for the continuous improvement about waste wood (pallets), it was suggested replacing these by returnable plastic pallets.

Finally, it was suggested the Wuppertal methodology to be applied to calculate the environmental advantages in other situations where solutions are proposed for sustainable environmental management.

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