

Impetus for Recycling Activities across the Globe: An Overview

***Adu, D.A.**

Department of Science and Technology, Leadwell Academy, KM 4, Idiroko
road, Ota, Ogun State

e-mail: dafe20062007@yahoo.com

and

Aremu, A.S.

Department of Civil Engineering, University of Ilorin, Ilorin, Nigeria

e-mail: aremu_adeniyi@yahoo.com

***Corresponding author**

Abstract

Solid waste is a prominent feature since the existence of life and the need to manage solid waste is felt all over the world. This paper presents an overview of solid waste generation rates and characteristics, as a spur to recycling activities across the globe. Disparity in generation rates and composition of solid wastes was observed across the globe. According to income groups, countries with higher income tend to generate more solid wastes per capita which have higher proportions of recyclables and inorganics, than developing countries. A typical solid waste stream from low-income, middle-income and high-income countries is composed of about 17%, 43% and 62% recyclable materials respectively. However low-income and middle-income countries still have under developed recycling plans. Therefore it suggested that governments in developing countries should build capacity among micro and small scale enterprises in order to derive maximum social, economic and environmental benefits from recycling.

Key words: Solid waste, composition, recycling, income groups

1 Introduction

Solid wastes are all the wastes arising from human and animal activities that are normally solid and are useless or unwanted (Tchobanoglous, 1993). As such solid waste is a byproduct from various aspects of a society. The term "waste" is subjective because the possessor determines at a particular moment what is considered a waste. However, one common point of concurrence for all definitions of solid waste in literature is the use of the word "solid" which

typifies a non-liquid, non- gaseous material and “waste” which is a discarded material (Aremu, 2010).

Solid waste is multidirectional in context when viewed as a nuisance or resource with multiplier effects on various aspects of human endeavor. Solid waste management entails an understanding of waste generation, storage, collection, transport, processing, and disposal (Mihelcic and Zimmerman, 2010). Planning, design and implementation of solid waste management schemes vary from country to country and from city to city. Over the years several solid waste management methods have been fused together and coordinated to form an Integrated Solid Waste Management (ISWM) plan. The ISWM is a broad concept taking into consideration economic, environmental, social and institutional dimensions (Beukering et al., 1999).

The integration aspect lies in the trade-off between these four dimensions; economic, environmental, social, and institutional components. Actual integration takes place at the level of selection and combination of management options, participation of various stakeholders, interaction between the waste system and other relevant systems, and consideration of driving forces which influence the output and characteristics of wastes. The United Nations Environment Program (UNEP) equally endorsed a common approach to waste management known as the Integrated Waste Management (IWM) hierarchy. This hierarchy lists the options for the management of solid wastes according to decreasing priorities as waste reduction, reuse, recycling, composting, incineration, and landfilling. Accordingly, the IWM hierarchy seeks to list options to trim down the output of wastes and favour resource recovery from wastes.

2 Output of solid wastes according to income levels

The output and characteristics of solid wastes can be regarded as a quantitative indicator of the use of resources, and the aftermath of production and consumption processes. Economic prosperity and population growth are major inputs that account for the output of wastes (Zia and Devadas, 2008; Ağdağ, 2009; Mihelcic and Zimmerman, 2010). The World Bank classified the economy of countries according Gross National Income per capita (July 2011 classification) as low income, \$1,005 or less; lower middle income, \$1,006 - \$3,975; upper middle income, \$3,976 - \$12,275; and high income, \$12,276 or more (<http://data.worldbank.org>). From this classification, 35

countries are regarded as low-income countries, 56 are lower-middle income countries, 54 are upper middle income countries, and 70 are high-income

countries. Countries with low-and middle-income economies are referred to as developing countries while countries with high income economies are termed industrialized countries.

This criterion (economic status) forms a key indicator of a country's development and may reflect similar solid waste generation rate, composition and management technique of a group of countries in the same class. Some solid waste generation rates for low-income, middle -income and industrialized countries are shown in Table 1. The per capita solid waste generation rates is highest for industrialized countries, followed by middle income countries while low income countries have low per capita generation rates.

Table 1: Solid wastes generation rate based on income groups

Type of waste and origin	Low income country	Middle income country	High income country
Mixed urban waste	0.50	0.55	0.75
Large city(kg/capita/day)	0.75	1.10	2.2
Mixed urban waste	0.35	0.45	0.65
Medium city (kg/capita/day)	0.65	0.75	1.50
Residential waste only	0.25	0.35	0.55
(kg/capita/day)	0.45	0.65	1.00

Source: Cointreau (2006)

Specifically the rate of generation of residential waste in industrialized countries is about one and half times more than middle income countries and double the amount generated by low income countries.

A summary of the characteristics of solid waste from different income levels is presented in Table 2. It was observed that a typical solid waste from a low and middle income country (developing country) contains more organic materials and less paper, hence the waste is normally high in moisture content and low in calorific heating value. On the other hand, solid wastes from industrialized countries contain more paper, metals and plastics, and less organic materials. The resulting solid waste therefore has a high calorific value and low density.

Table 2: Solid wastes composition and characteristics according to income groups

Composition	Low-income country		Middle income country		High income country	
	*	**	*	**	*	**
Paper	2%	1-10%	14%	15-40%	31%	15-40%
Metal	2%	1-5%	2%	1-5%	8%	3-13%
Plastics	2%	1-5%	11%	2-6%	8%	2-10%
Glass	4%	1-10%	2%	1-10%	10%	4-10%
Textile, rubber, leather, wood	7%	N/A	14%	N/A	5%	N/A
Miscellaneous	N/A	1-5%	N/A	1-5%	N/A	2-10%
Vegetable	60%	40-85%	47%	20-65%	25%	20-50%
Others	22%	N/A	10%	N/A	13%	N/A
Fines	N/A	15-50%	N/A	15-40%	N/A	5-20%
**Density in trucks (kg/m ³)	250-500		170-330		120-200	
**Moisture (%)	40-80		40-60		20-35	
**Calorific heating value (kcal/kg)	800 - 1100		1000 - 1500		1500 - 2700	

*Source: www.inece.org **Source: Cointreau (2006)

3. Implications of solid waste composition on recycling

The previous sections show how waste generation rate and composition vary according to income levels. This information can be used to access materials/energy recovery options. Recycling, which is the extraction and recovery of valuable materials from scraps or other discarded materials, is employed to supplement the production of new materials. Basically, waste materials are reused, or remanufactured into new products. Recyclable solid wastes include textile, construction wastes, paper, plastic, ferrous and nonferrous metals, and glass. The plastic recycling industries shred plastics into pellets to manufacture other plastics and allied products. Some recycling factories process waste paper and cardboard to tissue paper, newsprint or bulk packaging materials. Waste glass is processed by glass or terrazzo companies, non ferrous metals are processed by aluminum smelters and tin is recovered from aerosol cans (Palczyski, 2002). Some products, such as paper, plastics,

glass, can be recycled or reused over and over again, and many new products are being made from recovered materials (<http://www.greenrenewing.com>).

Recycling activities in industrialized countries have become popular and some nations promote recycling through financial incentives and provision of market for these recyclables. In Europe, the European Union (EU) has launched a strong regulation on waste management which anchors around

recycling and recovery of waste. EU directives now require member States to introduce legislation on waste collection, reuse, recycling and disposal of their waste streams. A study of waste management activity of countries within the EU shows that Austria leads the group by recycling 69.86% of its waste (DEFRA, 2009). This is followed by Netherlands with 67.40% recycling/composting rate, Germany with 67.34% and Belgium with 60.62%.

Bulgaria and Malta have the least recycling rate of 3.93% and 4.85% respectively.

Most recycling activities in developing countries are performed by the informal sector with minimum input from the government (Cointreau-Levine, 1994; UNEP-IETC and CalRecovery, Inc., 2005). In some low-income countries, scavengers recycle about 10% of the waste stream because of the economic value, in addition to being an effective means of waste reduction (www.inece.org). In the middle and low income cities of East Asia/Pacific region, the informal sectors have also made enterprises from gathering, trading, and reprocessing materials (UNEP-IETC and CalRecovery, Inc., 2005).

Recycling of waste furnishes economic returns. The economic returns from some recycled goods in Argentina show that plastic wrap (chlorinated plastics with stretch ability) provides the highest economic return followed in decreasing returns by cardboard and paper, other plastics, and plastic soft drink bottles (McBean et al., 2005). In Turkey, the market price of recycled metal outstrips the revenue from other recyclables such as paper, cardboard, plastics, glass and compost. In Nssuka (Nigeria), the unit price of bones is the highest followed by batteries, tyres, aluminum, scrap metals and plastics respectively (Nzeadibe, 2009). Also Agunwamba (2003) observed that a well-planned recycling program in Nigeria could result in 78% savings in waste management cost and 79.5% landfill avoidance cost.

Aside from the economic gains of recycling, environmental benefits such as reduction of greenhouse gas emissions, and air and water pollution associated with production from virgin raw materials accrue from waste

recycling. For example, the United States Environmental Protection Agency reported that in 2009, the United States recycled 80 million tons of wastes which is equivalent to a reduction of 178 million metric tons of carbon dioxide and savings of almost 1.3 quadrillion Btu of energy.

4. Conclusion

Solid waste is an inevitable consequence of human activities on earth. However, there is disparity in the generation rates and composition of solid

wastes across the globe. According to income groups, countries with higher income tend to generate more solid wastes per capita than lower income countries due to higher commercial and industrial activities. Solid waste arising from such income group has higher proportions of recyclables and inorganics, which generally have high calorific values. Solid wastes from developing countries are mainly organics with lower calorific value. Recyclable materials in low-income, middle-income and high-income countries comprise about 17%, 43% and 62% of the total waste stream respectively. Several social, economic and environmental benefits amass from solid waste recycling; hence it is recommended that well planned recycling programs should be incorporated into solid waste management plans.

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