Kwame Nkrumah University of Science and Technology

Kumasi, Ghana.

Source separation, characterization and recycling potential of household solid waste.

A case study of Kumasi, Ghana.

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Source separation, characterization and recycling potential of household solid waste

A case study of Kumasi, Ghana.

By

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DECLARATION

I hereby declare that this thesis is the result of my own field work towards the MSc. and has been composed under supervision. It has not been submitted previously either wholly or partially for a degree in the university or elsewhere, except where due acknowledgement has been made in the text.

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DEDICATION

I dedicate this work to my beloved mother, Theresa Bediako.

ABSTRACT

A person stops generating waste only when he or she is in a state to be disposed of as waste (Adogame, 2009). As the generation of solid waste in Kumasi increases continuously with economic growth, the importance of recycling and other waste recovery options become more apparent in order to prolong the lifespan of the only existing landfill.

This study was undertaken to assess the willingness of households in low and middle income communities in Kumasi to separate household waste at source as well as the set out rate and efficiency at which the households can separate the waste into the desired categories in order to evaluate the potential of households to sort out uncontaminated solid waste for waste recovery options including recycling and composting. Parameters such as waste generation (kg/capita/day), waste composition and bulk density of solid waste were also considered. The recorded data was modelled to ascertain the possibility of predicting the per capita generation of waste using the household size as the independent variable. Households willing to source separate waste were given differently coloured bags and their solid wastes collected, sorted into components with the weight and volume measured. The separation efficiencies were taken into account. Over 70% of respondents in both groups were willing to separate waste at source. The solid waste generation rates were 0.407kg/capita/day and 0.578kg/capita/day for low and middle income groups respectively. The findings show that income levels influence solid waste generation as a result of differences in consumption patterns. The wastes were sorted into six fractions of which the highest constituent was organic, 62% on average. Separation efficiencies were highest in the organic category (over 70%), followed by other wastes category (over 69%), and the paper and plastics category (over 60%).The findings show a highly efficient source separation programme significantly enhances the recycling potential of recyclables in the waste stream whiles the high organic separation efficiencies could help recover majority of the organic waste in the waste stream for composting purposes.

Regression analysis of modelled data showed a significant positive relationship between the per capita generation of solid waste and the household size. The results indicate that household size could be an important tool to predict the per capita generation of solid waste, in addition to other social, cultural and economic parameters.

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List of Abbreviations and Acronyms

NESSAP	Environmental Sanitation Strategy and Action Plan
AMA	Accra Metropolitan Assembly
WFD	Waste Framework Directive
MDG	Millennium Development Goals
ISWM	Integrated Solid Waste Management
GHG	Green House Gas
SWM	Solid Waste Management
CCW	City and Country Waste
HH	House to House
CCC	Communal Container Collection
GDA	Ga Development Authority
EPA	Environmental Protection Agency
CDC	Center for Development Communication
NGO	Non-Governmental Organizations
WHO	World Health Organization
TMA	Tema Metropolitan Assembly

1. INTRODUCTION

1.1 Background

Waste generation is an unavoidable part of human activity and a person stops generating waste only when he or she is in a state to be disposed off as waste (Adogame, 2009).
The increasing economic development and living standards have influenced the demand for goods and services resulting in increased waste generation (Narayana, 2008) whiles it is worth noting that low sanitation levels on the African continent are significantly influenced by poor waste management practices especially dumping of waste in water bodies and uncontrolled dump sites (UNCSD, 2012).

Ghana has waste management difficulties that extend from the national to local level, and refuse of all shapes and sizes is a common site in major cities as well as rural areas. These difficulties are concentrated and complicated by population pressures in the few heavily populated cities of which Accra and Kumasi are the most prominent (MLGRD-ESP, 2010). Solid waste management is an essential factor contributing to the health, productivity and welfare of the people of Ghana. It is identified in Ghana's programme of economic and social development set out in "Vision 2020" as a key element underlying health and human development (MLGRD-ESP, 2010). Landfilling is the general method of waste disposal in Ghana and currently Kumasi is served by the Dompoase Landfill facility. Incineration does not play a significant role in solid waste management in Ghana and it is primarily used for the treatment of healthcare waste.

The revised Environmental Sanitation Policy (2010) promotes reduction, re-use, recycling and recovery (4Rs) of all types of waste streams as a way of reducing the volume and cost of waste delivered to final disposal sites (MLGRD-ESP, 2010). The National Environmental Sanitation Strategy and Action Plan (NESSAP) has taken this further by emphasizing that all wastes are regarded as material-in-transition ("MINT") whereby "waste" is not discarded but kept in transition and value added on or extracted at every stage along the solid waste management functions or processes. However, a lot still has to be done in our pursuit of environmental cleanliness (MLGRD -EHSD, 2010).

Demand for reliable data on waste has grown in Ghana for the purposes of planning, management and researches but generally, there is inadequate information on quantification and characterization of waste in Kumasi. Nevertheless, good quality waste characterization data are vital to strategies to manage environmental challenges associated with waste. Solid waste cannot be managed effectively and efficiently, unless the origin, composition, quantities, processes and the associated environmental risks are thoroughly understood (Kum et al., 2005). Effective Solid Waste Management requires a complete understanding of the composition of a waste stream as well as the activities that determine its generation in the first place (Farmer et al., 1997).

In view of the urgency created by limited landfill space and air pollution from incineration, waste recycling has been taken as an intermediary measure to tackle the waste problem. With the primary aim to lessen environmental damage and achieve environmental sustainability, waste recycling can save energy, conserve resources, reduce emissions from incinerators and prolong lifespan of landfills (Seik, 1997; Rondinelli and Berry, 2000; Ekins et al., 2003; Tinmaz and Demir, 2006; Tsai 2008; Yung Yau, 2010). However, source separation of solid waste is crucial to achieving successful recycling. Source separated solid waste is easily handled as the sorted waste streams can be channeled to their respective treatment facilities like composting, recycling or waste to energy. A lot of effort is however required to make source separation successful since it is not naturally part of present day urban lifestyles (Annepu, 2012).

In this sense, the basic aim of this research is to aid in obtaining adequate data with respect to source separation, characterization and recycling of solid waste in Kumasi in order to ensure effective handling and management alternatives for solid waste.

1.2 Problem Statement

The current domestic waste generation in Kumasi is 1500 tonnes of which about 900 tonnes is collected (KMA –WMD, 2010). The growing volume of uncollected solid waste is of grave concern having in mind accompanying health implications.

Changing lifestyles and consumption patterns of the growing urban middle class in particular, is likely to increase the complexity and composition of waste streams. However, waste characterization data specific to African cities is generally not available (UNEP-DTIE, 2012). The limited data means gaps between waste management policy and legislation and actual waste management practices are widening. This is further compounded by capacity constraints and lack of waste management facilities for various waste streams. Access to major investments and acquiring the technical know-how needed to resolve the capacity constraints remain a tall order.

Though a well-engineered sanitary site is currently in use at Dompoase for the disposal of waste from Kumasi, dump spaces are diminishing and there is difficulty in finding suitable places for the construction of landfills. Increasing cost and decreasing space of landfills are forcing considerations of alternative options of solid waste management (Zia et al., 2007). Whiles Kumasi has yet to face problems with situating landfills, AMA is currently faced with the problem of land acquisition for siting landfills as residents reject the idea of constructing this facility in their localities – the 'Not In My Back Yard' or 'Build Absolutely Nothing Anywhere Near Anything' attitudes (Morrissey and Browne 2004). Recycling activity in Ghana is low as organized recycling is virtually non-existent in Kumasi and only 2% of the solid waste generated in Accra, the capital, is recycled at a recycling facility (Global Project-Accra, as cited by Thompson, 2010).

This implies that most of the waste generated is either disposed of straightaway at the landfill site, which is a threat to the lifespan of the facility. Also lack of recycling activity means fractions of the waste which could be sources of pollution are left to remain in the waste stream.

1.3 Main Objective

The objective of this study is to assess households' ability to source separate solid waste for the assessment of recycling potential in low and middle income groups in the Kumasi Metropolis.

The specific objectives are:

a. To investigate the obstacles and incentives, the willingness and set out rate of households towards source separation of solid waste.
b. To characterize the household waste and determine the generation rate and bulk density.
c. To assess the separation efficiency of source separated household waste.
d. To develop models used to predict average generation rate using household size as the independent variable.

1.4 Justification

Integrated waste management system is significant to the realization of sustainable development (de Vega et al., 2008). For such a system to be effective in Kumasi, it is imperative to carry out waste characterization studies. Characterizing the waste in Kumasi will enable accurate assessment of waste load and it would be easier for proper planning of a solid waste management system. This would aid in sustainable use of resources and protection of environment and public health in Kumasi. The waste characterization study will show what could be recycled that is currently being thrown away.

It is imperative to have knowledge of the quantities of waste generated, separated for recycling, and collected for further processing or disposal. Recycling has economic and environmental benefits as there is generally no space for waste. It is therefore important to know the recycling potential of waste generated by households in Kumasi.

1.5 Scope of Study

The selected study area is the Kumasi Metropolis. Only two sub-metropolitan areas representing both the low and middle income classes were selected for the study due to lack of funds and logistics. The study focused on assessing the willingness of households to separate waste and the separation efficiency of the source separated waste. The willingness of households to source separate waste also involved the set out rate to source separation. The separation efficiency also comprised characterization of waste collected in the different bags.

1.6 Limitations

Difficulties encountered during the study included:

a. Lack of adequate funds and logistics.

b. Poor commitment of some of the households towards the source separation.

1.7 Structure of Thesis

The report is subdivided into five chapters. Chapter one starts with the introduction which consists of the background, objectives, problem statement, the justification, the scope of study and the limitations to the work.

Chapter two comprises a review of related literature on relevant areas of the research. Chapter three describes the study area and research methodology. Detailed results and discussions of all the study components are presented in chapter four. The conclusions and recommendations from the results and discussions and also from the literature review have been outlined in chapter five.

2. LITERATURE REVIEW

2.1 Definition of Waste

Waste generation is an unavoidable part of human activity. Waste is defined according to the Waste Framework Directive of the European Union as “substance or object which the holder discards or intends or is required to discard’’ (WFD, 2008). Waste does not occur in nature but arises from our daily activities and waste mismanagement could pose a serious threat to the environment.

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The United Nations Statistics Division also defines waste as **“** materials that are not prime products (that is products produced for the market) for which the generator has no further use in terms of his/her own purposes of production, transformation or consumption, and of which he/she wants to dispose’’(UNSD, as cited by UNEP,2004). Solid waste in this thesis therefore comprises of non-liquid items that are deemed unfit for use, which the owner has an ultimate aim of finally getting rid of.

2.2 Sources and Types of Solid Wastes

Varieties of different wastes arise from different sources as a result of our daily activities. These include prominent sources such as Industrial, Commercial, Residential, Institutional, Process, Agriculture, Construction and demolition, as well as Municipal Services.

Table 2.1: Sources, generators and types of solid wastes

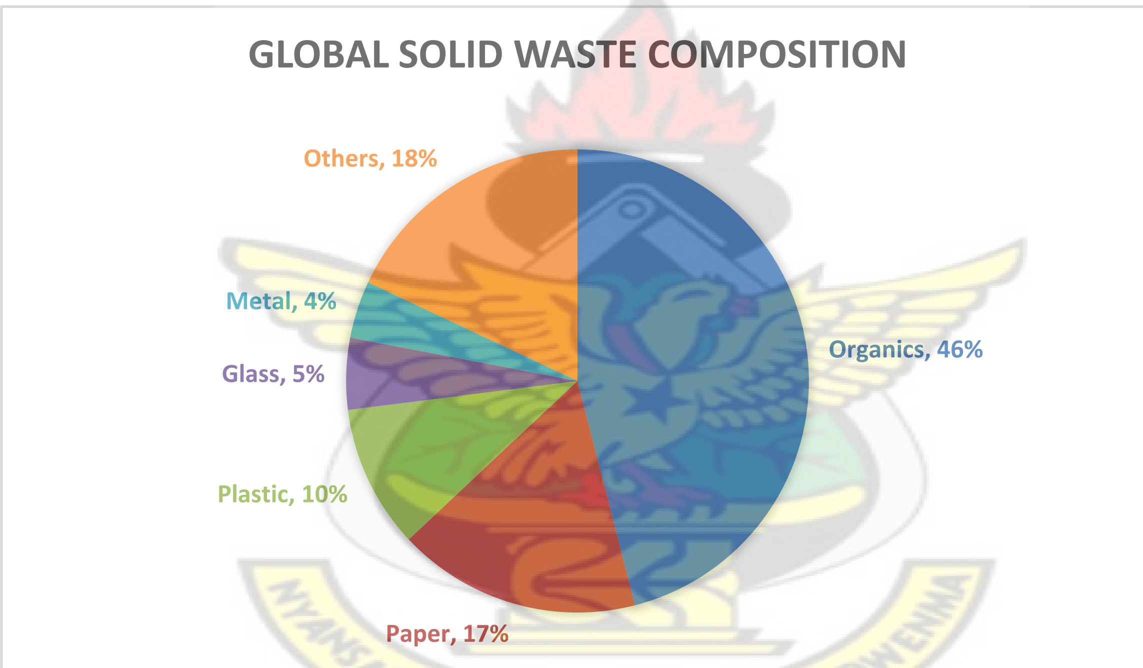
SOURCE	TYPICAL WASTE GENERATORS	TYPES OF SOLID WASTES
Residential	Single and Multi dwelling families	Food wastes, paper, cardboard, plastics, textiles, leather, yard wastes, wood, glass, metals, ashes, special wastes (e.g. bulky items, consumer electronics, white goods, batteries, oil, tires), and household hazardous wastes
Industrial	Light and heavy manufacturing, fabrication, construction sites, power and chemical plants	Housekeeping wastes, packaging, food wastes, construction and demolition materials, hazardous wastes, ashes, special wastes
Commercial	Stores, hotels, restaurants, markets, office buildings, etc.	Paper, cardboard, plastics, wood, food wastes, glass, metals, special wastes, hazardous wastes
Institutional	Schools, hospitals, prisons, government	Food wastes, glass, metals, special wastes, hazardous wastes, paper, cardboard, plastics, wood,
Process	Heavy and light manufacturing, refineries, chemical plants, power plants, mineral extraction and processing	Industrial process wastes, scrap materials, off specification products, slag, tailings
Construction and Demolition	New construction sites, road repair, renovation sites, demolition of buildings	Wood, steel, concrete, dirt, etc.
Municipal Services	Street cleaning, landscaping, parks, beaches, other recreational areas, water and wastewater treatment plants	Street sweepings, landscape and tree trimmings, general wastes from parks, beaches, and other recreational area, sludge
Agriculture	Crops, orchards, vineyards, dairies, feedlots, farms	Spoiled food wastes, agricultural wastes, hazardous wastes (e.g. pesticides)

Source: UNESCAP, 2000.

2.3 Solid Waste Composition and Characteristics

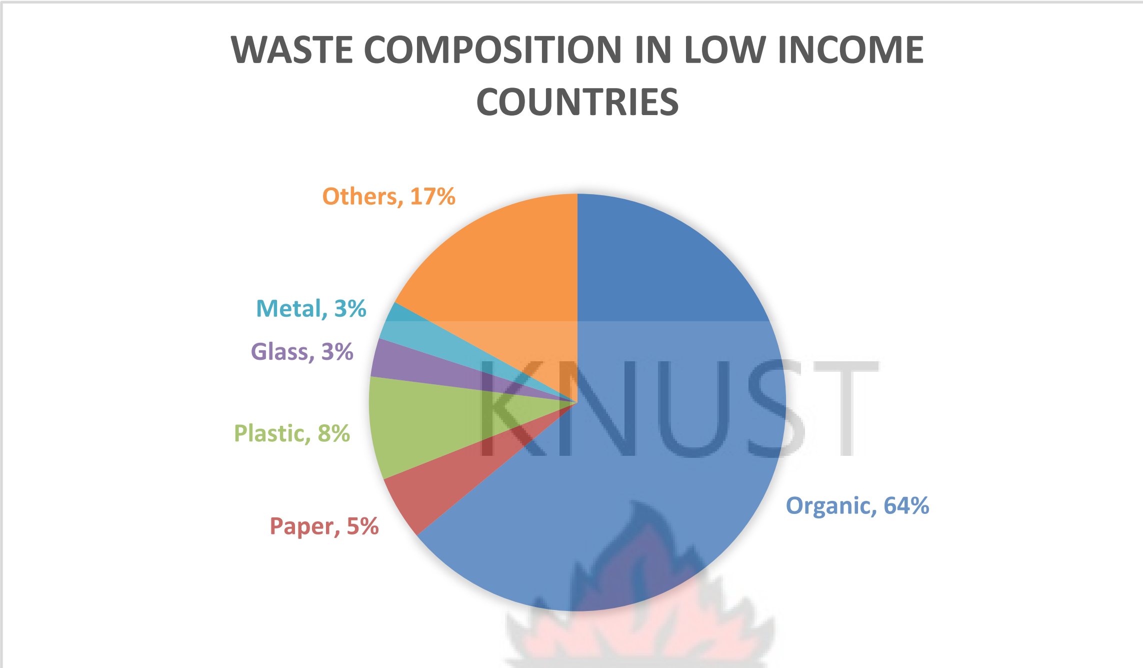
Individual components and their relative distribution in the waste stream make up waste composition. According to Hoornweg and Bhada-Tata (2012), low income countries have the highest proportion of organic waste as shown in figure 2.1 and figure 2.2 because affluence increases at a slower rate in these countries and waste composition is influenced by factors including climate, culture, economic development among others furthermore influencing waste collection and disposal.

Figure 2.1: Global solid waste composition



Source: Hoornweg and Bhada-Tata, 2012.

Figure 2.2: Solid waste composition in low income countries



Source: Hoornweg and Bhada-Tata, 2012.

Knowledge of the composition and characteristics of solid waste is useful for effective planning and operation of solid waste management systems.

Bulk density data is important to the implementation of waste disposal and management plan for the selection of resource and energy recovery potentials (Bin Yousuf and Rahman, 2007).

The bulk density of waste is mostly measured using the weight-volume analysis. Changes in bulk density for a municipality occur as a result of factors which include seasons of the year, geographic location and duration of storage (Mensah, 2010).According to the WHO expert report (1982) as cited by Mensah (2010), bulk density of wastes produced in low income countries is in the range of 100-500Kg/m^3 .

2.4 Waste Management

Waste management describes the processes of collecting, removing, processing, and disposal of materials or items considered waste. Many countries around the world are confronted by one major environmental issue which is waste disposal and management. As observed by Pacione (2005):"Most city governments are confronted by mounting problems regarding the collection and disposal of solid waste. In high-income countries, the problems usually centre on the difficulties and high cost of disposing of the large volume of waste generated by households and businesses. In lower-income countries, the main problems are related to collection, with between one-third and one-half of all solid waste generated in Third World cities remaining uncollected" (Pacione, 2005).

Kironde (1999) has observed that the city environment in most developing countries is characterized by heaps of garbage, overflowing waste containers, chocked drains, clogged streams and stinking gutters. The generally poor waste situations in developing country cities and the perpetuation of social and environmental injustice against the poor remain critical challenges and deviate from the objectives of the Millennium Development Goals (MDGs), Agenda 21 and other moves to address these problems to improve the living conditions of the poor.

2.5 Integrated Solid Waste Management

According to UNEP-DTIE (2012), ISWM **"**refers to the strategic approach to the sustainable management of solid wastes, covering all sources and all aspects, from generation, through segregation, transfer, sorting, treatment, recovery and final disposal; and considering and involving all stakeholders in the process. Such management is undertaken in an integrated manner, with an emphasis on maximizing resource use efficiency. It is based on the 3R (reduce, reuse, recycle) approach".

This is re-echoed by Staniskis (2005), who stressed that waste management consists of an ordered set of closely interrelated processes which should not compete against each other but rather be harmonized in a holistic approach of waste management systems.

The need for integrated solid waste management is as a result of increasing population, industrialization and economic growth as well as increasing knowledge about effects of poor handling of waste. However, of paramount importance to a successful ISWM is proper planning. Developing countries have encountered failures in ISWM as a result of advanced technologies of waste management which were imported without proper planning (UN-HABITAT, 2010).

Waste management can have adverse impacts and these addressed be addressed through integrated process where all types of waste and the various waste management options are unified. Integrated Solid Waste management therefore requires a combination of different collection and treatment methods in dealing with waste generated in a way which is socially acceptable, makes economic sense and protects the environment thus ensuring sustainability (McDougall et al., 2001).

2.6 Sustainable Development

Sustainable development is defined in the Brundtland Commission's report as: "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987).

Resources, substances and materials are extracted and processed in order to meet human needs and sustain life. After the beneficial use of the resources, these products and materials become available as waste and subsequently have the potential of being used as raw materials for other purposes (Giegrich and Vogt, 2004). This highlights the fact that the handling of resources is extremely important in any strategy for sustainable development.

2.7 Sustainable Solid Waste Management

Sustainable Solid Waste Management is an example of a system which is self-sufficient in the sense that its maintenance over time does not deplete the resources on which it depends on and its deemed feasible based on technical, environmental, social, economic, financial, institutional and political considerations (World Bank, 2012).

In developing countries, local governments often spend twenty to fifty per cent of their budget on solid waste management. Despite the huge financial commitments to solid waste management, about thirty to sixty per cent of all the urban solid waste in developing countries is not collected and population coverage for waste management services is low. In some cases, as much as eighty percent of the collection and transport equipment is out of service, in need of repair or maintenance and in most developing countries, open dumping with open burning is the norm (World Bank, 2012). Sustainability of waste management is key to providing an effective service that satisfies the needs of the end users.

Sustainable solid waste management can be achieved if there is a shift from the conventional approach of efficient removal to waste avoidance, minimization and recycling options through harmonization of technical requirements with the objectives of environmental protection and interests of various stakeholders especially the urban poor (ISEB, 2007).

2.8 Millennium Development Goals and Solid Waste Management

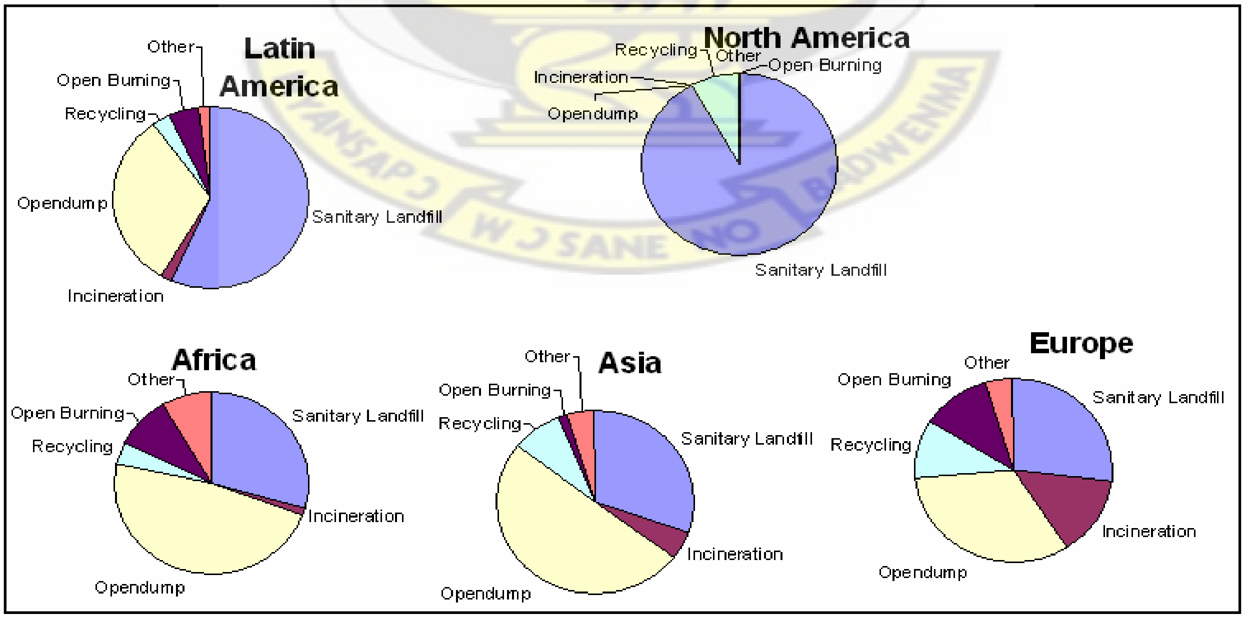
Solid waste management plays an important role in achieving some of the MDGs irrespective of the fact that it was not clearly outlined in the Millennium Development Goals, their targets and accompanying indicators.

An efficient solid waste management system is important to achieve the goals of improving public health and protecting the environment. With respect to MDGs concerned with education and gender balance the workforce involved in solid waste management are seen to play major roles. Recycling initiatives as well as extension of the coverage of solid waste management services means jobs will be generated and others will earn more which all contribute to tackling poverty (Gonzenbach and Coad, 2007).

2.9 Trends in Waste Disposal

The different trends of waste disposal across different continents of the world have been compared.

Figure 2.3: Trends in waste disposal across the world



Source: UNEP, 2010.

2.10 Climate Change and Solid Waste

Climate change refers to seasonal changes of the elements of weather over a long period of time and these changes or patterns highly influence natural ecosystems, humans as well as cultures which depend on them (IPCC,2007).

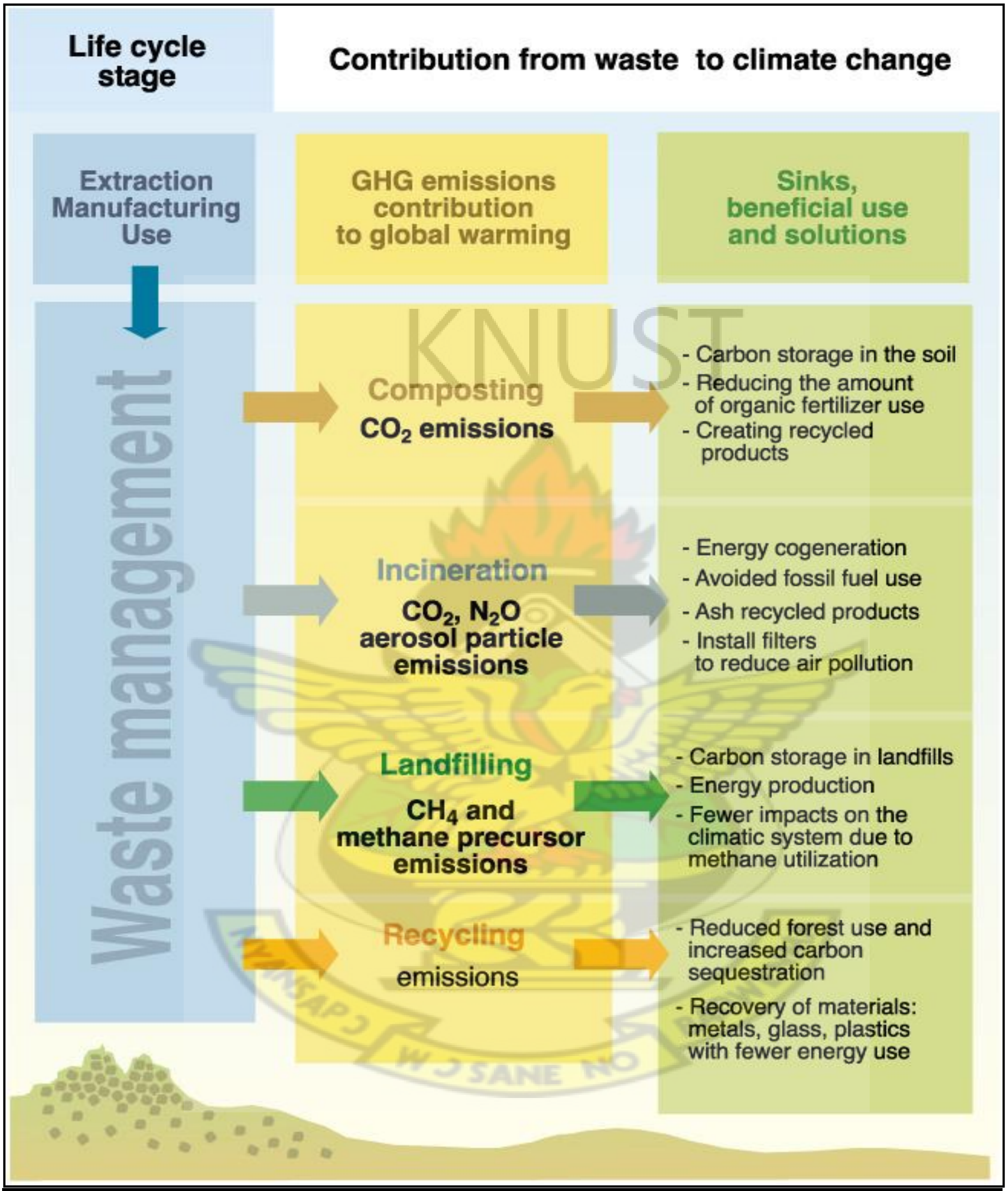
It has been described in some quarters as "a long-term shift in the statistics of the weather including its averages" (NOAA, 2007).

Methane and CO2 are important greenhouse gases (GHG) which contribute to global warming and climate change. Essentially, landfills emit methane which is considered as the most important source of climate impact in the waste sector. Open burning of waste and controlled ones in the form of incineration also give out Carbon Dioxide (UNEP, 2010).

According to Bogner et al., (2007), the role of the waste sector for reducing global GHG emissions has been underestimated because decisions about waste management are made locally without concurrent quantification of GHG mitigation.

Waste affects climate change in diverse ways because energy consumption, methane emissions and carbon sequestration are affected in different ways by the different wastes and waste management options. For example Source reduction and recycling of paper products, reduce energy consumption, decrease combustion and landfill emissions, and increase forest carbon sequestration (US EPA, 2006).

Figure 2.4: The contributions of solid waste to climate change



Source: Rekacewicz , 2012.

2.11 Solid Waste Management in Ghana

Solid waste management in Ghana has seen many challenges especially with increase in economic development and rapid urbanization of the country. Over the years, waste has been disposed in the open with no specific management systems in place. Zoomlion and other waste management companies have been given permits by government to ensure effective collection and responsible disposal of solid wastes within most of the urban centres of the country.

Apart from the urban areas where conscious efforts are being made to manage waste in an organized way, the rural areas of the country seem to have been left to their own fate with regards to waste management. Tsiboe and Marbell (2004), identified three main ways through which waste has been managed in Ghana, and thus mainly in the urban localities. Unfortunately all these waste collected are deposited at landfills. The first is collection of waste by trucks directly outside houses, the second is collection from public communal containers where people come to dump their wastes whiles the third is door to door collection by labour intensive methods.

The Environment Protection Council was the first attempt by the Government of Ghana to have an agency to regulate issues concerning the environment (JICA, 1999). This council was created in 1973. Decentralization of government to the district levels also brought another dimension to the waste management issues after the PNDC law 207 was enacted in 1988. This time, the central government was not directly in charge of the waste management issues in the various districts. This was left into the hands of the municipal and district assemblies to manage.

2.12 Role of Private and Informal Sectors in Solid Waste Management in Ghana

According to UNEP (2005), the waste management services delivery by the public sector in many developing countries is ineffective while regulation of the private sector is limited and as a result there is indiscriminate and illegal dumping of domestic and industrial waste which is as a result of the low priority given to waste management in these countries.

The 'formal private' sectors involved in solid waste management (SWM) consist of enterprises which enjoy official recognition, protection and support because they are registered or have been given a license by the local government or municipality to carry out their operations (Suchada et al., 2003).

According to Boorsman (1994), private sector involvement in solid waste management is crucial because the private sector is endowed with qualities such as political independence, economic rationality, efficiency, dynamism and innovation, qualities which makes it a more favourable option compared to public sector enterprises.In Ghana, examples of this sector include the City and Country Waste (CCW) as well as the leading waste management company, Zoomlion Ghana Limited (Oteng-Ababio, 2010). They engage in wide-ranging activities in solid waste management systems, varying from waste collection, incineration, landfill operation and resource recovery or recycling (Wilson et al., 2006).

There are two main arrangements for waste collection – HH (House to house) and CCC (Communal Container Collection) systems. The former operates in high- and middle-income areas by the private sector on franchise basis, while the latter (service contract) is in the low-income areas and managed by both the private and public sectors (Oteng-Ababio, 2010). However, apart from some inconsistencies in the frequency of collection, actual performance depends on the technical capacity (*i.e.* availability, appropriateness and state of waste machines) of the contractors. Landfill operation is the recommended choice for solid waste disposal for the metropolitan and municipal areas (comprising about 10 cities with populations over 200,000). Landfilling is considered the most feasible option from the point of view of costs and level of environmental impact. However, when poorly designed, landfills pollute surrounding air, water and also the soil (Vergara and Tchobanoglous, 2012). The national policy recommends small scale incineration plants for the treatment and disposal of health care and hazardous wastes. These facilities involve simple designs with lateritic bricks, cement blocks and metal. Local firewood is the most common energy source and the facilities are easily operated and maintained by environmental health staff of the District Assemblies. These simple incinerators have provided several years of service in dealing with relatively small quantities of hazardous hospital wastes. However in reality many of such facilities have no environmental controls and often comprise nothing more than combustion of medical and chemical waste in an oven or open pit (Vergara and Tchobanoglous, 2012).

On the other hand, the term `informal sector' refers to unregistered, unregulated, or casual activities carried out by individuals and, or family or community enterprises, that engage in value-adding activities on a small-scale with minimal capital input, using local materials and labour-intensive techniques (Furedy, 1990). These groups are typically driven by poverty and thus, initiated personally or spontaneously in the struggle for survival; although some enterprises, especially those engaged in recycling activities, manage to make considerable profits (Vergara.and Tchobanoglous, 2012). Consequently, the choice of materials to collect is in the first place determined by the value of the waste materials, and in the second place, by their ease of extraction, handling, and transport. The roles performed by the informal sector can be divided into categories, depending on where and how material recovery takes place (Wilson et al., 2006).

One category consists of itinerant waste buyers, and these are waste collectors who often go from door to door, collecting sorted dry recyclable materials from householders or domestic servants, which they buy or barter and then transport to a recycling shop of some kind or a dumpsite. Apart from their labour, they may also invest capital to acquire and run a vehicle (Wilson et al., 2006). This activity is widespread across Ghana and also in many parts of the world. In the Accra Metropolitan Assembly (AMA) and Ga Development Authority (GDA), this is known as 'Kaya Bola' activity and is confined to the high- and middle-income areas while in Tema Metropolitan Assembly (TMA ,a planned area) it is in the low-income areas (Oteng-Ababio, 2010).

The formal and informal sectors could provide advantages in terms of cost, control and reliability (Suchada et al., 2003).

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2.13 Regulations and Policies on Solid Waste in Ghana

The following regulations and legislation with regards to solid waste management can be highlighted: Under the Local Government Act of 1993 (Act 462), the provision of appropriate environmental sanitation services, including sanitary sites and final disposal sites at strategic locations in urban, peri urban and rural areas falls under the responsibility of the local government (GLFPSF, 2005).

Crucially, Section 2(d) of the EPA Act of 1994 (Act 490) states that one of the EPA's functions is "to secure in collaboration with such persons as it may determine the control, and prevention of discharge of waste into the environment and the protection and improvement of the quality of the environment." (GLFPSF, 2005).

Also, Section 2(f) of the EPA Act of 1994 (Act 490) provides that the EPA is to “issue permits and pollution abatement notices for controlling the volume, types, constituents and effects of waste discharges, emissions, deposits or other source of pollutants and of substances which are hazardous or potentially dangerous to the quality of the environment or any segment of the environment.” (GLFPSF, 2005).

The Environmental Sanitation Policy reckons that, **“**Waste management shall be carried out by a Waste Management Department, within Metropolitan and Municipal Assemblies, or a Waste Management Unit, within the Environmental Health and Management Departments of District Assemblies. They may provide the services directly or indirectly through private contractors or franchisees. The Assemblies shall in all cases maintain an in-house capacity to provide at least twenty (20) per cent of the services directly’’ (MLGRD-ESP, 2010).

According to SDAP (2010), environmental sanitation which aims at developing and maintaining a clean, safe and pleasant physical environment is important in contributing to the health, productivity and welfare of Ghanaians, thus highlighted in the Environmental Sanitation Policy with respect to the collection and sanitary disposal of wastes including solid waste.

2.14 Waste Hierarchy

The “waste hierarchy*”* ranks waste management options according to what is best for the environment (DEFRA, 2011**).** This is emphasized through identification of waste management options and ranking them according to their potential impacts on the environment. The waste hierarchy is set out in Article 4 of the revised European Waste Framework (Directive 2008/98/EC) as consisting of the following stages: prevention, preparing for re-use, recycling , other recovery and disposal as described in Table 2.2. The waste hierarchy primarily seeks to derive optimum benefits from products whiles generating the least possible amount of waste.

Table 2.2: Stages of the waste hierarchy

STAGES	INCLUDE
Prevention:	Using less material in design and manufacture. Keeping products for longer; re-use. Using less hazardous materials
Preparing for re-use:	Checking, cleaning, repairing, refurbishing, whole items or spare parts
Recycling:	Turning waste into a new substance or product. Includes composting if it meets quality protocols
Other Recovery:	Includes anaerobic digestion, incineration with energy recovery, gasification and pyrolysis which produce energy (fuels, heat and power) and materials from waste; some backfilling
Disposal:	Landfill and incineration without energy recovery

Source: DEFRA, 2011.

2.15 Waste Recovery Methods

Recovery is defined as any waste management operation that diverts waste material from the waste stream and which results in a certain product with a potential economic or ecological benefit. Recovery mainly refers to processes including material recovery, energy recovery, biological recovery as well as waste re-use (OECD, 2010).

2.15.1 Composting

Composting refers to the natural decomposition of organic waste material under controlled conditions. Various forms of composting technologies exist and these include open windrow, vermi-composting, enclosed composting, anaerobic digestion and fermentation (Engledow & Eichestadt. 2007).

Table 2.3: Various composting methods

Open Windrow-Forced Aeration Composting	Garden waste, wood waste, sewage sludge, manure, fruit waste	Compost, soil conditioner
Vermi-composting	Sewage sludge, food & garden waste	Compost, soil conditioner
Enclosed composting	Mixed organics (food & garden)	Compost, soil conditioner, high calorific value
Anaerobic digestion	Mixed organics (food & garden)	Biogas, green energy
Fermentation	Agricultural waste, mixed organics	Liquid fuel

Source: Engledow & Eichestadt, 2007.

2.15.2 Incineration

Incineration is the burning of waste materials under controlled conditions and may have an option of energy based on technical grounds.

Incineration is attractive for its ability to reduce significantly the volume of combustibles by 80 to 95 percent further reducing the need for landfill capacity (Haukohl et al, 2000).

However, incineration is less significant in municipal waste management in Africa as a result of its relatively high costs ,inadequate human, mechanical and institutional resource as well as high content of inerts in the waste stream making the technology inappropriate on the African terrain for the time being (ADB,2002).

2.15.3 Recycling

Recycling is the process of make new materials out of previously new ones which have been considered as waste (US EPA, 2010). It is the process of collecting and sorting desired waste materials to be processed as raw material for the production of new items. Whiles re-using entails the multiple usage of an old product, recycling focuses on producing a new product.

Examples of materials that can be recycled are plastic, glass, paper, batteries, and aluminium among others.

Recycling requires collective action in order to achieve the numerous benefits it presents which means all stakeholders including polluters should be involved to make it a success.

Among the numerous benefits derived from recycling are:

a. Landfill spaces are saved because waste which might have ended up in landfills is diverted.
b. Pollution is reduced and natural resources are conserved because virgin materials are not used to manufacture new products which ensure environmental sustainability also an MDG.
c. Energy and manufacturing costs are reduced.
d. Recycling helps in reducing GHGs which contribute to climate change. Development researchers (e.g., Smith *et al.*, 2001; WRAP, 2006) have begun to comprehensively quantify the significant benefits of recycling for indirect reductions of GHG emissions from the waste sector.

e. Jobs are created helping to reduce poverty in accordance with MDGs.

As beneficial as waste recycling might be in the social and environmental context, it could also have negative impacts which include poor health and living conditions as well as exploitation of waste pickers (Furedy, 1992).The rate of recycling in Africa is difficult to determine because there are few official statistics on solid waste recycling for the continent (UNEP-IETC, 1998).

According to Yhdego (1995), heavy dependence on imported goods means that there is a non-existent local market for recyclables in most African cities. However, efforts are being made to create local markets for recyclables in Africa. For example, in South Africa, there is a demand for recycled materials as a result of the sizeable tin mining and processing industry which has led to the institution of a deposit system used to encourage the return of bottles and tin and aluminium cans (UNEP, 2012).

Waste recycling is often undertaken as a survival strategy when the urban poor are unable to obtain formal employment and when non-waste resources are scarce or unaffordable (Cointreau and de Kadt, 1991). About 15-35% of solid wastes generated in cities in low and middle income countries are being recovered as a result of informal recycling activities (UN-Habitat, 2010).

Linkages have been established between the recycling activities of the informal sector and the Millennium Development Goals (MDGs) and the recycling activities of the informal sector according to development researchers (Coad, 2006; Langenhoven & Dyssel, 2007; Medina, 2006).

These linkages are evident in the creation of jobs through informal waste recycling which serves as a source of income for those involved thus reducing poverty which is featured prominently in the MDGs. Recycling also means less virgin materials are taken for the manufacture of goods which ensures environmental sustainability.

Kaseva et al., (2002), however argue that there is the need for the solid waste management strategies in developing countries like Ghana to be redesigned to include a separate collection and processing system for waste recycling that can work parallel with the conventional systems already in operation as a result of success stories of recycling programmes that have been recorded elsewhere in the world

2.15.4 Re-Use

Solid waste re-use involves reusing a product repeatedly without the need for re-processing. In this case a material which would have been disposed of after slight usage stays in the system and saves landfill space.

Simelane and Mohee (2012), point out that devising better management options through reuse of waste in Africa will help the continent to achieve the Millennium Development Goal (MDG) number 7: to ensure environmental sustainability. Waste re-use has limitations with respect to sanitation and public health; however its proper integration into a well-designed solid waste management programme will be beneficial in the areas of waste reduction, material conservation, cost savings and environmental protection (Diaz, 2012).

2.16 Source Separation of Solid Waste

Source separation of household waste describes a conscious effort by households to sort out waste into different categories for the purposes of recycling, reuse or improved waste management.

Household items that are frequently separated include newspapers, magazines, scrap paper, boxboard, plastic bags, food and drink cans and containers, and in some cases, organic wastes and bulky goods.

Bennagen et al., (2002), assert that it is better to separate recyclable materials at source rather than mixed waste recovery as cleaner and higher quality materials are produced through source separation. Al-Salem et al., (2009), in their journal article "recycling and recovery routes of plastic solid waste: A review", emphasize that sorting is the most important step in the recycling loop irrespective of how efficient a recycling scheme might be.

According to UNDP (1999), instances of household level separation being promoted in developing countries include, Jaipur -India, where Center for Development Communication (CDC) developed an innovative model for management of waste, which promoted household efforts to segregate organic and inorganic waste to aid the services of the municipal bodies by developing community awareness, promoting cooperation between the NGOs, municipal authorities and the community.

Furedy and Maclaren (1990), indicate that developing nations are embracing source separation of waste motivated by reasons which include the desire of households to recover some residual value from their waste through sale, barter or reuse; emergency resource scarcity in the society, consciousness of the need for resource conservation; and solid waste disposal crisis. Previous findings by Asase and Oduro-Kwarteng (2010) showed that over 70 % of households were willing to separate waste so far as motivations such as free bins were in place.

3. RESEARCH APPROACH AND METHODOLOGY

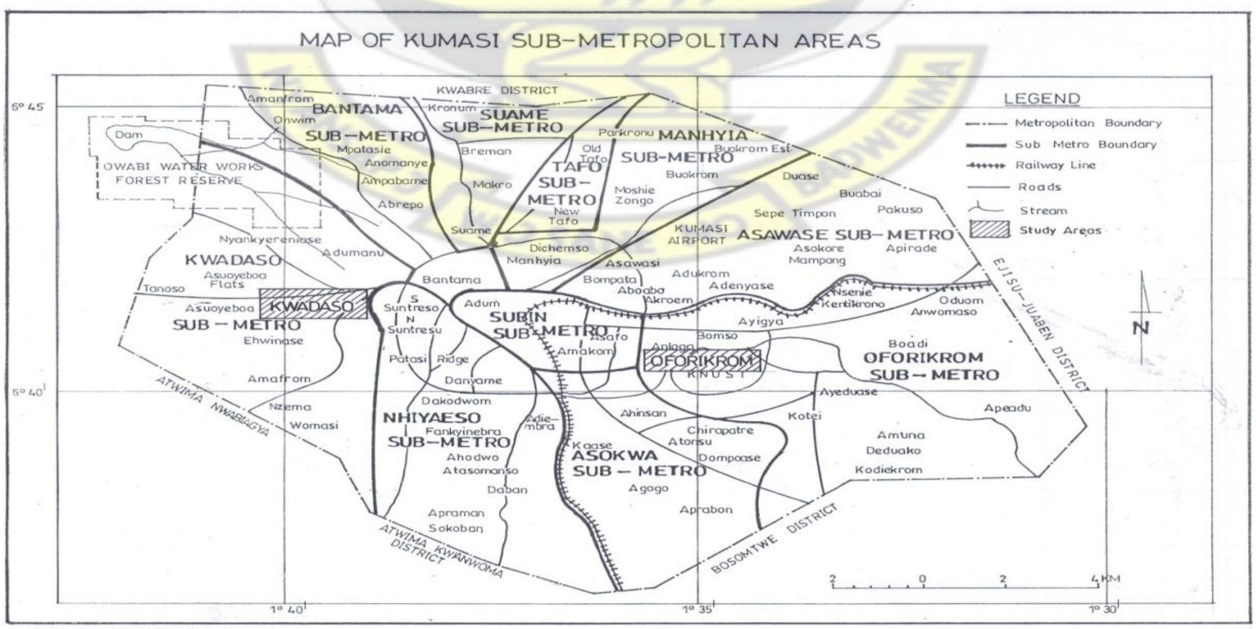
3.1 Description of Study Area

Kumasi is the second largest city in Ghana and the capital of Ashanti region. It is situated about 280km by road from the national capital, Accra. The Kumasi Metropolis shares boundary with four districts; to the north, Kwabre, on the south Bosomtwe- Atwima Kwanwoma; on the east, Ejisu-Juaben; on the west, Atwima. The total land coverage of Kumasi Metropolitan Area is approximately 254sq.Km and the major sectors of the economy fall under trade/ commerce/services which accounts for about 71%, manufacturing/industry which takes up of 24% and the primary production sector which takes only 5 %.(KMA, 2006).

The metropolis is politically divided into ten (10) sub-metropolitan areas namely; Manhyia, Tafo, Suame, Asokwa, Oforikrom, Asawase, Kwadaso, Nhyiaeso and Subin,

The figure 3.1 gives a pictorial arrangement of the various sub- metropolitan areas with the selected study areas shaded. These are the Kwadaso and the Oforikrom sub-metropolitan areas.

Figure 3.1: Map indicating the study area, Kumasi with its sub-metros



SOURCE: Kumasi Metropolitan Assembly

3.1.1 Location and Climate

Kumasi is a nodal city with major arterial routes linking it to other parts of the country. The city lies between latitude 6.35^o – 6.40^o and longitude 1.30^o – 1.35^o. It is located in the transitional forest zone and has an elevation which ranges between 250 – 300 metres above sea level with an area of about 254 sq.km.

The climate in the city is typical of a wet sub-equatorial type and the vegetation generally falls in the moist semi-deciduous ecological Zone. Temperatures in the metropolis range between 21^o- 30 ^{o} at the minimum and maximum respectively whiles the average rainfall is about 1400mm in the year. Kumasi is drained by rivers and streams, which include the Subin, Wiwi, Sisai, Owabi, Aboabo, Nsuben to mention but a few.

3.1.2 Population

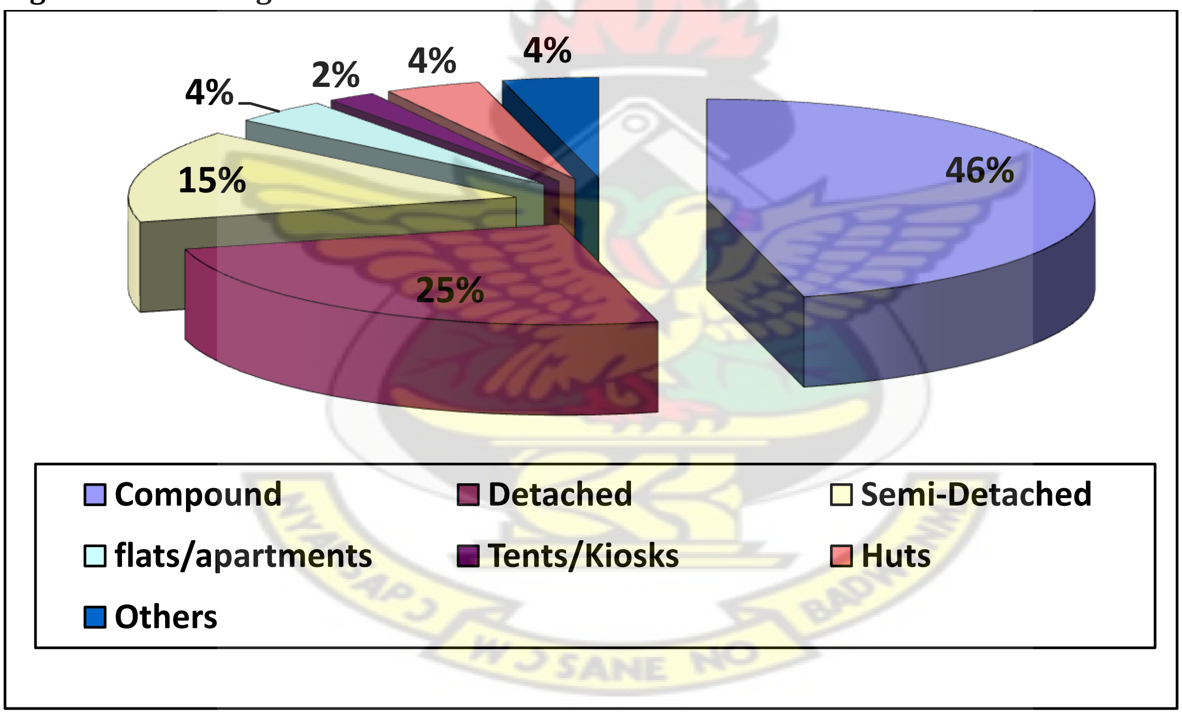
Kumasi is the most populated of all the administrative political districts in the Ashanti region. The 2000 Population Census estimated a population of 1.17million for the city which further shot up to a projected 1.61miilion in 2006 based on a growth rate of 5.4% per annum (KMA, 2006). Current estimates show the city has a population of about 2.1million which shows it continues to grow. Kumasi is a cosmopolitan city attracting people from within Ghana and neighbouring countries significantly due to the centrality of Kumasi as a nodal city with major arterial routes linking it to other parts of the country as well as the high level of commercial activities .Asante Twi is widely spoken and understood though migrant communities maintain their language and cultural identities.

3.1.3 Housing

The growth in population in Kumasi over the years means the importance of housing cannot be underestimated. The Bank of Ghana (2007), in their research classified housing in Ghana based on the 2000 census as follows Compound Houses, Detached, Semi Detached, Flat/Apartments Tents/Kiosks, Huts and Other.

However, housing in Kumasi, has been categorized into four which include high cost housing, government housing, indigenous housing and tenement housing. The housing distribution and the characteristics are presented in figure 3.2 and table 3.1 below.

Figure 3.2: Housing Distribution in Ghana



Source: Bank of Ghana,2007.

Table 3.1: Characteristics of categories of housing in Kumasi

PARAMETER	HIGH COST	GOVERNMENT	TENEMENT	INDIGENOUS
Description	Low density high class area	Medium density medium class area	High density medium class area	High density low class area
Population Density (per ha)	50persons	100persons	200persons	300-600persons
Houses (per ha)	1-3	3-5	5-7	over 10

Source: KMA, 2006.

3.2 Sample Size Selection

The sample size selection depends on the error permitted in the data, the standard deviation (σ) of the data available and the confidence interval, but when the standard deviation (σ) is unknown (as in this case), n is large (say $n \geq 30$), the value of the σ can be approximated by the sample standard deviation. However due to cost constraint and inadequate logistics, a sample of 60 households, 30 each for the low and middle income groups was selected. This followed the procedure used by Mensah (2010), in selecting sample size for his study on physic-chemical characteristics of solid waste for treatment options.

3.3 Household Identification

Households for the study were selected based on two income groups consisting of the low and middle income groups. One community each was then located in the two sub-metros where the characteristics of low and middle income groups could be identified. This method of classifying the households based on income groups was based on a model from Mensah (2010), which adopted the criteria used by the Waste Management Department of the Kumasi Metropolitan Assembly critically using the living standards, housing among others as classification criteria. The table below lists the characteristics of low and high income communities from which a middle income community could be identified.

Table 3.2: Criteria to categorize communities according to income groups

LOW INCOME	HIGH INCOME
Mostly tenants	Occupants Own House
Low Population Density	High Population Density
Unreliable electricity	Reliable electricity
Poor community layout	Good community layout
Poor Water Supply	Potable Water supply
Poor Security	High level Security
Poor Waste management Services	Good Waste Management Services
Poor road and drainage systems	Good road and drainage systems

Source: Modified from Mensah, 2010.

Note: A combination of these two could be classified as middle income.

3.4 Household Questionnaire Survey

Taking into consideration the topic of the research, questionnaires were administered to all the selected households to investigate their current practices and their level of understanding of the general solid waste management issues in their respective communities. The number of persons in each household was also noted from the survey. Very crucial to this research was their understanding of source separation of solid waste hence the questionnaire ascertained their willingness to separate solid waste and their motivation to do so. The questionnaire also helped discover their knowledge about recycling, the items they recycled as well as the importance of recycling in their perspective. Households were then asked about their willingness to participate in pilot study on source separation of solid waste.

Plate 3.1 shows the administration of questionnaires with a sample of the questionnaires also included in the appendix.

Plate 3.1: Administration of questionnaires to households

3.5 Education

The need to educate the participating households about the importance of source separation to waste recycling and re-use cannot be neglected. Time was set aside to educate households on the need to separate the waste into different categories to prevent them from being contaminated and make them fit for further use or processing. There was education on the types of recyclables and the need to efficiently separate them.

Different plastic bags which had unique colours were shown to them and the types of wastes expected to be put in each was explained to them. Questions and doubts were addressed after which each participating household was given a copy of the education brochure which served as guidelines to what was expected of them. The plate below shows the household education being undertaken.

Plate 3.2: Household education on source separation procedures

3.6 Field Operation

This involved the collection and sampling of solid waste after sorting had taken place at the points of generation.

3.6.1 Collection of Waste

The need to sort waste into different material categories meant different bins had to be provided for storage of the various waste types. Plastic bags of colours black, white and yellow were given to the households. The expected contents of each bag are described in the table below.

Table 3.3: Content Description of designated separation bags

PLASTIC BAG	COLOUR DESCRIPTION	CONTENT DESCRIPTION
BLACK		Organics including food waste, fruits and vegetables, garden waste, wood, leaves etc
WHITE		Plastic bottles, Paper, plastic bags, etc.
YELLOW		Other inorganics including glass, metals, tin cans, aluminium cans, wigs, textile , leather and miscellaneous

Participating households were assigned numbers and subsequently given six each of the black, white and yellow plastic bags. The respective coloured bags were to be used to separate the waste into the desired categories daily for a total period of six days. There was daily collection of the source separated waste from the households at a specified time for six consecutive days taking into consideration the probable differences in waste generation rates on different days in the week. The plate 3.3 below shows the collection of the waste in the different bags:

Plate 3.3: Collection of wastes from households for sorting

3.6.2 Sorting and Sampling

The three plastic bags were collected each morning from the households and measurements were made and recorded. The main parameters measured were the volume and the weight of the waste. First, the weight of each of three plastic bags for the respective households was determined using a measuring scale and recorded. The contents were then transferred separately into a graduated bucket where the volume was measured and recorded. The combined values of the three plastic bags represented the total waste generated per household per day as well as the volume.

Plate 3.4 shows the measurement of the weight and volumes of waste samples. Each bag was then analysed to find the materials which were placed wrongly by the households and the weight of these wrongly placed wastes recorded to help determine the separation efficiency. Special attention was paid to the white and yellow bags where the different types of recyclables in them where identified and their proportion by weight was recorded on the data sheet. Plate 3.4 depicts the separated recyclables and their subsequent measurement:

Plate 3.4: Recyclables being sorted for measurement

Plate 3.5: Wastes being sorted for measurement

3.7 Mathematical Modelling of Per Capita Solid Waste Generation

In this method, Microsoft Excel was used to model the data available from the household waste generation recordings in a regression analysis in order to predict the per capita generation rate of solid waste using household size as the independent variable. The models were then tested to prove their statistical significance and their appropriateness in predicting the per capita generation rate.

4. RESULTS AND DISCUSSIONS

The results of the study and the discussion of their significance on the study objectives are presented in this section.

4.1 Household obstacles, incentives and willingness to source separate solid waste.

A total of 60 households from the low and middle income groups were involved in the study. In the course of the study, the number of households varied with respect to willingness to source separate in both income groups. Some respondents acknowledged the significance of the research study and fully embraced it whiles others showed some reluctance. Observations and challenges encountered at the low and middle income groups are elaborated below.

4.1.1 Low income level response to study

The level of response from the households in the low income groups was high because they had problems with solid waste and therefore welcomed any initiative that could help them solve their waste problems. The economic incentive of not having to pay any disposal fees during the study period also influenced the decision of the households to partake in the study. Challenges encountered at the low income group included the burning of waste by some households which meant they were not willing to store the waste for the study. The picture below shows a typical scenario during the study period where waste was burned.

Plate 4.1: Waste burning in low income community

Other respondents also expressed the fear of storing waste for collection by the research team because in the event of a no show by the research team for collection they could be arrested by sanitary inspectors.

4.1.2 Middle income level response to study

The peculiar nature of the community representing the middle income group was that it consisted of several blocks of flats in a planned community. In this category, 30 households were visited and they all used door to door collection. Majority of respondents agreed to participate because they saw the significance of such research in planning for solid waste management services whiles other participated because of the poor solid waste collection services they were experiencing and wanted it to go on record. The picture below shows the appalling aesthetic nature of the waste bins awaiting collection.

Plate 4.2: Unpleasant aesthetic appearance of waste in middle income community

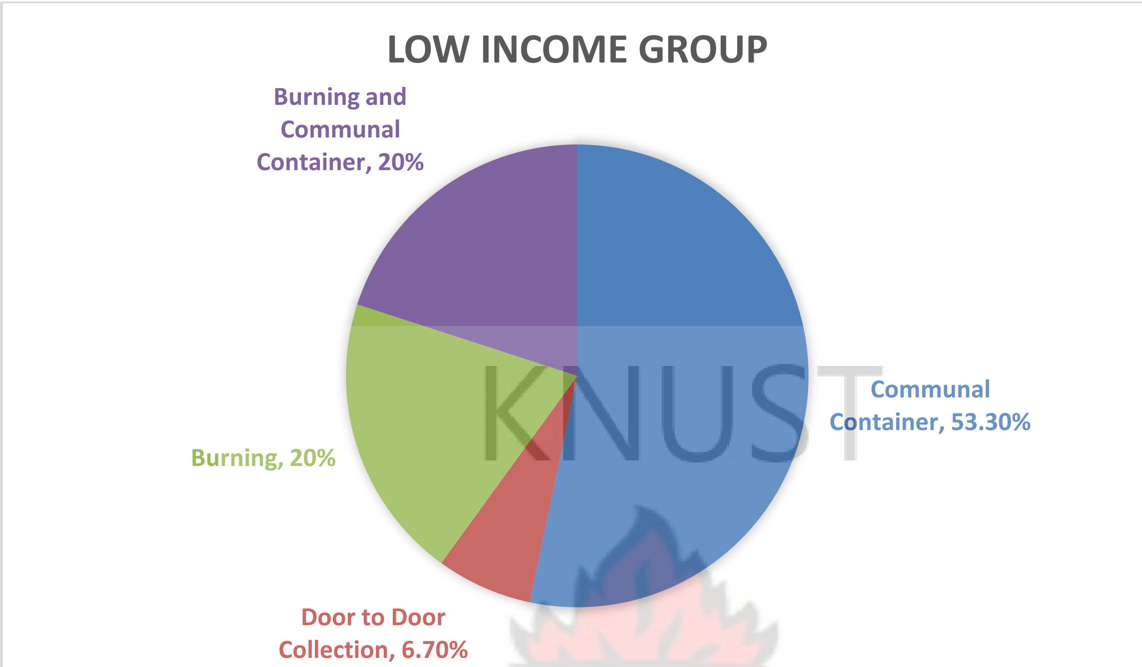
Some households refused to participate because they had busy schedules and could not get time to segregate their waste.

4.1.3 Mode of disposal of household waste.

The mode of disposal of household solid waste in both income group levels is represented in the figures below.

The study showed that 53.3% of the households in the low income used the communal container under the PAYT system whiles 6% used door to door collection. Significantly, 20% burned their waste whiles another 20% combined the communal container and burning. This confirms that communal container service which is supported by the local government remains the most utilized means of household waste disposal.

Figure 4.1: Mode of solid waste disposal in low income community



However, of concern is the rate at which waste burning as a means of solid waste disposal in low income communities. Field data by Fiafor (2010), in his study "effects of waste management on local governments' revenue: a case of Assin North Municipal Assembly" revealed that 5.8% of the people burned solid waste discounting the public health effects through release of poisonous gases. Adepoju and Salimonu (2010), reported that 37.5% of their study households in Osun State, Nigeria burned their waste.

The 20% rate of waste burning recorded in this study could be attributed to the long distance between some households and the communal container sites which shows that communal container allocations may be inadequate. Economic reasons could also be attributed to the decision of some households to use both burning and the communal container. The implications of this observation are that, aside public health issues, waste resources which could otherwise have been recovered are totally lost.

The middle income group in the study area recorded a 100% disposal by Door to Door Collection. This is attributed to the fact that the particular community consisted of blocks of government flats which is influenced by higher authority with respect to the solid waste management practices. The 100% door to door rate shows the contributions of the private sector to solid waste management in Kumasi since they provide these services.

4.1.4 Level of Satisfaction with Current SWM

Households were asked about their level of satisfaction with the current waste situations in their respective communities. Over 80% of the respondents in both income groups were dissatisfied with solid waste situations in their communities citing reasons ranging from high cost of disposing of waste to the stench caused by late collection of solid wastes.

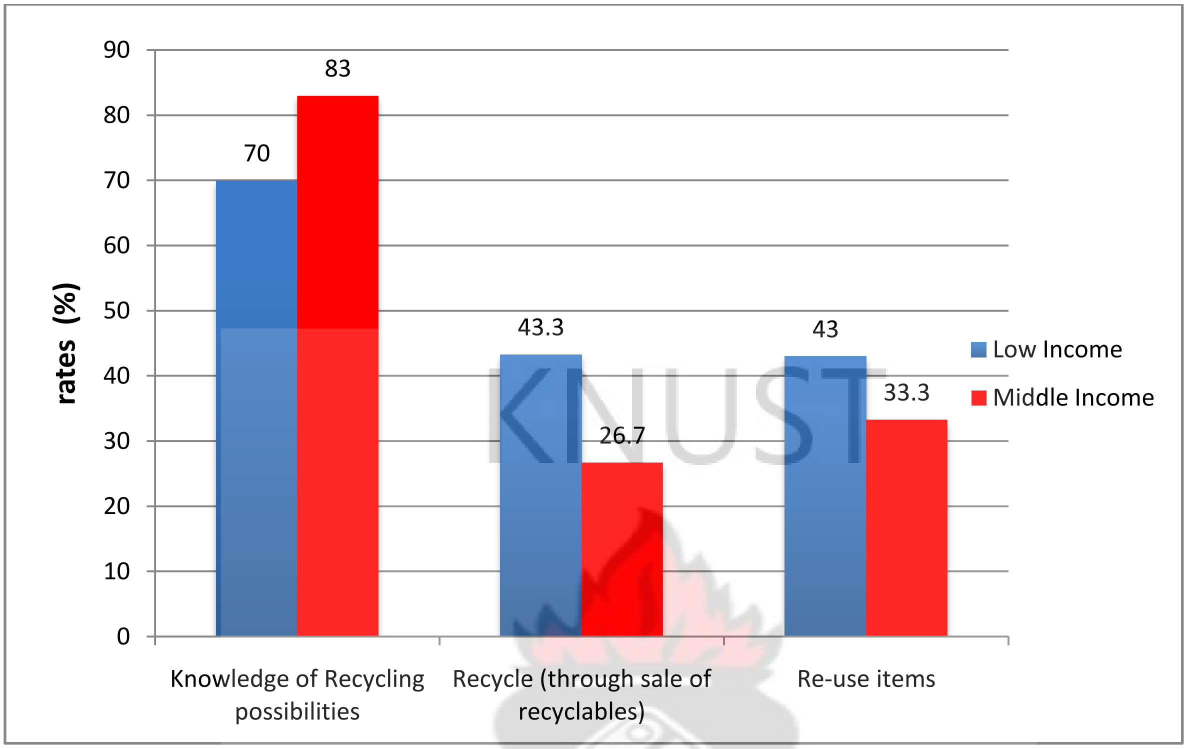
4.1.5 Solid Waste Recycling and Re-Use

The current solid waste recycling and re-use activities, items recycled and where recyclables went from the households under study were considered.

4.1.5.1 Current Recycling and Re-Use Activities

Figure 4.2 presents results of respondents current recycling and waste re-use activities. The results show that knowledge about recycling possibilities with respect to whether the respondents knew of the possibility to recycle solid waste was high in both low and middle income group levels at 70% and 83 % respectively. However, less than 50% of the respondents in both income group levels either participated in recycling through sale of the recyclables in their waste stream or re-used their items.

Figure 4.2: Current waste recycling and re-use activities of households



This implies that despite knowledge about the environmental and economic benefits of recycling, there is low rate of recycling because there are no organized and effective recycling programmes in operation and informal sector recycling largely remains the active source of recycling in Ghana. This is confirmed by the fact that only 2% of the solid waste generated in Accra, the capital of Ghana is recycled in a recycling facility (Global Project,- Accra as cited by Thompson, 2010).

4.1.5.2 Common Recyclables

The common recyclables normally set aside for sale by households are presented as follows:

Table 4.1: Common recyclables set aside by household

LOW INCOME	Plastics	Aluminium Cans	Sachet Water polythene bags	Paper	Metals
MIDDLE INCOME	Plastics	Aluminium Cans	Glass Bottles	Paper	Metals

Plastics, papers, metals and aluminium cans were common recyclables set aside for sale in both income groups levels whiles the sachet water polythene was commonly stored for sale in the low income. The great purchasing power of the middle income group to buy and also discard confirms why glass bottles were set aside for sale by most people in the group. This is consistent with the study by Agarwal et al., (2004), which marked plastics, paper, glass, aluminium cans and other metals as the commonest recyclables in developing countries.

4.1.5.3 Buyers of Household Recyclables

The results of the survey show that households in the low and middle income levels who set aside recyclables sell them to itinerant waste buyers who go door to door. This re-affirms the contribution of the informal recycling sector to the realization of the economic and environmental benefits of recycling in developing countries as confirmed by Medina (2008).

4.1.5.4 Obstacles to Source Separation and Recycling

The respondents in the survey were asked of conditions which will prevent them from participating in source separation and recycling programmes. The responses are presented in the table 4.2 below.

Table 4.2: Households perceived barriers to source separation

OBSTACLES	LOW INCOME (%)		MIDDLE INCOME (%)	
	YES	NO	YES	NO
Knows about it	70	30	83.3	16.7
Need more information	53.3	46.7	46.7	53.3
Fits into daily routine	53.3	46.7	46/7	63.3
Too busy	30	70	63.3	36.7
Enough space	6.7	93.3	16.7	83.3

Prominent amongst the responses was the lack of space to store separated waste in their different categories. About 83.3% of middle income respondents were concerned with practicality of such programmes in the sense that their flats are not big enough to introduce several waste storage containers, so there may be storage problems. Most of the low income lived in compound houses where space was difficult to come by and this was confirmed by the 93.3% response with respect to lack of space. Less than 35% of the respondents on average did not have knowledge about solid waste recycling possibilities whiles over 45% will need more information since they were unsure what exactly they will be expected to do and exactly which materials are to go in which receptacle. Over 30% of respondents in both income groups acknowledged that their busy schedules with work means recycling activities would not fit into their normal routines. Recycling their household solid waste is not regularized into daily household routines so it is not carried out automatically and they might forget to separate at source. Studies done by Hornik et al., (1995) have shown that time, effort and convenience related to recycling are major barriers to its facilitation. Understanding what discourages people from recycling is an important step towards increasing future participation.

4.1.5.5 Incentives to Source Separate and Recycle

The respondents were also asked about what they thought would motivate them to participate in a source separation and recycling programme.

Table 4.3: Households perceived incentives to source separation

INCENTIVE	LOW INCOME (%)		MIDDLE INCOME (%)	
	YES	NO	YES	NO
More Bins	90	10	73.3	26.7
Financial Incentives	90	10	86.7	13.3
Government Guidelines	66.7	33.3	83.3	16.7
Mass Education	83.3	16.7	83.3	16.7
No Incentive	10	90	10	90

Respondents in both income groups admitted that incentives ranging from financial to mass education could facilitate their participation in any source separation programme. Over 70% of respondents confirmed that multiple bins are necessary in order to help them sort separate waste recognizing the need to sort the waste into different categories to avoid contamination.

About 90% of low income respondents suggested that financial incentives such as waiving waste disposal fees in the pay as you throw system will be a source of motivation whiles 86.7% from the middle income suggested financial incentives such as reduction in monthly disposal fees in order to participate in such programmes. The downfall of financial incentives is the short term effects it has on recycling behaviour because as soon as the incentive is taken away recycling and source separation efforts reduce (Purdon et al., 2010).

Over 60% of respondents in both groups suggested clear guidelines from government in order to participate in source separation and recycling programmes. This they believed would assure them of the commitment of the authorities towards the success of such programmes.

Meanwhile, about 83.3% of respondents thought mass education will aid in the success of any recycling programme. Comments regarding recycling education provided a clear message that education was needed, and that it should be clear, concise and cogently offered to the households. Only 10% of the households were willing to source separate without any incentive mainly based on their concern for the environment.

4.1.6 Willingness to Separate Household Waste at Source

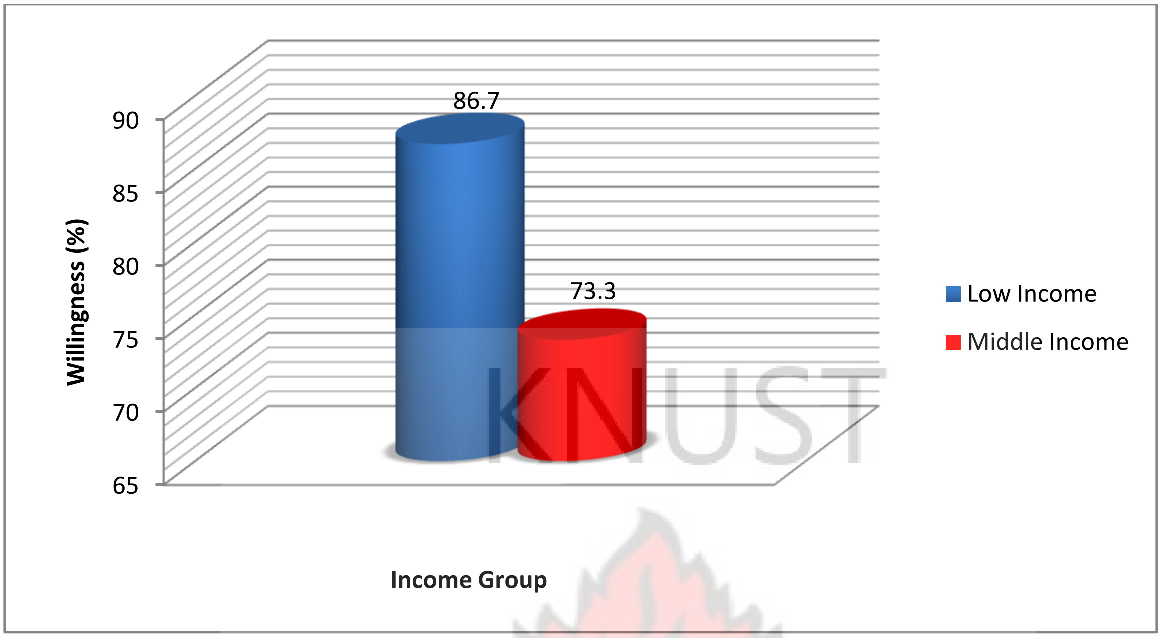
The willingness of households to separate waste at source was defined as:

$$\text{Willingness} = \frac{\text{No. of households willing to separate household waste at source}}{\text{Total no. of households}} \times 100$$

Equation 4.1

The willingness of households to separate waste at source was assessed and presented in the figure 4.3 below. The results show that 73.3 % and 86.7 % for the low and middle income groups respectively were willing to separate their waste at source. This is consistent with research by Asase and Oduro-Kwarteng (2010), who recorded that over 70% of respondents in their study area were willing to separate their household waste at source. The results from other researchers have also confirmed the high willingness to separate household waste in Ghana (Danso et al., 2003; Asante, 2008; Dagadu, 2005 as cited by Asase and Oduro-Kwarteng, 2010).

Figure 4.3: Willingness of households to source separate household waste



4.1.7 Set out Rate for Source Separation.

The set of rate for this study has been defined as:

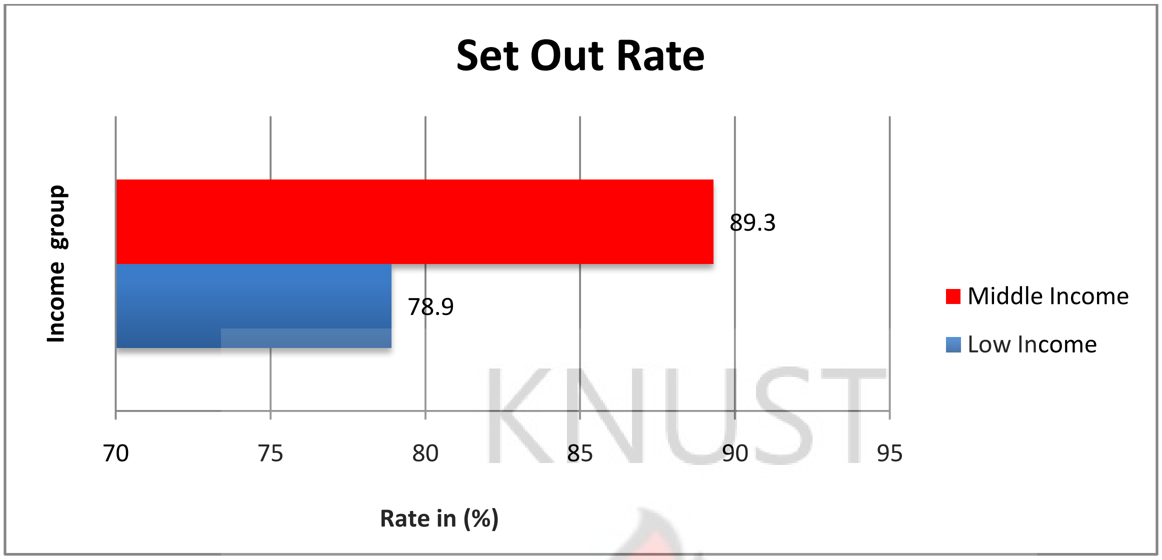
$$\text{Set out rate} = \frac{\text{No. of households segregating their waste into designated bags}}{\text{Total no. of households}} \times 100$$

Equation 4.2

The figure 4.5 shows the average set out rate over the study period for both study income level groups.

The set out rate for the study was 78.9% and 89.4% for the low and middle income groups respectively. This outlines the number of households who showed willingness to source separate and actually participated in the source separation. The set out rate has a bearing on the success rate of any recycling activity since that is also dictated by the number of households or people participating.

Figure 4.4: Set out rate of households towards source separation of household waste



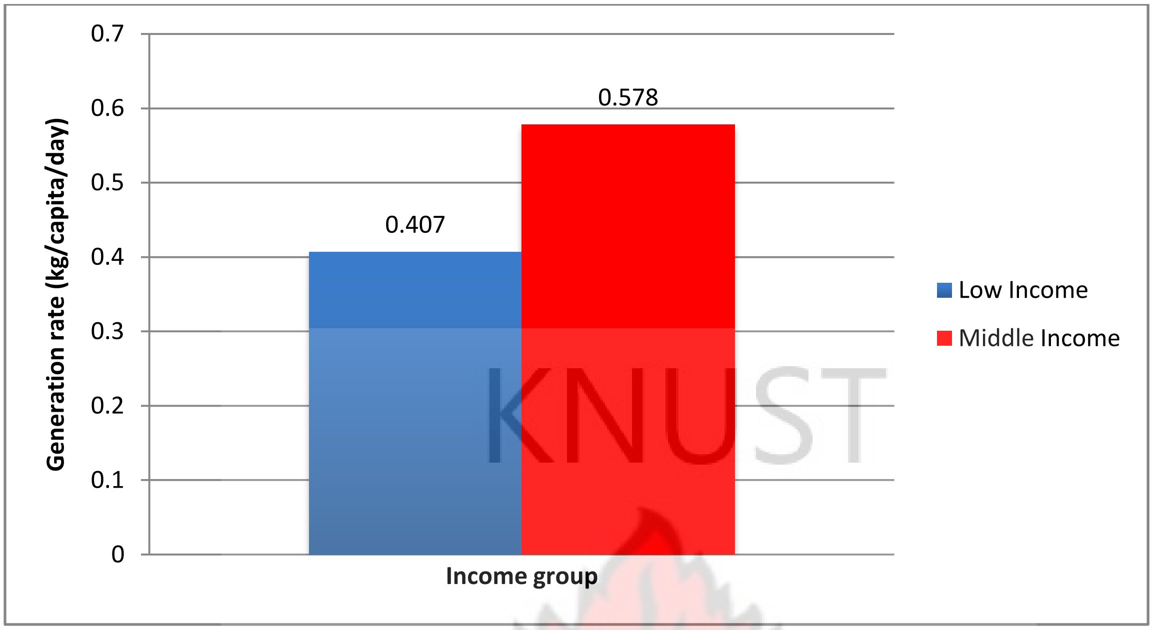
4.2 Household Solid Waste Characterization

The per capita generation rate, bulk density as well as the waste compositions and variations were some of the physical characteristics taken into account.

4.2.1 Per capita generation rate

The solid waste generation rate in kg/capita/day is presented in figure 4.5 below for the low and middle income level groups. The rate of generation of solid waste was 0.41 kg/per capita/day in the low income community whiles the middle income community recorded a generation rate of 0.58 kg/per capita/ day. Comparison of waste generated in developing countries recorded a range of 0.4–0.6 kg/person/day (Chandrappa and Das, 2012) and the values obtained in this research fall within this range.

Figure 4.5: Waste generation rates (kg/capita/day) of income groups

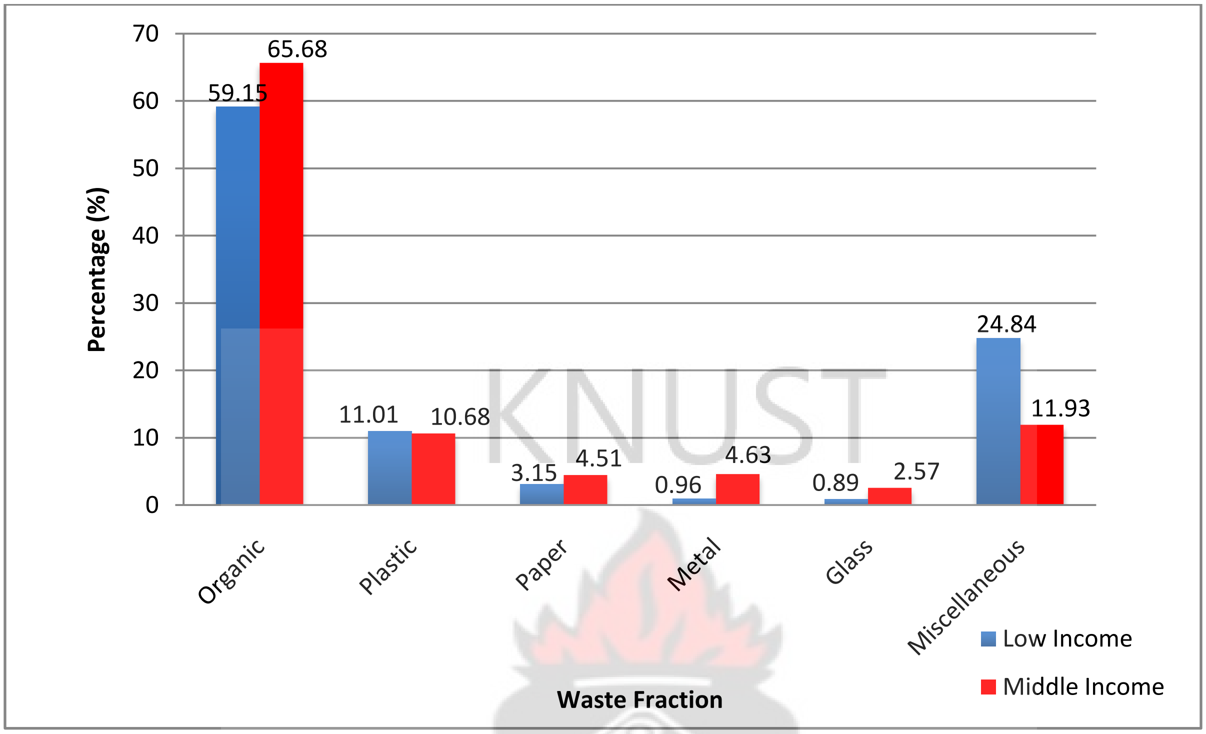


The variation in generation rates between the income groups shows that rate of generation of waste is influenced by the level of household income. This can be attributed to the relatively low standard of living in the lower income level since the quantities of waste generated rise with increase in the consumption of goods and services which correlates with the household disposable income level (Hoornweg and Bhada-Tata ,2012).

4.2.2 Waste composition and variations

The components of the waste generated were sorted manually and the results of the waste composition by household income levels are presented in Figure 4.6. The figure summarizes in percentages the 6 main fractions characterized.

Figure 4.6: Waste composition in the low and middle income group levels



In this study, the main fractions recorded are organic (59.15%, 65.68%), miscellaneous (24.84%, 11.93%), plastics (11.01%, 10.68%) for the respective low and middle income groups. The study shows that organic waste is the highest component of household waste in the study areas and this is consistent with other studies on household waste composition in Ghana and other developing countries. The average percentage of organic waste in the middle income group is similar to figures obtained by Mensah (2010), whiles other research show that 60–70 % of household waste from Ghana is organic (Carboo et al., 2006; Fobil et al.,2002; Hogarh et al.,2008).

The study showed lower organic percentage at the lower income group compared to the middle income group and this could be attributed to diversion of organic waste in low income areas to serve as feed for livestock.

Miscellaneous waste was defined by this study to include inert materials like sand and ash along with other components like wood, textiles and wigs. The 24.84% recorded for low income group could be due to the use of traditional cooking systems like coal pots which generate great amount of ash as well as sweeping of unpaved compounds which add soil particles to the waste stream. This is however lower than the 36% recorded by Mensah (2010) and the 34% recorded by Ketibuah et al., (2004) though this can be explained by the improved living standards over the years which has brought about modern systems of cooking including gas stove. The miscellaneous average for the middle income was however consistent with what was obtained by Mensah (2010).

Plastic waste generation in both groups was similar at 11.01% and 10.71% for the low and middle income levels respectively. This is close to the respective 8% and 10 % recorded by Mensah (2010) and shows a consistent rise in plastic waste since 1993 when an average of 4% as recorded by (Schweizer and Annoh, 1996) up to the year 2000 when (Fobil, 2000) recorded an average plastic composition of 8% largely due to the proliferated use of plastic polythene packaging . Plastics do not decompose and compact easily which is why it significantly affects transportation cost and landfill life.

The recorded averages for paper waste was 3.15% for low income and 4.51% for middle income and shows a significantly higher rate than the 2% recorded at both income levels by Ketibuah et al., (2004) as well as the 2.27% obtained by Kotoka (2001) which can be explained by increased use of paper packaging. Glass and metal waste were both recorded below 1.2% across all levels and this is consistent to the averages recorded by Kotoka (2001) and Ketibuah et al., (2004).

In general the variations in compositions in both income levels may be attributed to the differences in the living standard and lifestyle of the inhabitants of the two income groups.

4.2.3 Bulk Density of Solid Waste

The bulk densities of solid waste recorded in this study were 251.59 Kg/m^3 for low income level and 245.44kg/m^3 for the middle income level. The bulk density is important in the design of landfills as well as in the management of waste storage, collection and transport. The recorded values fall in range of (100-500) Kg/m^3 characteristics of low income countries according to WHO expert report (1982) as cited by Mensah (2010).

4.3 Source Separation Efficiency

The source separation efficiency in this study assesses the ability of participating households to correctly sort the waste components into their designated coloured bags. It is defined as the share of waste which has been correctly separated by households calculated based on the weight of waste in each bag (Asase and Oduro-Kwarteng, 2010).The results of the average separation efficiency of households over the study period in the two income groups are presented in Table 4.4.

Table 4.4: Separation Efficiency for the source separated wastes

SEPARATION EFFICIENCY			
	BLACK BAG (ORGANICS)	**WHITE BAG (PAPER &PLASTICS)**	**YELLOW BAG (“OTHERS”)**
LOW INCOME	73.17% organics	64.54% p&p	69.89% “ others”
	26.83% impurity	25.46% impurity	30.11% impurity
MIDDLE INCOME	82.89 % organics	67.58% p&p	79.55% “others”
	17.11% impurity	22.42% impurity	20.45% impurity

The results as observed from table shows that separation efficiencies for all categories were higher in the middle income group than the low income group. However, in both groups, we can note that separation efficiency was highest in the organic components in the low and middle income groups respectively at (73% and 82%) followed by “other” wastes with separation efficiency at (69% and 79%) with the plastics and papers components having the least separation efficiency at (64% and 67%) .This is consistent with previous research by Asase and Oduro-Kwarteng (2010), who investigated the source separation efficiency of households participating in a pilot project in Kumasi where they reported the highest separation efficiency in the organic component followed by other wastes and the least separation efficiency being recorded in the plastic component.

It can be anticipated from the high organic separation efficiency that if separately collected could lead to high recovery of organic waste. The higher separation efficiencies of over 70%, 60% and 69% for the organic, papers and plastics and other wastes respectively in this research compared to the over 50%, 30% and 50% respectively achieved by Asase and Oduro-Kwarteng (2010), can be attributed to the fact that, participating households where available, were re-educated each day on the sorting procedures. This underlines the effect more education could have on improving source separation programmes.

4.4 Recycling Potential and Solid Waste Treatment Options

A major highlight of this research is to assess the compositions of household wastes which are currently sent to the landfill but could have been diverted through other recovery options.

4.4.1 Recycling Potential and Re-Use

Source separation of solid waste ensures that wastes are kept clean for recovery purposes. The plastic compositions in this study were 10.95% and 10.71% for the low and middle income groups respectively whiles paper was 3.06% and 4.54% respectively. The separation efficiency of over 60% for the plastic and papers components shows that about 60% of the papers and plastics if not contaminated can be potentially diverted from the waste stream through re-cycling and re-use. The respective compositions of glass and metals was 2.61% and 4.67% for the middle income group whiles the low income recorded 0.86% and 0.95% of glass and metals respectively. Despite the lower compositions, the separation efficiency of over 69% means significant recovery could be made if uncontaminated.

The recovered plastics could be re-used or recycled to produce materials like chairs, rubber sheets etc. This is significant to the lifespan of the landfill because of the bulky volume of plastics. Papers in all forms when cleanly recovered could be used to produce toilet rolls as well as other paper products (Mensah, 2010). Metals are used by companies as raw materials whiles glass are sold to construction companies (Asase and Oduro-Kwarteng, 2010).

This shows the significance of an effective source separation programme to enhance the recycling potential of recyclables and in the end help divert waste from landfills thereby increasing their lifespan.

4.4.2 Composting

The study recorded an average of over 60% organic waste by weight and this indicates the composting potential of the waste stream in study areas. The sorting efficiencies were highest for the organic components with over 70% for both low and middle income groups. This shows that an effective source separation programme could help recover majority of the organic waste in the waste stream. Previous research by Mensah (2010), also show that the C/N ratios and moisture contents of organic wastes produced in the Kumasi Metropolis fall within the optimal ranges needed for composting.

4.4.3 Landfilling

Miscellaneous wastes which cannot be recovered for re-use, recycling or composting can be land filled. From the study, miscellaneous wastes, averages 18.4% and this will be significantly lower than the initial scenario where all of the household solid waste generated will have ended up at the landfill site thereby helping prolong the lifespan of the landfill.

4.5 Mathematical Modelling of Household Waste Generation Rate

Mathematical models were developed to predict the per capita generation rate of solid waste using household size as the independent variable in a bivariate regression analysis. Two models each were developed for the low and middle income groups after which the most statistically significant model was chosen.

4.5.1 Scatter Plots for Low and Middle income groups: Generation rate per capita vs. household size

Scatter plots of the field data in figure 4.7 and figure 4.8 for the low and middle income groups respectively showed a negative linear relation between household waste generation rate per capita and the household size which presupposes that the generation rate per capita decreases with increasing household size. This is confirmed by previous research work which recorded decreasing household generation rates per capita with increasing household size as a result of economies of scale in the consumption of goods and packaging in low income countries (Abu-qdais et al., 1997, as cited by Mbeng et al., 2012).

Figure 4.7: Scatter plot of waste generation vs. household size for low income

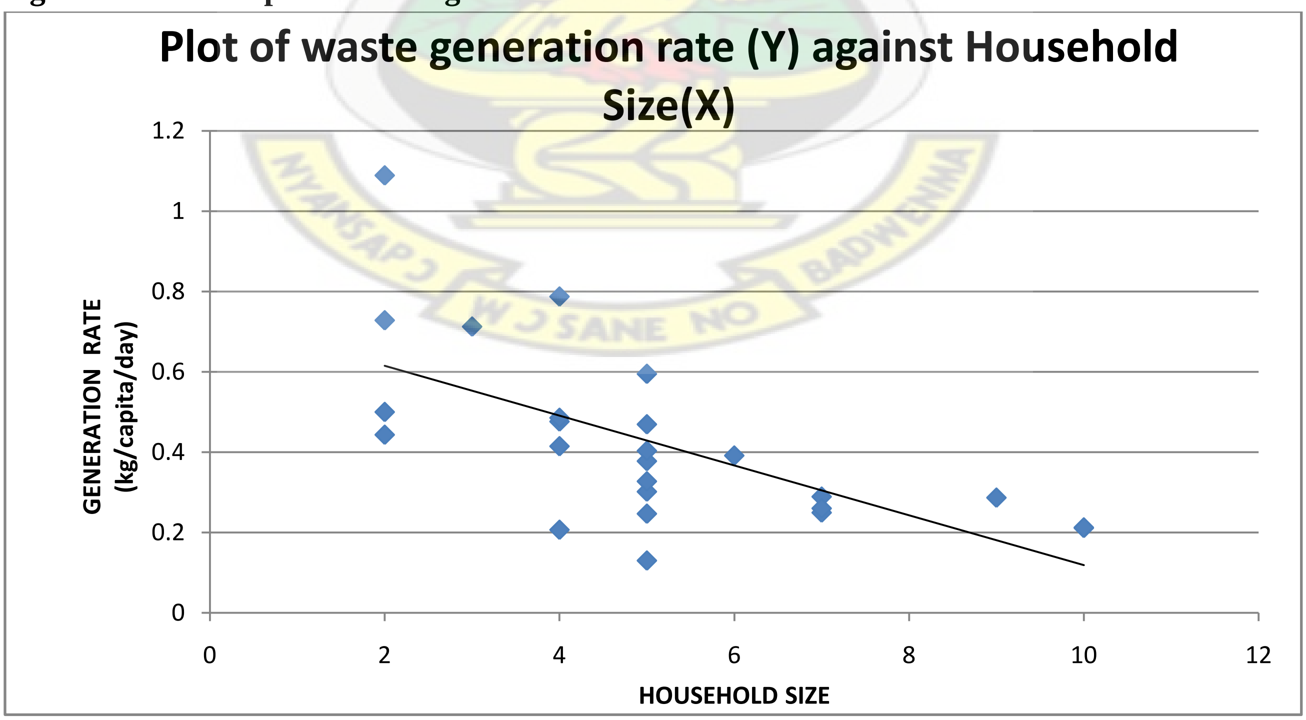
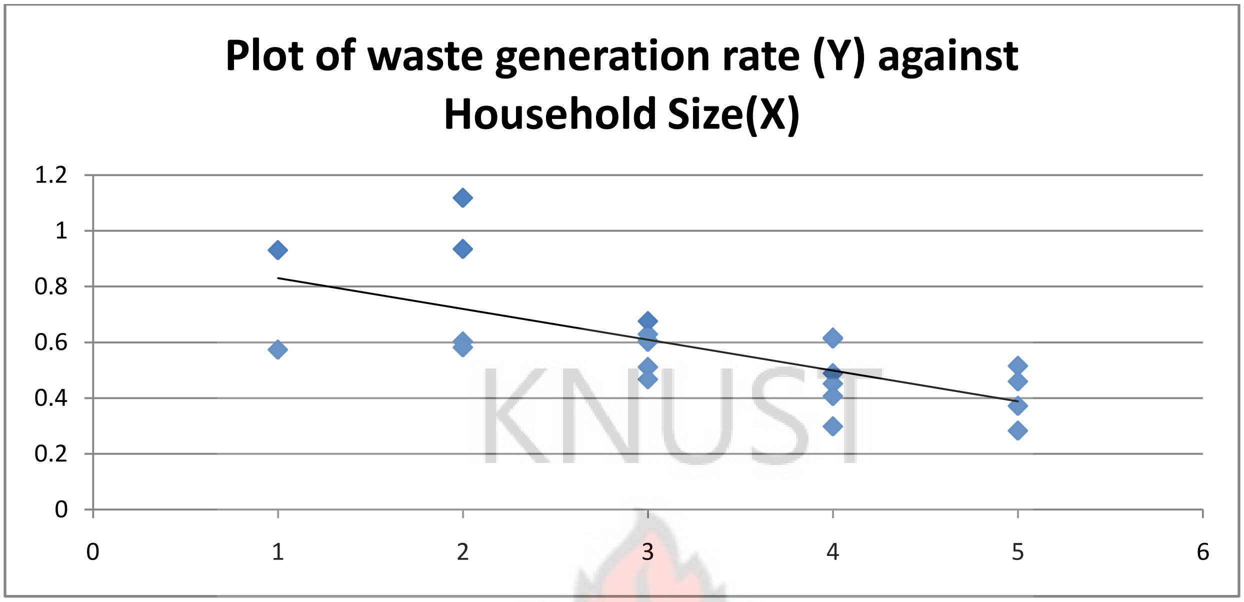


Figure 4.8: Scatter plot of waste generation vs. household size for middle income



4.5.2 Predictive Models for Household Per Capita Generation Rates

Data from the summary outputs in table 4.5 and table 4.6 for the low income and middle income groups respectively were used to explain the models developed to predict the per capita generation rate using the household size as the independent variable.

From the low income model (y = -0.062x + 0.7386), r^2 value which is a measure of the extent to which the total variation of the dependent variable is explained by the regression (Sykes, 1992) is 0.405, which means the prediction model explained about 41% of the entire regression. The model gave us a P value of 0.000619 which is less than 0.05 working with an alpha value of 95% confidence interval.

The middle income model (y = -0.1106x + 0.941), gave an r^2 value of 0.463 which means it explained almost 50% of the entire regression whiles p value was recorded as 0.000484 which is less than 0.05 working with an alpha value of 95% confidence interval making the model statistically significant.

Previous work shows that a model was too poor to make a prediction if the r^2 value explains less than 35% of the entire regression (Mendenhall 1990. as cited by Thanh et al 2010). The predictive models chosen for both income groups explained 41% and 46% for the low and middle income groups regressions respectively hence deemed statistically good enough to make a prediction of the generation rate per capita per day using the household size as the independent variable.

The predictive model for the low income is written as:

$y = -0.062x + 0.7386$ **Equation 4.3**

The predictive model for the middle income is written as:

$y = -0.1106x + 0.941$ **Equation 4.4**

Where:

y is the dependent variable (generation rate /capita /Kg)

x is the independent variable (household size)

Table 4.5: Regression Statistics for Low Income Model

Multiple R	0.636829
R Square	0.405
Adjusted R Square	0.379705
Standard Error	0.174047
Intercept	0.73855
Significance at 95%	0.000619
Observations	26

Table 4.6: Regression Statistics for Middle Income Model

Multiple R	**0.681058**
R Square	0.463839
Adjusted R Square	0.437031
Standard Error	0.151316
Intercept	0.940955
Significance at 95%	0.000484
Observations	22

4.5.3 Linear Regression Plots for predictive models.

Line fit plots for the predictive models in the low and middle income groups in figure 4.9 and figure 4.10 showed a positive correlation between the generation rate per capita and the household size hence household size significantly influenced the generation rate per capita.

Mbeng et al., found a statistically significant but weak positive relationship (r^2 = 015) in low income areas and a strong positive relationship (r2 = 0.26) in middle income areas between waste generation and household size in Limbe, Cameroon.

The result from this study is consistent with previous research which confirms that household size contributes significantly to variations in per capita generation rate (Mohd.Yusof et al., 2002). In order to increase the models' level of reliability, more independent variables should be added, which however were not included in this study.

Figure 4.9: Line fit plot of predictive model for Low income

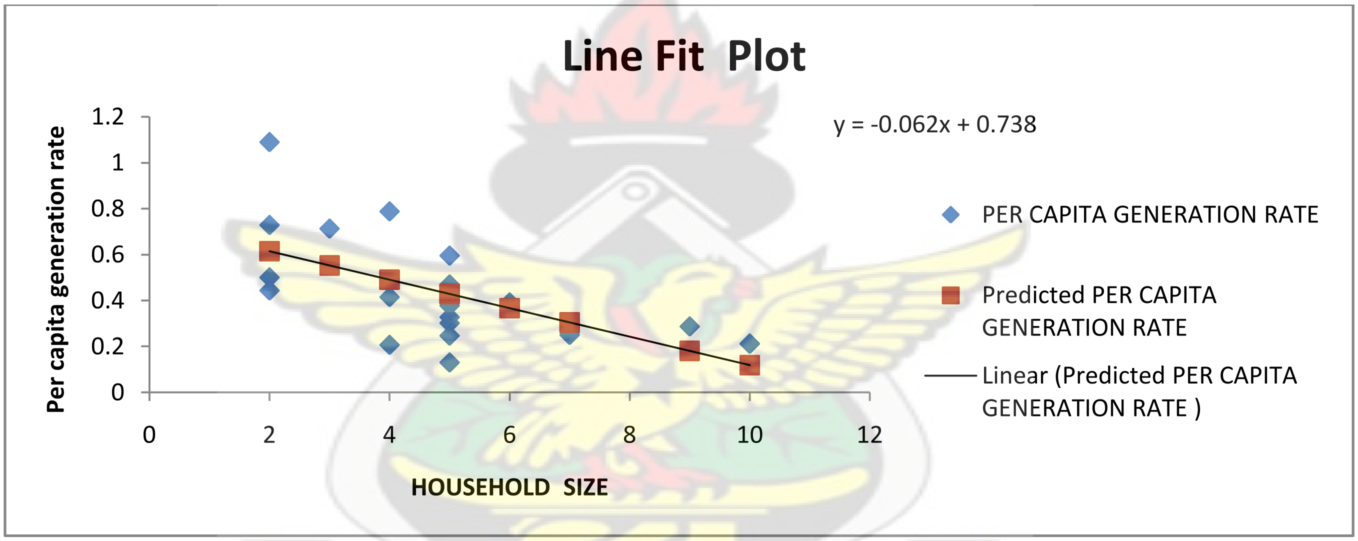
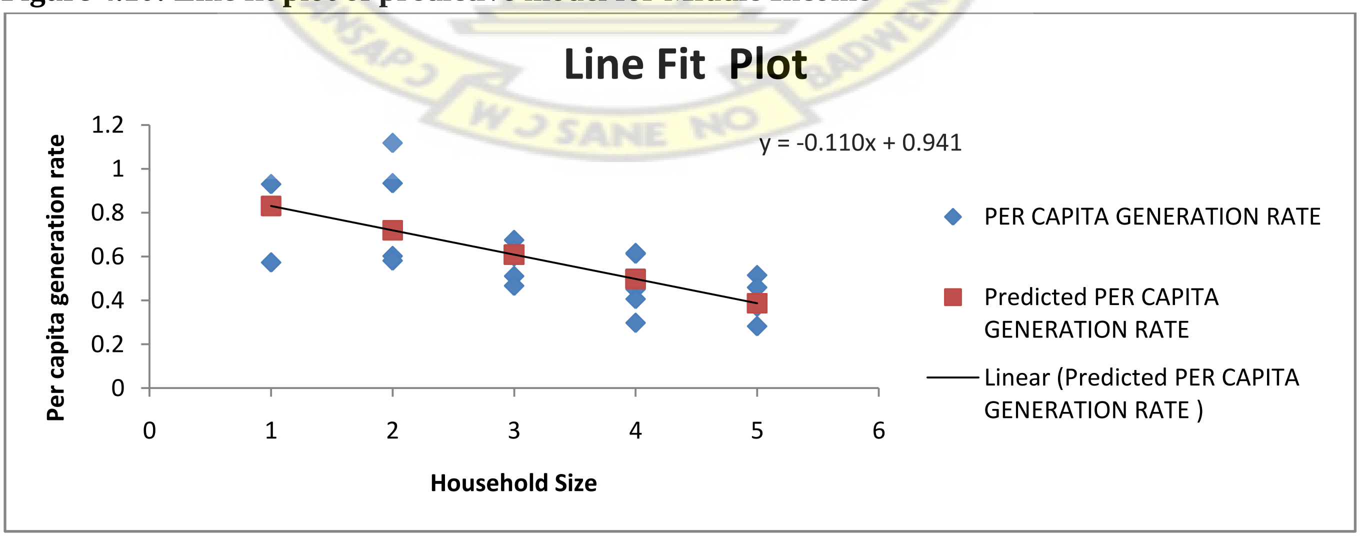


Figure 4.10: Line fit plot of predictive model for Middle Income



5. CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

1. The study highlighted the fact that households are not entirely satisfied with current solid waste management in their communities and this is supported by their high willingness to source separate waste (low income, 73% and middle income, 86%) as a facilitator for other solid waste treatment options. Households had knowledge of solid waste recycling possibilities but the absence of organized arrangements for recycling meant they hardly contributed.
2. The solid waste generation rates were 0.407kg/capita/day and 0.578kg/capita/day for low and middle income groups respectively. The bulk densities of solid waste generated were 251.59 Kg/m^3 for low income level and $245.44kg/m^3$ for the middle income level .The differences in generation rates show that income levels influence solid waste generation as a result of differences in consumption patterns. The main fractions of solid waste characterized in the low income area included organics (59.15%), plastics (11.01%), papers (3.15%), glass (0.89%), metals (0.96%) and others (24.84%). The main fractions of solid waste characterized in the middle income area included organics (65.68%), plastics (10.68%), papers (4.51%), glass (2.57%), metals (4.63%) and miscellaneous (11.93%). The highest fractions in both income groups were organic.
3. The constant education of households on separation methodology influenced the separation efficiencies. The best separated component was the organic component (over 70%) followed by “others” (over 69%) and last, the plastics and papers components” (60%). This showed effective source separation programme significantly enhances the recycling potential of

recyclables in the waste stream whiles the high organic separation efficiencies could help recover majority of the organic waste in the waste stream for composting purposes.

4. The predictive models were statistically significant and showed a positive correlation between the generation rate per capita and the household size which means household size significantly influenced waste generation and could be used to predict the average generation rate per capita.

5.2 Recommendations

The following recommendations have been made as a result of the research findings and relevant conclusions.

1. Source separation of solid waste is recommended in order to produce uncontaminated raw waste materials for the purposes of waste recovery and the public should be well educated on separation methodology in order to improve separation efficiencies.
2. The Kumasi metropolis can prolong the lifespan of the existing landfill through recycling and composting by initiating arrangements for organized solid waste recycling arrangements and improving composting efforts.
3. Further research should be conducted into how waste generation is influenced by other social, cultural and economic factors in order to improve the statistical significance of models as a means of predicting waste generation.

REFERENCES

1. Adepoju, A. A., Salimonu, K.K. (2010): Household willingness to pay for improved solid waste management in Osun state, Nigeria. http://www.appropriatetech.net/files/HOUSEHOLD_WILLINGNESS_TO_PAY_FOR_IMPROVED_SOLID_WASTE_MANAGEMENT_IN_OSUN_STAT1.pdf. Accessed 10/03/2013
2. Adogame, L. (2009):"Toward Enhanced Public- Private Partnership in Solid Waste Management in Lagos State", Paper presented at the workshop on effective solid waste management, Lagos Airport Hotel, Ikeja, Nigeria.
3. ADB (2002): Study on Solid Waste Management Options for Africa, pp. 15.
4. Agarwal A., Singhmar M. K., Mittal A.K. (2004): Municipal solid waste recycling and associated markets in Delhi, India. ***Resources, Conservation and Recycling 44 (2005) 73-90.***
5. Annepu R. K. (2012): Sustainable Solid Waste Management in India. http://www.seas.columbia.edu/earth/wtert/sofos/Sustainable%20Solid%20Waste%20Management%20in%20India_Final.pdf Accessed 27/05/2012.
6. Al-Salem, S.M., P. Lettieri, J. Baeyens (2009): Recycling and recovery routes of plastic solid waste (PSW): A review. ***Waste Management 29 (2009) 2625–2643***.
7. Asase, M.A.D., Oduro-Kwarteng S., (2010): Potential for source separation of municipal solid waste: Case study of Ghana.
8. Asase, M.A.D., Oduro-Kwarteng S., (2010): Source Separation Efficiency and Level of Compliance by Households Participating in Pilot Project in Kumasi.
9. Bennagen, E. C., G. Nepomuceno, C. Ramil. (2002): Solid waste segregation and recycling in Metro Manila: Households' attitude and behavior. Resource, Environment and Economic Centre for Studies (REECS), Quezon City 1109, Philippines.

10. Bank of Ghana, (2007): The Housing Market Ghana.

http://www.bog.gov.gh/privatecontent/Research/Research%20Papers/bog%20housing.pdf

Accessed: 4/12/12

11. Bogner, J., M. Abdelrafie Ahmed, C. Diaz, A. Faaij, Q. Gao, S. Hashimoto, K. Mareckova, R. Pipatti, T. Zhang, (2007) : Waste Management, In Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panelon Climate Change [B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

12. Bin Yousuf,T., & Rahman, M.(2007): Monitoring quantity and characteristics of municipal solid waste in Dhaka City. ***Environ Monit Assess (2007) 135:3–11.***

13. Boorsman, P. (1994) : Privatization: Political and economic consideration. In: M.P. van Dijk, N.G. Schulte Nordholt (Eds.), Privatization experience in African and Asian countries, pp.17–34.Amsterdam.

14. Carboo D, Fobil JN (2006) : Physico-chemical analysis of municipal solid waste (MSW) in the Accra metropolis. West Africa J Appl Ecol.

15. Chandrappa, R., Das. D.B., (2012): Solid Waste Management, Environmental Science and Engineering, DOI: 10.1007/978-3-642-28681-0_2.

16. Coad, A. (2006): Solid waste, health and the millennium development goals. Report of the CWG-WASH workshop, Kolkata, India.

17. Cointreau, S.J., M. de Kadt, (1991): Living With Garbage: Cities Learn to Recycle. Development Forum, January-February.

18. DEFRA, (2011): Guidance on applying the Waste Hierarchy. http://www.defra.gov.uk/publications/files/pb13530-waste-hierarchy-guidance.pdf Accessed 26/11/12

19. DEFRA, (2011): http://www.defra.gov.uk/environment/waste/legislation/waste-hierarchy/Accessed: 26/11/12

20. De Vega C.A., Benitez S.O., Barreto, E.R. (2008): Solid waste characterization and recycling potential for a university campus*. Waste management 28 (2008) 521-526.*

21. Diaz, Luis F. (2012) : The 3Rs as the Basis for Sustainable Waste Management: Moving Towards Zero Waste http://www.uncrd.or.jp/env/spc/docs/3rd_3r/Keynote%20Address%20for%20the%203rd%20Regional%203R%20Forum_Luiz%20Diaz.pdf Accessed: 12/4/2012

22. Ekins,P., Simon,S., Deutsch,L., Folke,C., deGroot,R.,(2003) : A framework for the practical application of the concepts of critical natural capital and strong sustainability. Ecological Economics 44,165–185.

23. Engledow, S., Eichestadt, L. (2007): Integrated Analysis Solid Waste Baseline Report. Unpublished report commissioned by the Sustainability Institute and funded by the United Nations Development Program. Resource Management Services.

24. Environmental Sanitation Policy (Revised 2010) :Ministry of Local Government and Rural Development. http://wcghana.com/reports/environmental_sanitation_policy_june_2010.pdf Accessed: 3/11/2012

25. Farmer, G., Staniewicz N., Michael, B., Wojcik A, Lim Y, Ivokovic D, Rajakulendran J. (1997): Audit of waste collected over one week from ten dental practices: a pilot study. ***Aust Dent J. Vol. 42(2), pp. 114–7.***

26. Fiafor, S.A (2010): Effects of waste management on local governments revenue: a case of Assin north municipal assembly. http://ir.ucc.edu.gh/dspace/bitstream/123456789/1075/1/FIAFOR%202010.pdf. Accessed 10/3/2013

27. Fobil,J.N., Carboo, D., Clement,C., (2002) : Defining options for integrated management of municipal solid waste in large cities in low income economies: the case of the Accra metropolis in Ghana. ***J Solid Waste Technol Manage 28(2):106–117***.

28. Fobil, J. N., (2000): Municipal Solid Waste Characterization for Integrated Management in the Accra Metropolis, (MSc. Thesis.), University of Ghana, Legon, Accra.

29. Furedy, C., (1992): Garbage: Exploring the Options in Asian Cities. ***Environment and Urbanization, Vol. 4(2), pp. 42-61.***

30. Furedy, C. (1990): Social aspects of solid waste recovery in Asian cities. Environmental Sanitation Reviews, no. 30. Bangkok, Thailand.

31. Furedy, C., Maclaren, V. (1990): Source Separation of Municipal Solid Wastes: A Framework for Comparative Analysis", by C Furedy and V Maclaren delivered at meeting of Association of American Geographers, Toronto.

32. Giegrich, J. and Vogt, R. (2004): The contribution of waste management to sustainable development in Germany. http://www.ifu.com/uploads/tx_ifureference/ifeu_abfallw_sonderteil_umwelt_BMU_engl.pdf Accessed 24/9/2012

33. GLFPSF (2005): Planning Land Use and Enforcing Mechanisms for Effective Management of Solid Waste Disposal in Urban and Rural Communities. Ghana Land and Forestry Policy Support Facility, March 2005.

34. Gonzenbach, B., Coad, A. (2007): Collaborative Working Group on Solid Waste Management in Low- and Middle-income Countries. http://www.cwgnet.net/documentation/skatdocumentation.2007-06-28.8568961372/file Accessed 24/9/12

35. Haukohl, J., Marxen, U., T.,Rand (2000), Municipal Solid Waste Incineration: Decision Maker's Guide. The World Bank, Washington DC.

36. Hogarh, J.N., Fobil, J.N., Ofosu-Budu, G.K., Carboo, D., Ankrah, N.A., Nyarko, A. (2008): Assessment of heavy metal contamination and macro-nutrient content of composts for environmental pollution control in Ghana***. Glob J Environ Res 2(3):133–139.***

37. Hornik, J. Cherian, J. Madanskey, M. Narayana, C. (1995) Determinants of recycling behaviour: A synthesis of research results, **Journal of Socio-Economics, 24, 1, 105-27**.

38. Hoornweg, D., P. Bhada-Tata. (2012): What a Waste: A Global Review of Solid Waste Management. Urban and Local Government Working Paper. World Bank.

39. IPCC (2007): CLIMATE CHANGE 2007, Synthesis report. http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr.pdf Accessed: 10/10/12

40. ISEB (2007): Sustainable Development and Waste Management. Vol. 13 No. 1. http://isebindia.com/05_08/07-01-1.html Accessed: 24/9/12

41. JICA (1999): Environmental policies and regulatory framework in Ghana.

42. Kaseva, M.E., Mbuligwe, S.E., Kassenga, G. (2002): Recycling in organic domestic solid wastes: results from a pilot study in Dar es Salaam City, Tanzania .***Resources, Conservation and Recycling. Vol. 35 pp. 243–257.***

43. Ketibuah, E., Asase,M., Yusif,S., Mensah,M.Y., Fischer,K.,(2004): Comparative analysis of household waste in the cities of Stuttgart and Kumasi,-option for waste recycling and treatment in Kumasi, Proceedings of the 19th international CODATA Conference ,Berlin 7-10,pp.1-8,

44. Kironde, J.M.L. (1999): Dares Salaam, Tanzania. Onibokun, A.G. (Ed). Managing the Monster. Urban Waste and Governance in Africa. Pp. 101-172. Ottawa, IDRC.

45. KMA (2006):http://www.kma.ghanadistricts.gov.gh/?arrow=atd&_=6&sa=5492 Accessed 27/05/2012.

46. KMA WMD (2010): Kumasi Metropolitan Assembly Waste Management Department:"Data for purposes of planning waste management intervention programmes" (Kumasi: WMD).

47. Kotoka, P. (2001): Physical analysis of solid waste in selected high income communities in Kumasi.Msc thesis report, K.N.U.S.T, pp. 21-44.

48. Kum, V., Sharp, A., Harnpornchai, N. (2005): Improving the solid waste management in Phnom Penh City: a strategic approach. ***Waste management. Vol. 25, pp. 626-637***.

49. Langenhoven, B., Dyssel, M. (2007): The recycling industry and subsistence waste collectors: a case study of Mitchell's plain. ***Urban Forum, Vol. 18(1), pp. 114–132***.

50. Mbeng, L.O., Phillips P. S., Fairweather, R. (2012) : Waste Characterization as an Element of Household Waste Management Operations: A Case Study in Limbe, Cameroon. ***The Open Waste Management Journal, 2012, 5, 49-58.***

51. McDougall, F.R., White, P., Franke M., & Hindle P. (2001) : Integrated Waste Management: A Life Cycle Inventory (2nd ed.). Blackwell Science, Oxford UK.

52. Medina, M. (2006): Achieving the MDGs through the informal recycling sector: a case study in Northern Mexico. Paper delivered at the CWG-WASHworkshop, 1–5February, 2006, Kolkata, India.

53. Medina, M. (2008): The informal recycling sector in developing countries .Organizing waste pickers to enhance their impact. https://www.ppiaf.org/sites/ppiaf.org/files/publication/Gridlines-44-Informal%20Recycling%20-%20MMedina.pdf Accessed, 10/2/13

54. Mensah, A.A. (2010): Physico-chemical characteristics of solid waste and management options. Msc.thesis report.pp.6-45.

55. MLGRD -EHSD (2010): National Environmental Sanitation Strategy and Action Plan (NESSAP). Draft Final.

56. MLGRD –ESP (2010): Environmental Sanitation Policy, Revised 2010. www.ecowrex.org/.../2010_environmental-sanitation-policy_ministry.htm Accessed: 12/02/2013.

57. Mohd.Yusof M.B., Othman F., Hashim N. & Ali, N.C. (2002). The role of socio-economic and cultural factors in municipal solid waste generation: A case study in Taman Perling, Johor Bahru. Jurnal Teknologi, 37(F) Dis. 2002: 55–64.

58. Morrissey, A.J., Browne, J. (2004): Waste Management Models and their Application to Sustainable Waste Management .***Waste Management Vol. 24; pp 297–308***.

59. Narayana, T. (2008): Municipal Solid Waste Management in India: From Waste Disposal to Recovery of Resources. ***Waste Management Vol. 29(3), pp. 1163 – 1166***.

60. NOAA (2007) : National Climatic Data Center site on Global Warming: http://www.ncdc.noaa.gov/oa/climate/globalwarming.html Accessed : 15/11/2011

61. OECD,(2010): Eurostat joint questionnaire on waste. http://unstats.un.org/unsd/environment/OECD_FAO%20questionnaires.htm.Accessed, 26/11/12

62. Oteng-Ababio, M. (2010): Private sector involvement in solid waste management in the Greater Accra Metropolitan Area in Ghana. ***Waste Management & Research, Vol. 28 pp 322–32.***

63. Pacione, M. (2005): Urban Geography. A Global Perspective. 2nd. Edition. London and New York. Routedge, Taylor & Francis Group.

64. Purdon,M. E., Man-San, M., Vandevooren,H., Bam, P. and Gomes,S.(2010). Analyzing and identifying barriers to recycling attitudes and behaviors of students in the south residence of the University of Guelph. http://www.pr.uoguelph.ca/sustain/docs/Why_Dont_Students_Recycle_South_Residence_2010.pdf Accessed : 15/03/2013.

65. Rekacewicz,Philippe(2012):UNEP/GRID-Arendal2012. http://www.grida.no/publications/vg/wasteACCESSED 11/26/12

66. Rondinelli,D.A., Berry,M.A.,(2000) : Environmental citizenship in multinational corporations : social responsibility and sustainable development. ***European Management Journal 18, 70–84.***

67. Schweizer F. and Annoh C. K. (1996): Privatization of Solid Waste Management in Ghana, Trialog 48: 50.

68. Sdap, (2010): Securing the Future for the Next Generation of Ghanaians. National Programme on Sustainable Consumption and Production (Scp) for Ghana (2011-2016), Vol. 2, Final Report, pp. 8-9.

69. Seik,F.T.,(1997).Recycling of domestic waste: early experiences in Singapore***. Habitat International 21,277–289.***

70. Simelane, T., R. Mohee (2012): Future Directions of Municipal Solid Waste Management in Africa.AISA POLICY brief Number 81 – September 2012.

71. Smith, A., K. Brown, S. Ogilvie, K. Rushton, J. Bates, (2001): Waste management options and climate change. Final Report ED21158R4.1 to the European Commission, DG Environment, AEA Technology, Oxfordshire, 205 pp.

72. Staniškis, J. (2005): Integrated Waste Management: Concept and Implementation. ***Environmental research, engineering and management, Vol. 3(33), pp. 40-46***.

73. Suchada, P., Trankker, J., Cholada, K. and Scholl, W. (2003) : The role of formal and informal sectors in solid waste management of developing countries. Proceedings Sardinia, Ninth International Waste Management and Landfill Symposium, Environmental Sanitary Engineering centre, Italy.

74. Sykes,A.O.(1992): An introduction to regression analysis. http://www.law.uchicago.edu/files/files/20.Sykes_.Regression.pdf. Accessed: 1/03/13

75. Thanh, N.P., Matsui, Y., Fujiwara, T. (2010): Household solid waste generation and characteristic in a Mekong Delta city, Vietnam. ***Journal of Environmental Management 91 (2010) 2307e2321.***

76. Thompson,I.A. (2010) :Domestic Waste Management Strategies in Accra, Ghana and Other Urban Cities in Tropical Developing Nations. http://www.cwru.edu/med/epidbio/mphp439/Waste_Mgmt_Accra.pdf Accessed, 13th June,2012.

77. Tinmaz,E.,Demir,I.,(2006) :Research on solid waste management system: to improve existing situation in Corlutown of Turkey. ***Waste Management 26, 307–314.***

78. Tsai,T.,(2008) :The impact of social capital on regional waste recycling. ***Sustainable Development 16, 44–55.***

79. Tsiboe, I. A., Marbell, E. (2004): A look at the urban waste disposal problems in Accra, Ghana. Unpublisehed masters' thesis. Roskilde University, Denmark.

80. UNCSD, (2012): Africa review report on waste management. http://www.uncsd2012.org/content/documents/AfricanReviewReport-onWasteManagementSummary.pdf Accessed: 27/05/2012.

81. UNDP, (1999) : Effective Solid Waste Management With The Participation Of Waste Producers, Report from, Calcutta UNDP-World Bank Water and Sanitation programme and Seventh Meeting Of The Urban Think Tank, January 1999).

82. UNEP, (2005): Selection, Design and Implementation of Economic Instruments in the Solid Waste Management Sector. http://www.unep.org/PDF/Kenya_waste_mngnt_sector/chapter1.pdf Accessed 14/11/2012.

83. UNEP, (2010): Trends in Solid Waste Management: Issues, Challenges and Opportunities .International Consultative Meeting on Expanding Waste Management Services in Developing Countries 18-19 March 2010 Tokyo, Japan.

84. UNEP, (2010): Waste and Climate change. Global trends and strategy framework. http://www.unep.or.jp/ietc/Publications/spc/Waste&ClimateChange/Waste&ClimateChange.pdf . Accessed 23/09/2012

85. UNEP, (2012) : http://www.unep.or.jp/ietc/estdir/pub/msw/ro/africa/topic_a.asp Accessed 30/11/2012

86. UNEP- DTIE, (2012): Regional Overviews and Information Sources Africa. Newsletter and Technical Publications Municipal Solid Waste Management .http://www.unep.or.jp/ietc/estdir/pub/msw/ro/africa/Topic_g.asp. Accessed, 25/07/2012.

87. UNEP- DTIE, (2012): UNEP DTIE IETC, Integrated Solid Waste Management Work Plan for 2012/ 2013. http://new.unep.org/gpwm/Portals/24123/images/Working%20group%20meeting/ISWM.pdf Accessed 21/11/2012.

88. UNEP-IETC, (1998): Source of Alternative Technologies for Freshwater Augmentation in Africa. Technical Publication Series, No. 8. Osaka/Shiga: UNEP International Environmental Technology Centre.

89. UN-Habitat, (2010): Solid waste in the world's cities. Third global report on water and sanitation in the world's cities, 2010.In A. Scheinberg, C.W. David, & L. Rodic (Eds.).Newcastle-on-Tyne, UK: Earthscan Publications.

90. UN-HABITAT, (2010): "Solid Waste Management in the World's Cities/Water & Sanitation in the World's Cities 2010", Malta.

91. UNESCAP,(2000):http://www.unescap.org/esd/environment/soe/2000/documents/CH08.PDF . Accessed 19/11/2012.

92. UNEP, (2004): What is waste - A multitude of approaches and definitions. http://www.grida.no/publications/vg/waste/page/2853.aspx accessed 2/10/2012.

93. US EPA, (2006): Solid Waste Management and greenhouse gases a life-cycle assessment of emissions and sinks page es-5.

94. US EPA, (2010): Recycling basics. http://www2.epa.gov/recycle/recycling-basics. Accessed: 10/9/12

95. Vergara, S. E., Tchobanoglous, G. (2012): Municipal Solid Waste and the Environment: A Global Perspective. Annu. Rev. ***Environ. Resourc. Vol. 37 pp. 277–309***.

96. WFD (2008): Guidance on the interpretation of key provisions of Directive 2008/98/EC on waste ...http://ec.europa.eu/environment/waste/framework/pdf/guidance_doc.pdf. Accessed.1/10.2012.

97. Wilson, D.C., Velis, C.,Cheeseman, C. (2006) :Role of informal sector recycling in waste management in developing countries. ***Habitat international, Elsevier, Vol. 30, pp. 797-808.***

98. WCED (1987): Our Common Future. Oxford: Oxford University Press. pp. 27. ISBN 019282080X.

99. World Bank (2012): Urban Solid Waste Management. http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTURBANDEVELOPMENT/EXTUSWM/0,,menuPK:463847~pagePK:149018~piPK:149093~theSitePK:463841,00.html (Accessed November 2012).

100. WRAP (2006): Environmental benefits of recycling, an international review of life cycle comparisons for key materials in the UK recycling sector. Waste and Resources Action Program, Peer reviewed report prepared by H. Wenzel *et al.*, Danish Technical University, published by WRAP, Banbury, Oxfordshire, England.

101. Yhdego, M. (1995): "Urban solid waste management in Tanzania Issues, concepts and challenges." ***Resource, Conservation and Research. Vol. 14, pp. 1-10.***

102. Yau, Yung (2010): Domestic waste recycling, collective action and economic incentive: The case in Hong Kong. ***Waste Management, Elsevier, Vol. 30, pp. 2440-2447.***

103. Zia, K.M., Bhatti, I. A. (2007): Methods for polyurethane and polyurethane composites, recycling and recovery. ***Reactive and Functional Polymers. Vol. 67(8), pp. 657-692***.

APPENDICES

Appendix A

HOUSEHOLD QUESTIONNAIRE: SOURCE SEPARATION AND CHARACTERIZATION OF SOLID WASTE IN KUMASI.

HOUSEHOLD NUMBER:
INCOME GROUP:
HOUSEHOLD SIZE:

QUESTIONS:

1. WHERE DOES YOUR SOLID WASTE GO ONCE IT LEAVES YOUR HOUSEHOLD?
   (i) COMMUNAL CONTAINER [ ]
   (ii) PRIVATE COLLECTION [ ]
   (iii) OTHER [……………………...]

2. WHAT IS YOUR LEVEL OF SATISFACTION WITH SOLID WASTE MANAGEMENT SERVICES IN YOUR COMMUNITY?
   (i) SATISFIED [ ]
   (ii) DISSATISFIED [ ]
   (iii) NO OPINION [ ]

3. DO YOU RE-USE ANY ITEMS?
   (i) YES [ ] . What Items? ………………
   (ii) NO [ ]

4. DO YOU KNOW ABOUT SOLID WASTE RECYCLING POSSIBLITIES?
   (i) YES [ ]
   (ii) NO [ ]

5. DO YOU RECYCLE IN ANYWAY?
   (i) YES [ ]
   (ii) NO [ ]

6. IF YES, WHAT DO YOU RECYCLE?

(i) PAPER/ CARDBOARD [ ]
(ii) CANS [ ]
(iii) METALS [ ]
(iv) GLASS [ ]

(v) PLASTIC BOTTLES [ ]
(vi) OTHERS […………………………]

7. WHERE DO YOU SEND YOUR RECOVERED RECYCLABLES?
   (i) ITINERANT WASTE BUYERS [ ]
   (ii) STREET PICKERS [ ]
   (iii) JUNK SHOPS [ ]

8. DO YOU GET PAID FOR RECYCLABLE MATERIALS?
   (i) YES [ ]
   (ii) NO [ ]

   IF YES, EXAMPLES OF PRICES OBTAINED FOR ANY THING RECYCLED
   …………………………………………..

9. WHAT DO YOU THINK ARE BARRIERS TO RECYCLING?
   (i) DON'T KNOW ABOUT IT [ ]
   (ii) NEED MORE INFORMATION [ ]
   (iii)DOES NOT FIT INTO DAILY ROUTINE [ ]
   (iv)TOO BUSY [ ]
   (v) NOT ENOUGH SPACE [ ]

10. DO YOU THINK IT IS IMPORTANT TO SOURCE SEPARATE WASTE?
    (i) YES [ ]
    (ii) NO [ ]

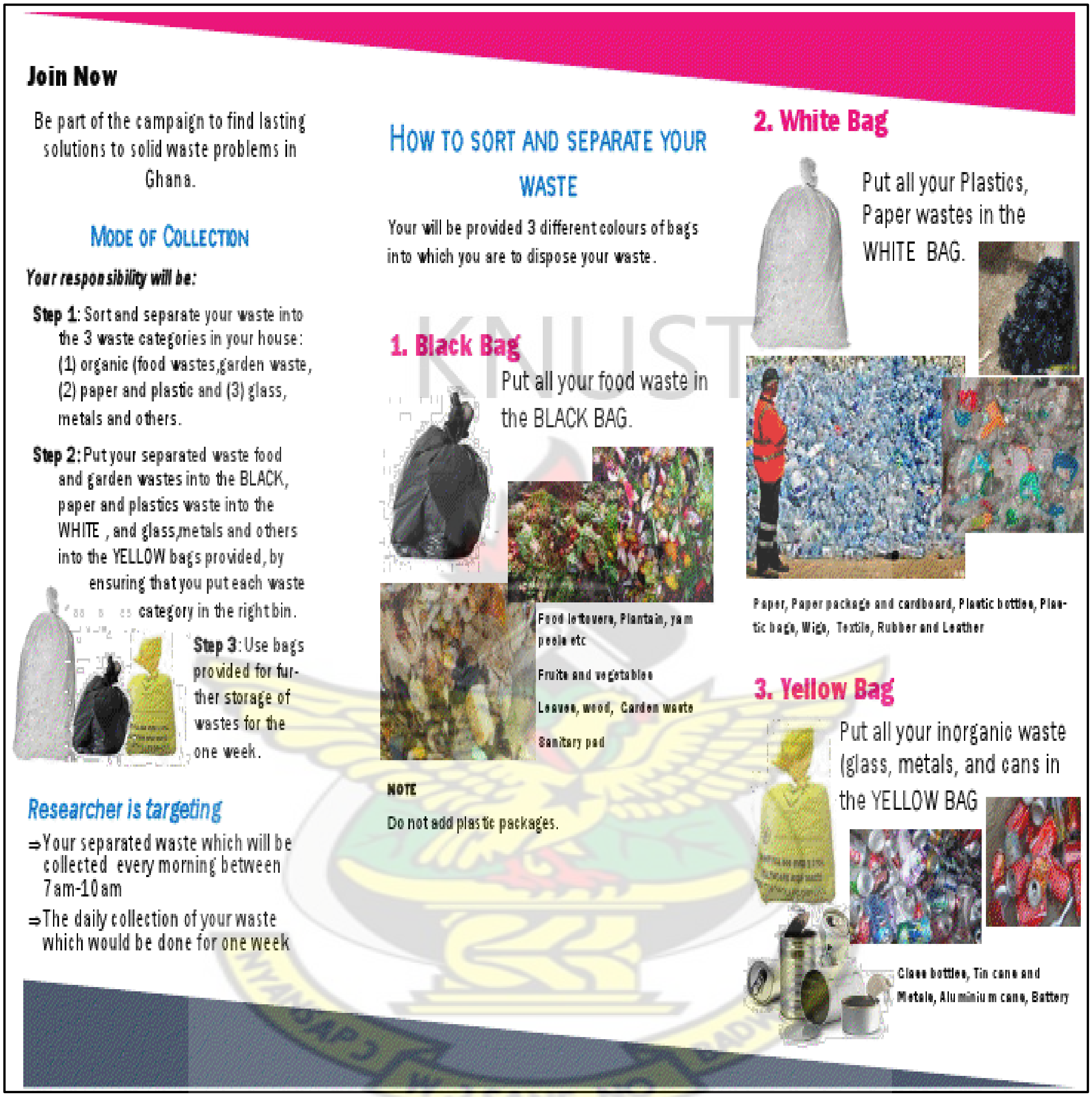
11. WHAT ARE SOME OF THE INCENTIVES YOU WOULD LIKE, IN OTHER TO SOURCE SEPARATE AND RECYCLE SOLID WASTE?
    (i) MORE BINS
    (ii) FINANCIAL INCENTIVE IN WASTE COLLECTION FEES
    (iii) CLEAR GUIDELINES FROM GOVERNMENT
    (iv) MASS MEDIA EDUCATION
    (v) NO INCENTIVE

12. ARE YOU WILLING TO PARTICIPATE IN A ONE WEEK RESEARCH FOR SOURCE SEPARATION OF WASTE IN YOUR HOUSEHOLD?
    (i) YES [ ]
    (ii) NO [ ]

Appendix B

Plate A.1: Public education brochure side one

Plate A.2: Public education brochure side two



Appendix: C

Table A.1: Waste compositions of low income group

DAY	ORGANIC (KG)	PLASTICS (KG)	PAPER (KG)	METALS (KG)	GLASS (KG)	OTHERS (KG)	TOTAL (KG)
1	31.67	9.97	0.74	0.21	0.22	15.85	58.66
2	29.13	3.66	1.34	0.52	0.68	11.14	46.47
3	20.85	3.9	1.32	0.25	0.28	7.57	34.17
4	33.23	4.86	2.28	0.26	0.46	10.42	51.51
5	26.23	5.24	2.2	1	0.52	14.68	49.87
6	22.78	2.88	0.85	0.43	0.31	9.14	36.39
PERCENTAGE	**59.15%**	**11.01%**	**3.15%**	**0.96%**	**0.89%**	**24.84%**	**277.07**

Appendix: D

Table A.2: Waste compositions of middle income group

DAY	ORGANIC (KG)	PLASTICS (KG)	PAPER (KG)	METALS (KG)	GLASS (KG)	OTHERS (KG)	TOTAL (KG)
1	26.31	5.73	2.71	3.22	0.96	3.39	42.32
2	26.03	3.82	1.81	2.3	1.09	3.8	38.75
3	24.87	4.9	2.09	1.72	1.03	6.15	40.76
4	22.31	3.34	1.03	1.12	0.72	3.9	32.42
5	29.64	3.31	1.25	1.29	1.04	6.76	43.29
6	20.84	3.29	1.41	0.92	1.03	3.35	30.84
TOTAL	**65.68%**	**10.68%**	**4.51%**	**4.63%**	**2.57%**	**11.93%**	**228.38**

APPENDIX: E

Table A.3: Characteristics of Source Separated Solid Waste generated from the low income group

DAY 1

	BLACK BAG (in Kg)							**WHITE BAG (in Kg)**							**YELLOW BAG (in Kg)**						
HHN	**Org**	**Pla**	**Pap**	**Met**	**Gla**	**Oth**	**Total**	**Org**	**Pla**	**Pap**	**Met**	**Gla**	**Oth**	**Total**	**Org**	**Pla**	**Pap**	**Met**	**Gla**	**Oth**	**Total**
1	1.25	0.19	0	0	0	0	**1.44**	0	0.61	0.04	0	0	0.12	**0.77**	0	0	0	0	0	0.77	**0.77**
2	0.25	0	0	0	0	0.22	**0.47**	0	0.3	0	0	0	0	**0.3**	0	0	0	0.03	0	0	**0.03**
3	2.4	0.17	0.01	0	0.03	0.7	**3.31**	0.1	0.23	0.04	0	0	0.06	**0.43**	0	0	0	0	0	0	**0**
4	1.45	0.04	0.03	0	0	0.83	**2.35**	0	0.2	0.05	0	0	0	**0.25**	0	0	0	0	0	0	**0**
5	3.4	0.02	0	0	0	0	**3.42**	0	0.18	0	0	0	0	**0.18**	0	0	0	0	0	0.3	**0.3**
6	0.58	0.05	0.01	0	0	0.3	**0.94**	0	0.17	0.02	0	0	0.07	**0.26**	0	0	0	0	0	0	**0**
7	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
8	0.45	0.2	0.01	0	0	0.56	**1.22**	0.15	0.2	0.03	0	0	0	**0.38**	0	0	0	0	0	0	**0**
9	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
10	1.1	0.05	0	0	0	0.72	**1.87**	0	0.48	0.02	0.03	0	0	**0.53**	0	0	0	0	0	0	**0**
11	1.49	0.15	0	0	0	0.6	**2.24**	0	0.32	0.02	0	0	0.2	**0.54**	0	0	0.02	0.04	0.02	0	**0.08**
12	1.7	0.11	0	0	0	0.64	**2.45**	0.2	0.25	0	0	0	0	**0.45**	0	0	0	0	0	0	**0**
13	1.51	0.04	0	0	0	0.71	**2.26**	0.09	0.58	0.05	0	0	0	**0.72**	0	0	0	0	0	0	**0**
14	1.2	0	0	0	0	0.3	**1.5**	0	0.02	0	0	0	0.08	**0.1**	0	0	0	0	0	0	**0**
15	1.3	0.03	0	0	0	0.65	**1.98**	0	0.12	0	0	0	0	**0.12**	0	0	0	0	0	0	**0**
16	1.17	0	0	0	0	0.87	**2.04**	0.18	0.64	0	0	0	0	**0.82**	0	0.01	0	0.02	0.03	0	**0.06**
17	0	0.32	0.02	0	0	0.8	**1.14**	0	0.59	0.06	0	0	0.16	**0.81**	0	0	0	0	0	0	**0**
18	0.9	0.14	0.03	0	0.02	0.88	**1.97**	0	0.61	0.02	0	0	0.06	**0.69**	0	0	0.02	0	0.02	0	**0.04**
19	1.1	0.25	0.01	0	0	0.4	**1.76**	0	0.54	0	0	0	0.19	**0.73**	0	0.11	0	0.04	0.06	0	**0.21**
20	1.7	0.16	0	0	0	0.93	**2.79**	0.1	0.21	0.05	0	0	0	**0.36**	0	0	0.01	0.02	0.02	0	**0.05**
21	2.4	0.01	0	0	0	0.15	**2.56**	0	0.19	0.1	0	0	0.05	**0.34**	0	0	0	0	0	0	**0**
22	1.58	0.06	0	0	0	0	**1.64**	0.12	0.36	0	0	0	0	**0.48**	0	0	0	0	0	0.43	**0.43**
23	1.8	0	0	0	0	0.9	**2.7**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
24	1.2	0.15	0.01	0	0	0.7	**2.06**	0	0.2	0.02	0	0	0.04	**0.26**	0	0	0	0	0	0	**0**
25	0.8	0	0	0	0	0.63	**1.43**	0	0.47	0	0	0	0.07	**0.54**	0	0.02	0	0.03	0.02	0	**0.07**
26	0	0.03	0	0	0	0.72	**0.75**	0	0.19	0.04	0	0	0.04	**0.27**	0	0	0	0	0	0	**0**

DAY 2

	BLACK BAG (in Kg)							**WHITE BAG (in Kg)**							**YELLOW BAG (in Kg)**						
HHN	**Org**	**Pla**	**Pap**	**Met**	**Gla**	**Oth**	**Total**	**Org**	**Pla**	**Pap**	**Met**	**Gla**	**Oth**	**Total**	**Org**	**Pla**	**Pap**	**Met**	**Gla**	**Oth**	**Total**
1	1.19	0.01	0.02	0	0	0.22	**1.44**	0.17	0.09	0.05	0	0	0.13	**0.44**	0	0.02	0.03	0	0	0.17	**0.22**
2	1.4	0.02	0.05	0	0	0.31	**1.78**	0.3	0.2	0	0	0.05	0.16	**0.71**	0	0.1	0.08	0.08	0	0	**0.26**
3	1.5	0.26	0.04	0	0	0.25	**2.05**	0	0.04	0.01	0	0	0	**0.05**	0	0	0	0	0	0.4	**0.4**
4	0.8	0.06	0.02	0.1	0.05	0	**1.03**	0	0.11	0.18	0	0	0	**0.29**	0.1	0	0	0.05	0	0.28	**0.43**
5	1.6	0	0	0	0	0.74	**2.34**	0	0	0	0	0	0	**0**	0.2	0.06	0	0	0	0.1	**0.36**
6	1.3	0.01	0	0	0.04	0.5	**1.85**	0	0.15	0	0	0	0	**0.15**	0	0	0	0	0	0	**0**
7	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
8	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
9	1.37	0	0.03	0	0	0.3	**1.7**	0	0.32	0.21	0	0	0.05	**0.58**	0	0	0.02	0	0	0.2	**0.22**
10	1.2	0	0	0	0	0.28	**1.48**	0.14	0.2	0.01	0	0	0.08	**0.43**	0	0	0	0	0	0.09	**0.09**
11	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
12	1.4	0.08	0	0	0	0.4	**1.88**	0.1	0.25	0	0	0	0	**0.35**	0.12	0	0	0	0	0.15	**0.27**
13	1.11	0	0	0	0	0.35	**1.46**	0.19	0.12	0.17	0	0	0.06	**0.54**	0	0	0	0.04	0	0.11	**0.15**
14	0.95	0.12	0	0	0	0.41	**1.48**	0	0.2	0	0	0	0	**0.2**	0.25	0	0	0	0	0.07	**0.32**
15	1.28	0	0	0	0	0.54	**1.82**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
16	1.1	0	0	0	0.06	0	**1.16**	0.1	0.13	0.22	0	0	0.11	**0.56**	0.3	0	0.03	0	0	0.5	**0.83**
17	0.9	0.03	0	0	0	0.22	**1.15**	0	0.23	0.06	0	0	0	**0.29**	0.38	0	0	0	0.18	0	**0.56**
18	1.37	0	0	0.09	0	0.6	**2.06**	0	0.12	0.04	0	0	0.18	**0.34**	0	0	0	0	0	0.1	**0.1**
19	1.5	0	0	0	0	0.3	**1.8**	0.12	0.2	0.07	0	0.06	0.1	**0.55**	0	0	0	0	0	0.15	**0.15**
20	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
21	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
22	1.1	0.12	0	0	0.04	0.5	**1.76**	0.12	0.12	0	0	0.04	0	**0.28**	0.2	0	0	0	0.16	0	**0.36**
23	1.25	0	0	0	0	0.83	**2.08**	0	0.05	0	0	0	0	**0.05**	0	0.07	0	0	0	0	**0.07**
24	1.05	0.03	0	0	0	0.39	**1.47**	0.05	0.1	0	0	0	0	**0.15**	0.1	0	0	0	0	0.13	**0.23**
25	1.1	0	0	0.09	0	0.5	**1.69**	0	0.04	0	0	0	0	**0.04**	0.22	0	0	0.07	0	0.18	**0.47**
26	1.5	0	0	0	0	0	**1.5**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**

DAY 3

	BLACK BAG (in Kg)							WHITE BAG (in Kg)							YELLOW BAG (in Kg)						
HHN	**Org**	**Pla**	**Pap**	**Met**	**Gla**	**Oth**	**Total**	**Org**	**Pla**	**Pap**	**Met**	**Gla**	**Oth**	**Total**	**Org**	**Pla**	**Pap**	**Met**	**Gla**	**Oth**	**Total**
1	0.8	0.1	0	0	0	0	**0.9**	0.14	0.31	0	0	0	0.15	**0.6**	0	0	0	0	0	0.3	**0.3**
2	1.55	0.14	0.02	0	0.02	0.15	**1.88**	0	0.12	0.15	0.02	0	0	**0.29**	0.2	0	0.03	0	0	0.22	**0.45**
3	1.7	0.03	0.1	0	0	0.52	**2.35**	0	0.07	0.28	0	0	0.11	**0.46**	0	0.31	0	0	0.08	0.2	**0.59**
4	1.2	0	0.28	0.06	0	0.28	**1.82**	0.16	0.25	0.01	0	0.06	0.1	**0.58**	0	0	0	0	0	0	**0**
5	1.8	0.04	0	0	0.04	0.2	**2.08**	0.18	0.23	0	0	0	0	**0.41**	0	0	0.07	0.04	0	1	**1.11**
6	1.15	0	0	0.05	0	0	**1.2**	0	0.15	0	0	0	0	**0.15**	0.15	0	0	0		0.5	**0.65**
7	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
8	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
9	1.1	0.16	0	0	0	0.3	**1.56**	0	0.13	0.09	0	0	0.12	**0.34**	0	0	0	0	0	0	**0**
10	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
11	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
12	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
13	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
14	1.11	0.14	0.06	0	0	0	**1.31**	0	0.1	0	0	0	0.18	**0.28**	0	0	0	0	0	0.26	**0.26**
15	1.3	0	0	0	0.05	0	**1.35**	0	0.15	0.04	0	0	0.56	**0.75**	0	0	0	0	0	0	**0**
16	0.96	0	0.02	0	0	0.3	**1.28**	0.07	0.24	0.03	0	0	0	**0.34**	0.1	0.09	0.01	0	0	0.18	**0.38**
17	1	0.02	0.02	0.04	0	0.16	**1.24**	0	0.13	0.03	0	0	0	**0.16**	0	0	0	0	0	0.3	**0.3**
18	1.32	0.17	0	0.04	0.03	0	**1.56**	0	0	0	0	0	0	**0**	0	0	0	0	0	0.84	**0.84**
19	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
20	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
21	1.42	0	0.02	0	0	0.4	**1.84**	0	0.41	0.06	0	0	0	**0.47**	0.14	0.03	0	0	0	0.12	**0.29**
22	1.05	0.17	0	0	0	0.12	**1.34**	0.15	0.21	0	0	0	0	**0.36**	0.3	0	0	0	0	0	**0.3**
23	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
24	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
25	1.8	0	0	0	0	0	**1.8**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
26	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**

DAY 4

	BLACK BAG (in Kg)							WHITE BAG (in Kg)							YELLOW BAG (in Kg)						
HHN	**Org**	**Pla**	**Pap**	**Met**	**Gla**	**Oth**	**Total**	**Org**	**Pla**	**Pap**	**Met**	**Gla**	**Oth**	**Total**	**Org**	**Pla**	**Pap**	**Met**	**Gla**	**Oth**	**Total**
1	1.28	0.01	0.1	0.03	0	0.42	**1.84**	0	0.1	0	0	0	0	**0.1**	0.12	0.02	0	0	0	0.07	**0.21**
2	1	0.12	0.04	0	0	0.25	**1.41**	0	0.01	0.03	0	0	0	**0.04**	0	0.07	0	0	0.03	0.15	**0.25**
3	1.85	0.03	0.08	0	0	0.44	**2.4**	0.07	0.33	0.11	0	0	0.09	**0.6**	0	0	0	0	0	0	**0**
4	0.97	0.04	0	0	0.06	0.31	**1.38**	0.13	0.14	0	0	0.06	0.19	**0.52**	0	0.02	0	0	0.08	0	**0.1**
5	1.94	0.1	0	0.12	0	0.47	**2.63**	0	0.12	0	0	0	0.1	**0.22**	0.14	0	0.04	0	0.04	0.13	**0.35**
6	1.5	0.02	0.02	0	0	0.2	**1.74**	0.18	0.17	0.07	0	0	0	**0.42**	0	0	0	0.06	0	0.18	**0.24**
7	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
8	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
9	1.42	0	0	0	0	0.39	**1.81**	0	0.07	0	0	0	0.17	**0.24**	0.07	0	0	0	0	0	**0.07**
10	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
11	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
12	1.56	0.36	0	0	0	0.53	**2.45**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
13	1.8	0	0	0	0	0	**1.8**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
14	0.62	0	0.07	0	0	0	**0.69**	0	0.7	0.11	0	0	0.08	**0.89**	0	0	0	0	0.05	0.37	**0.42**
15	1.38	0.02	0.25	0.05	0	0.3	**2**	0.11	0.16	0.05	0	0.08	0	**0.4**	0.1	0	0	0	0	0	**0.1**
16	1.27	0	0	0	0	0.45	**1.72**	0	0.1	0.08	0	0	0	**0.18**	0	0		0	0	0	**0**
17	1.3	0.09	0.1	0	0	0.29	**1.78**	0	0.09	0	0	0	0.17	**0.26**	0.16	0	0	0	0	0	**0.16**
18	1.79	0	0	0	0	0.51	**2.3**	0.16	0.03	0.14	0	0	0	**0.33**	0	0.12	0	0	0.04	0.21	**0.37**
19	1.62	0.01	0	0	0.02	0.17	**1.82**	0	0.21	0	0	0	0	**0.21**	0	0	0.25	0	0	0.4	**0.65**
20	1.51	0.03	0	0	0	0.32	**1.86**	0	0.1	0.1	0	0	0	**0.2**	0.15	0.02	0.08	0	0	0.24	**0.49**
21	1.92	0	0.15	0	0	0.4	**2.47**	0.18	0.21	0	0	0	0.14	**0.53**	0	0	0	0	0	0	**0**
22	1.16	0.11	0.06	0	0	0	**1.33**	0	0	0.13	0	0	0	**0.13**	0.1	0.1	0	0	0	0.44	**0.64**
23	1.83	0.13	0	0	0	0.28	**2.24**	0	0	0.04	0	0	0	**0.04**	0.17	0	0.05	0	0	0	**0.22**
24	1.35	0.02	0	0	0	0.3	**1.67**	0.12	0.5	0	0	0	0.07	**0.69**	0	0.09	0	0	0	0.31	**0.4**
25	1.1	0	0.03	0	0	0.34	**1.47**	0	0.08	0.07	0	0	0.16	**0.31**	0.1	0	0	0	0	0.12	**0.22**
26	0.95	0.09	0.03	0	0	0.26	**1.33**	0.05	0.12	0	0	0	0	**0.17**	0	0	0	0	0	0	**0**

DAY 5

	BLACK BAG (in Kg)							WHITE BAG (in Kg)							YELLOW BAG (in Kg)						
HHN	**Org**	**Pla**	**Pap**	**Met**	**Gla**	**Oth**	**Total**	**Org**	**Pla**	**Pap**	**Met**	**Gla**	**Oth**	**Total**	**Org**	**Pla**	**Pap**	**Met**	**Gla**	**Oth**	**Total**
1	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
2	0.74	0.03	0	0.03	0	0.11	**0.91**	0.1	0.12	0.05	0	0	0	**0.27**	0	0	0.13	0	0.03	0.16	**0.32**
3	1.65	0.12	0.1	0	0	0.82	**2.69**	0	0	0.1	0.06	0	0	**0.16**	0.15	0	0	0	0	0.2	**0.35**
4	1.6	0.13	0.06	0	0.02	0.39	**2.2**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
5	1.47	0.04	0	0	0	0.25	**1.76**	0	0.02	0	0	0	0	**0.02**	0.18	0	0.05	0.04	0	0	**0.27**
6	1.02	0.02	0	0.07	0.06	0.7	**1.87**	0.08	0.37	0.15	0	0	0	**0.6**	0	0.09	0	0	0	0.29	**0.38**
7	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
8	1.5	0	0	0	0	0	**1.5**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
9	1.1	0.03	0	0	0	0.31	**1.44**	0.05	0.42	0.07	0	0.08	0	**0.62**	0.12	0	0.04	0	0	0	**0.16**
10	0.85	0.13	0.1	0.06	0	0.46	**1.6**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
11	1.1	0.21	0	0.08	0	0	**1.39**	0	0	0	0	0	0	**0**	0	0	0.08	0	0	0.63	**0.71**
12	0.9	0	0.31	0	0	0.45	**1.66**	0	0.34	0	0	0	0	**0.34**	0	0	0	0	0.07	0	**0.07**
13	0.75	0.02	0.1	0	0.05	0.35	**1.27**	0	0.22	0.12	0	0	0	**0.34**	0.35	0.02	0	0.05	0	0.32	**0.74**
14	1.22	0	0	0	0	0.38	**1.6**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
15	1.05	0.09	0	0.08	0	0.61	**1.83**	0	0.33	0.12	0	0	0.06	**0.51**	0.05	0.06	0	0	0.05	0.15	**0.31**
16	1.3	0.04	0.03	0	0	0.43	**1.8**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
17	0.85	0	0	0.05	0	0.84	**1.74**	0.13	0.16	0.05	0	0	0	**0.34**	0.12	0.2	0	0	0	0	**0.32**
18	1	0.56	0.11	0.08	0.07	0.71	**2.53**	0	0	0	0	0	0	**0**	0	0	0	0	0	0.27	**0.27**
19	1.4	0.01	0.07	0	0.03	0.82	**2.33**	0	0.23	0	0.12	0	0.27	**0.62**	0	0	0	0	0	0	**0**
20	0.96	0.03	0	0	0	0.5	**1.49**	0.24	0	0	0	0	0	**0.24**	0	0.02	0	0.11	0	0.32	**0.45**
21	1.67	0	0	0	0	0	**1.67**	0	0	0.09	0	0	0	**0.09**	0.18	0	0	0	0	0.96	**1.14**
22	0	0.61	0.11	0.12	0.06	1.35	**2.25**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
23	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
24	1.15	0.09	0.03	0	0	0.55	**1.82**	0.15	0.12	0.08	0	0	0	**0.35**	0	0	0	0	0	0.13	**0.13**
25	0.99	0.02	0	0	0	0.42	**1.43**	0	0.16	0.05	0	0	0.25	**0.46**	0.06	0.18	0	0.05	0	0.22	**0.51**
26	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**

DAY 6

	BLACK BAG (in Kg)							WHITE BAG (in Kg)							YELLOW BAG (in Kg)						
HHN	**Org**	**Pla**	**Pap**	**Met**	**Gla**	**Oth**	**Total**	**Org**	**Pla**	**Pap**	**Met**	**Gla**	**Oth**	**Total**	**Org**	**Pla**	**Pap**	**Met**	**Gla**	**Oth**	**Total**
1	1.12	0.14	0.05	0	0	0.39	**1.7**	0.2	0.1	0.01	0	0.06	0	**0.37**	0	0.01	0.04	0	0	0.28	**0.33**
2	1.22	0.02	0	0	0	0.2	**1.44**	0.08	0.25	0	0	0	0.19	**0.52**	0	0	0	0	0	0	**0**
3	1.55	0.02	0	0	0	0.21	**1.78**	0	0.12	0	0	0	0	**0.12**	0.25	0.61	0	0	0	0.24	**1.1**
4	0.78	0.06	0	0.02	0	0	**0.86**	0	0.03	0.03	0	0	0	**0.06**	0	0	0	0	0	0.28	**0.28**
5	1.31	0.02	0	0	0	0.5	**1.83**	0	0.12	0.03	0	0	0	**0.15**	0.13	0.02	0	0.03	0	0.24	**0.42**
6	0.69	0	0	0	0	0.21	**0.9**	0.09	0.09	0.03	0	0	0.09	**0.3**	0	0	0	0	0	0	**0**
7	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
8	0	0	0	0	0	0	**0**	0	0	0.09	0	0	0	**0.09**	0	0	0.03	0.18	0.1	0.4	**0.71**
9	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
10	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
11	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
12	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
13	1.2	0	0	0	0	0	**1.2**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
14	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
15	1.17	0.07	0	0	0	0.56	**1.8**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
16	0.79	0.02	0.01	0	0	0.4	**1.22**	0.1	0.1	0.06	0.02	0	0	**0.28**	0	0	0	0	0	0	**0**
17	1.18	0.18	0	0	0	0.49	**1.85**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
18	0.99	0.01	0.04	0	0.02	0.3	**1.36**	0.16	0	0.04	0	0	0.11	**0.31**	0	0.09	0.01	0	0	0.33	**0.43**
19	1.1	0	0	0	0	0	**1.1**	0	0.17	0	0	0	0.27	**0.44**	0.14	0	0	0	0	0.22	**0.36**
20	2.1	0.1	0.14	0.08	0.07	0.51	**3**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
21	1.69	0.02	0.03	0	0	0.3	**2.04**	0	0.13	0.03	0	0	0	**0.16**	0.2	0	0	0	0.06	0.24	**0.5**
22	1.4	0.02	0	0.1	0	0	**1.52**	0.28	0.09	0.11	0	0	0	**0.48**	0	0	0	0	0	0.78	**0.78**
23	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
24	0.45	0.07	0	0	0	0.27	**0.79**	0	0	0	0	0	0	**0**	0.09	0	0	0	0	0.02	**0.11**
25	1.24	0.01	0.04	0	0	0.52	**1.81**	0	0.11	0	0	0	0	**0.11**	0.2	0	0.03	0	0	0.25	**0.48**
26	0.7	0	0	0	0	0.21	**0.91**	0	0.08	0	0	0	0	**0.08**	0.18	0	0	0	0	0.13	**0.31**

APPENDIX F

Table A.4: Characteristics of Source Separated Solid Waste generated from the middle income group

DAY 1

	BLACK BAG (In Kg)							WHITE BAG (In Kg)							YELLOW BAG (In Kg)						
HHN	**Org**	**Pla**	**Pap**	**Met**	**Gla**	**Oth**	**Total**	**Org**	**Pla**	**Pap**	**Met**	**Gla**	**Oth**	**Total**	**Org**	**Pla**	**Pap**	**Met**	**Gla**	**Oth**	**Total**
1	0.84	0.08	0.1	0	0	0	**1.02**	0.14	0	0.02	0	0	0.18	**0.34**	0	0	0	0.2	0	0	**0.2**
2	0.56	0.13	0.05	0	0	0.2	**0.94**	0.38	0.06	0.1	0	0	0.22	**0.76**	0	0	0	0	0	0	**0**
3	1.6	0	0	0.08	0	0	**1.68**	0	0.56	0	0	0	0	**0.56**	0	0	0	0.16	0	0	**0.16**
4	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
5	1.9	0.4	0	0.32	0	0	**2.62**	0.9	0.21	0.12	0.2	0	0	**1.43**	0	0	0	0	0	0.6	**0.6**
6	1.48	0	0	0	0	0	**1.48**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
7	2.02	0	0.2	0	0	0	**2.22**	0	0.06	0.2	0.26	0	0.14	**0.66**	0	0	0	0	0.34	0	**0.34**
8	1.8	0	0	0	0	0.4	**2.2**	0	0.21	0.05	0	0	0	**0.26**	0	0	0	0.3	0	0	**0.3**
9	1.1	0.06	0	0	0	0.26	**1.42**	0	0.34	0.3	0	0	0.1	**0.74**	0	0	0.05	0.24	0	0	**0.29**
10	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
11	1.65	0	0	0	0	0	**1.65**	0	0.36	0.24	0	0	0	**0.6**	0	0	0	0.4	0	0.15	**0.55**
12	1.2	0.2	0	0	0	0.13	**1.53**	0.3	0.25	0.05	0	0	0.12	**0.72**	0	0	0	0.3	0	0	**0.3**
13	0.8	0	0	0.2	0.2	0	**1.2**	0.5	0	0.1	0	0.1	0.19	**0.89**	0	0	0	0	0	0	**0**
14	0	0	0	0	0		**0**	0	0.3	0.2	0	0	0	**0.5**	0	0	0	0	0	0	**0**
15	1	0	0	0	0	0.1	**1.1**	0	0.38	0.1	0	0	0	**0.48**	0	0	0	0	0.12	0	**0.12**
16	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
17	1.3	0	0.12	0	0	0.12	**1.54**	0	0.6	0	0	0	0	**0.6**	0	0	0	0.16	0	0	**0.16**
18	1.35	0.1	0	0	0	0.2	**1.65**	0	0.42	0.13	0	0	0	**0.55**	0	0	0	0.25	0	0	**0.25**
19	2.04	0.22	0	0	0	0	**2.26**	0	0.14	0.17	0	0	0.1	**0.41**	0	0.08	0	0.15	0	0	**0.23**
20	1.25	0	0	0	0	0	**1.25**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
21	1.12	0	0	0	0	0.18	**1.3**	0	0.47	0.11	0	0	0	**0.58**	0	0	0	0	0	0	**0**
22	0.68	0.1	0	0	0	0	**0.78**	0.2	0	0.3	0	0	0	**0.5**	0.2	0	0	0	0.2	0	**0.4**

DAY 2

	BLACK BAG (In Kg)							**WHITE BAG (In Kg)**							**YELLOW BAG (In Kg)**						
HHN	**Org**	**Pla**	**Pap**	**Met**	**Gla**	**Oth**	**Total**	**Org**	**Pla**	**Pap**	**Met**	**Gla**	**Oth**	**Total**	**Org**	**Pla**	**Pap**	**Met**	**Gla**	**Oth**	**Total**
1	1.28	0.08	0	0	0	0.25	**1.61**	0	0.22	0.11	0	0	0	**0.33**	0	0	0	0	0.22	0	**0.22**
2	1.36	0	0.22	0	0	0	**1.58**	0	0.22	0	0	0	0	**0.22**	0	0	0	0.18	0	0.22	**0.3**
3	0.78	0.02	0.04	0	0	0	**0.84**	0.2	0.04	0	0	0.16	0.08	**0.48**	0	0	0	0.2	0	0.2	**0.4**
4	2.2	0	0	0	0	0.2	**2.4**	0	0.35	0.07	0.15	0	0.12	**0.69**	0	0	0	0	0	0.19	**0.19**
5	1.37	0	0	0	0.19	0.15	**1.71**	0.11	0	0	0	0	0	**0.11**	0.37	0.02	0	0.34	0	0	**0.73**
6	1.5	0	0	0.4	0	0.2	**2.1**	0	0.14	0.16	0	0	0	**0.3**	1.2	0	0	0	0	0	**1.2**
7	1.72	0.12	0	0	0	0	**1.84**	0	0.09	0.05	0	0	0.25	**0.39**	0	0	0	0.22	0	0	**0.22**
8	1.5	0	0	0	0	0	**1.5**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
9	1.62	0	0.05	0	0	0.44	**2.11**	0	0.14	0.14	0	0	0	**0.28**	0	0	0	0	0.09	0	**0.09**
10	0	0	0	0	0	0	**0**	0.1	0.22	0.3	0	0	0	**0.62**	0	0	0	0	0.24	0	**0.24**
11	0.75	0.01	0.05	0	0	0.18	**0.99**	0.1	0.39	0	0	0	0	**0.49**	0	0	0.12	0	0	0	**0.12**
12	1.25	0	0	0	0	0	**1.25**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
13	1	0.03	0.05	0	0.13	0	**1.21**	0.12	0.24	0.11	0	0	0.1	**0.57**	0	0	0	0	0	0.2	**0.2**
14	0.52	0.18	0.02	0	0	0.16	**0.88**	0	0	0	0	0	0	**0**	0	0	0	0.07	0	0	**0.07**
15	1.2	0.24	0.13	0.12	0	0.31	**2**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
16	0.94	0.11	0.01	0	0	0.1	**1.16**	0.3	0.14	0	0	0	0.1	**0.54**	0	0	0	0.15	0	0	**0.15**
17	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
18	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
19	1.34	0.16	0	0	0	0.1	**1.6**	0	0.08	0.1	0	0	0	**0.18**	0	0.01	0	0.2	0.06	0	**0.27**
20	0.4	0	0	0.12	0	0	**0.52**	0.15	0.17	0.04	0	0	0.04	**0.4**	0	0	0	0	0	0	**0**
21	1.35	0	0	0	0	0	**1.35**	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
22	1.3	0	0	0	0	0.21	**1.51**	0	0.4	0	0	0	0	**0.4**	0	0	0.04	0.15	0	0	**0.19**

DAY 3

	BLACK BAG (In Kg)							**WHITE BAG (In Kg)**							**YELLOW BAG (In Kg)**						
HHN	**Org**	**Pla**	**Pap**	**Met**	**Gla**	**Oth**	**Total**	**Org**	**Pla**	**Pap**	**Met**	**Gla**	**Oth**	**Total**	**Org**	**Pla**	**Pap**	**Met**	**Gla**	**Oth**	**Total**
1	1.6	0.32	0	0.11	0	0.13	**2.16**	0.28	0.09	0.07	0	0.1	0.12	**0.66**	0	0	0	0	0	0	**0**
2	1.15	0	0	0	0	0	**1.15**	0	0.27	0.09	0.05	0	0	**0.41**	0	0	0	0.11	0	0.18	**0.29**
3	0.6	0.04	0.01	0	0.04	0.1	**0.79**	0.12	0.17	0.03	0	0	0	**0.32**	0	0	0	0	0.09	0	**0.09**
4	1.5	0.12	0.06	0.06	0	0.18	**1.92**	0	0.12	0.1	0	0	0.02	**0.24**	0	0	0.04	0	0	0.05	**0.09**
5	1.22	0.07	0	0	0	0.25	**1.54**	0	0.14	0.2	0	0	0	**0.34**	0	0.01	0	0.14	0.07	0	**0.22**
6	2.13	0	0	0	0	0.59	**2.72**	0	0.15	0.01	0	0.07	0	**0.23**	0	0	0	0	0	0	**0**
7	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
8	1.1	0.15		0.1	0	0.25	**1.6**	0.2	0.1	0.12	0	0	0.13	**0.55**	0	0	0	0	0	0	**0**
9	1.71	0.03	0.09	0.06	0.09	0.18	**2.16**	0	0.09	0.03	0	0	0.08	**0.2**	0	0.01	0.02	0.11	0.12	0	**0.26**
10	0	0	0	0	0	0	**0**	0	0.52	0.1	0.04	0	0.25	**0.91**	0	0	0.02	0.07	0.05	0	**0.14**
11	1.24	0.06		0.08	0	0.23	**1.61**	0	0.2	0.1	0	0	0.09	**0.39**	0	0	0	0	0	0	**0**
12	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**	0.23	0	0	0	0	1.29	**1.52**
13	1	0	0	0.15	0	0.19	**1.34**	0.4	0.09	0.09	0	0.16	0	**0.74**	0	0	0	0	0	0	**0**
14	0	0	0	0	0	0	**0**	0	0.45	0.15	0	0	0.25	**0.85**	0	0.01	0.01	0.18	0	0	**0.2**
15	1.7	0.13	0.13	0.19	0	0.16	**2.31**	0.1	0.29	0.09	0	0	0.14	**0.62**	0	0.02	0	0	0.15	0	**0.17**
16	1.8	0	0	0.07	0	0.27	**2.14**	0	0.39	0.07	0	0	0.1	**0.56**	0	0	0	0	0	0	**0**
17	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
18	0.8	0.04	0	0	0	0.22	**1.06**	0	0.2	0.04	0	0	0	**0.24**	0	0	0.01	0	0.05		**0.06**
19	1.54	0.12	0.03	0	0	0.24	**1.93**	0.14	0.09	0.15	0	0	0	**0.38**	0	0.03	0	0.06	0	0	**0.09**
20	0.75	0.03	0.02	0	0.04	0.18	**1.02**	0	0.12	0.02	0	0	0	**0.14**	0	0	0	0	0	0	**0**
21	1.6	0	0	0	0	0	**1.6**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
22	1.76	0	0	0	0	0.28	**2.04**	0.2	0.23	0.15	0	0	0	**0.58**	0	0	0.04	0.14	0	0	**0.18**

DAY 4

	BLACK BAG (In Kg)							WHITE BAG (In Kg)							YELLOW BAG (In Kg)						
HHN	**Org**	**Pla**	**Pap**	**Met**	**Gla**	**Oth**	**Total**	**Org**	**Pla**	**Pap**	**Met**	**Gla**	**Oth**	**Total**	**Org**	**Pla**	**Pap**	**Met**	**Gla**	**Oth**	**Total**
1	1.28	0.08	0	0	0	0	**1.36**	0	0.15	0.05	0.04	0	0.05	**0.29**	0	0	0	0	0	0.3	**0.3**
2	1.54	0.02	0.08	0	0.06	0.26	**1.96**	0	0.38	0.03	0	0	0.2	**0.61**	0	0	0.01	0	0.1	0	**0.11**
3	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
4	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
5	1.2	0.01	0.01	0	0	0.34	**1.56**	0.1	0.29	0.07	0	0	0.12	**0.58**	0	0.05	0	0.07	0	0	**0.12**
6	1.06	0	0.03	0.07	0	0.09	**1.25**	0	0.09	0.02	0	0	0.06	**0.17**	0	0	0	0	0	0	**0**
7	1.61	0.02	0	0	0	0.2	**1.83**	0	0.15	0.05	0	0	0.1	**0.3**	0	0	0	0.03	0.14		**0.17**
8	1.62	0	0	0	0	0	**1.62**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
9	1.85	0.11	0.04	0.06	0	0.42	**2.48**	0	0.18	0.01	0	0.1	0	**0.29**	0	0	0	0.08	0	0	**0.08**
10	0.35	0	0	0	0	0	**0.35**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
11	0.6	0.16	0	0	0	0	**0.76**	0.1	0.04	0.04	0	0	0	**0.18**	0.1	0.01	0	0	0	0.21	**0.32**
12	1.85	0	0	0	0	0	**1.85**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
13	0.7	0	0.02	0.06	0	0.25	**1.03**	0	0.11	0.04	0	0	0	**0.15**	0	0	0	0	0	0	**0**
14	0	0	0	0	0	0	**0**	0.06	0.22	0.04	0	0	0.2	**0.52**	0.07	0	0	0.09	0	0	**0.16**
15	1.18	0.12	0.03	0	0.04	0.2	**1.57**	0	0.24	0	0.15	0	0	**0.39**	0	0	0	0	0	0	**0**
16	1.2	0.02	0.01	0.1	0	0.13	**1.46**	0	0.11	0.07	0	0	0	**0.18**	0	0.08	0	0	0	0.1	**0.18**
17	1.36	0	0	0	0	0	**1.36**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
18	1.1	0.01	0.07	0	0.09	0.09	**1.36**	0	0.19	0.01	0	0	0	**0.2**	0	0	0.05	0.14	0	0.2	**0.39**
19	2.46	0	0	0.06	0	0.27	**2.79**	0	0.28	0.16	0	0	0	**0.44**	0	0.01	0.02	0.06	0.05	0.11	**0.25**
20	0.81	0.04	0	0.06	0	0	**0.91**	0.11	0.17	0.06	0	0	0	**0.34**	0	0	0.01	0.05	0.14	0	**0.2**
21	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
22	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**

DAY 5

	BLACK BAG (In Kg)							WHITE BAG (In Kg)							YELLOW BAG (In Kg)						
HHN	**Org**	**Pla**	**Pap**	**Met**	**Gla**	**Oth**	**Total**	**Org**	**Pla**	**Pap**	**Met**	**Gla**	**Oth**	**Total**	**Org**	**Pla**	**Pap**	**Met**	**Gla**	**Oth**	**Total**
1	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
2	0.95	0.03	0.01	0	0	0.03	1.02	0	0.15	0.04	0	0.03	0	**0.22**	0.13	0	0.03	0	0.05	0.2	**0.41**
3	1.2	0.03	0.05	0	0.08	0.14	1.5	0.2	0.2	0.07	0	0	0	**0.47**	0	0	0	0.11	0	0.28	**0.39**
4	2	0.12	0.02	0	0.02	0.2	2.36	0	0.15	0.06	0.06	0	0	**0.27**	0	0.01	0	0.14	0	0.1	**0.25**
5	1.15	0	0	0	0	0	1.15	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
6	2.24	0	0	0	0	0.59	2.83	0	0	0	0	0	0.15	**0.15**	0	0	0	0	0	0	**0**
7	1.4	0.11	0	0.07	0	0	1.58	0	0.1	0.06	0	0	0	**0.16**	0	0	0.02	0	0	0.2	**0.22**
8	1.9	0.02	0.04	0	0	0.2	2.16	0.1	0.23	0.08	0	0	0	**0.41**	0	0.04	0	0.12	0.04	0.21	**0.41**
9	1.6	0.05	0.05	0	0	0	1.7	0	0.16	0.04	0	0.03	0.1	**0.33**	0.15	0	0	0.08	0.05	0.29	**0.57**
10	0.6	0.07	0.03	0	0.1	0.19	0.99	0.1	0.04	0.05	0	0	0	**0.19**	0	0	0	0	0	0	**0**
11	1.06	0.02	0.01	0.1	0	0.12	1.31	0	0.13	0	0	0.1	0	**0.23**	0	0	0.05	0	0.09	0.18	**0.32**
12	1.7	0.01	0	0.06	0.06	0.4	2.23	0	0	0	0	0	0	**0**	0	0.01	0	0	0	0.21	**0.22**
13	1.3	0	0	0	0	0	1.3	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
14	0.85	0.1	0	0.1	0	0.13	1.18	0	0.03	0.06	0	0	0	**0.09**	0.09	0.01	0	0	0.08	0.1	**0.28**
15	0.8	0.03	0	0.06	0	0.2	1.09	0	0.1	0	0	0	0.16	**0.26**	0	0	0	0	0	0	**0**
16	1.94	0.01	0.02	0	0.1	0.14	2.21	0	0.15	0.02	0	0	0	**0.17**	0.11	0.06	0	0	0.05	0.3	**0.52**
17	1.22	0.19	0.06	0.1	0	0.41	1.98	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
18	0.8	0.16	0.02	0.03	0.06	0.32	1.39	0.12	0.01	0.03	0	0	0.05	**0.21**	0	0	0	0	0	0	**0**
19	1.08	0.01	0.01	0.08	0	0.27	1.45	0	0.15	0.06	0	0	0	**0.21**	0	0	0	0	0	0	**0**
20	1.45	0.14	0.03	0	0	0.26	1.88	0	0.2	0.11	0.03	0	0.1	**0.44**	0	0.02	0	0.04	0.07	0	**0.13**
21	1.7	0	0	0	0	0	1.7	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
22	1.6	0.01	0.04	0.03	0	0.23	1.91	0.1	0.23	0.06	0	0	0	**0.39**	0	0.02	0.02	0.08	0.03	0.3	**0.45**

DAY 6

	BLACK BAG (In Kg)							**WHITE BAG (IN KG) (kg)**							**YELLOW BAG (IN KG)**						
HHN	**Org**	**Pla**	**Pap**	**Met**	**Gla**	**Oth**	**Total**	**Org**	**Pla**	**Pap**	**Met**	**Gla**	**Oth**	**Total**	**Org**	**Pla**	**Pap**	**Met**	**Gla**	**Oth**	**Total**
1	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
2	1.3	0	0.06	0	0.04	0.3	**1.7**	0	0.11	0.07	0	0	0.08	**0.26**	0	0.02	0.01	0.09	0	0	**0.12**
3	0.86	0.14	0	0	0	0	**1**	0	0.07	0.05	0	0.05	0.13	**0.3**	0	0	0	0	0	0.22	**0.22**
4	1.75	0.01	0	0	0	0.35	**2.11**	0.09	0.27	0.12	0	0	0	**0.48**	0	0.02	0.01	0.13	0	0	**0.16**
5	1	0.09	0.06	0	0	0.28	**1.43**	0.16	0.19	0.05	0	0	0.1	**0.5**	0	0	0	0.02	0.05	0	**0.07**
6	1.76	0.05	0.1	0	0	0.15	**2.06**	0	0.19	0.02	0	0	0.09	**0.3**	0	0	0	0	0	0	**0**
7	1.15	0.03	0.04	0.1	0	0	**1.32**	0	0.21	0.1	0	0	0	**0.31**	0	0	0	0.11	0.06	0	**0.17**
8	2.3	0	0	0	0	0	**2.3**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
9	1.3	0.11	0.06	0.07	0	0.43	**1.97**	0	0.22	0	0	0	0	**0.22**	0.1	0	0	0	0.08	0.09	**0.27**
10	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
11	1.12	0.16	0.02	0	0	0.2	**1.5**	0	0.08	0.08	0	0	0.07	**0.23**	0	0	0.01	0.06	0	0	**0.07**
12	1.2	0	0	0	0	0	**1.2**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
13	1.45	0.04	0.06	0	0	0.26	**1.81**	0	0.18	0.06	0	0	0	**0.24**	0	0.03	0.01	0	0.11	0	**0.15**
14	0.85	0	0	0	0	0	**0.85**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
15	0.49	0	0	0	0	0.08	**0.57**	0.17	0.24	0.06	0.06	0	0	**0.53**	0	0	0	0	0	0	**0**
16	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**	0	0	0	0	0.45	0.05	**0.5**
17	0.82	0.01	0.01	0	0.07	0.23	**1.14**	0	0.2	0.12	0	0	0	**0.32**	0	0	0	0.06	0	0	**0.06**
18	0.55	0.03	0	0.04	0	0.11	**0.73**	0.05	0.12	0.06	0	0	0	**0.23**	0	0.01	0.02	0.06	0	0	**0.09**
19	0.8	0.08	0.05	0	0	0.13	**1.06**	0	0.1	0.02	0	0	0	**0.12**	0	0.03	0	0.04	0.05	0	**0.12**
20	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
21	0.45	0	0	0	0	0	**0.45**	0	0	0	0	0	0	**0**	0	0	0	0	0	0	**0**
22	1.12	0.02	0	0.08	0	0	**1.22**	0	0.23	0.08	0	0	0	**0.31**	0	0	0	0	0.07	0	**0.07**

Appendix: G

Table A.5: Characteristics of solid waste generated from low income group

House No.	Family size	Weight of sample (kg)	Volume (m^3)	Density of solid-waste (Kg/m^3)	Generation rate (Kg/capita/day)
1	4	2.980	0.01	298	0.745
2	5	0.800	0.002	400	0.160
3	4	3.740	0.008	475	0.95
4	7	2.600	0.008	325	0.371
5	5	3.900	0.008	487.5	0.780
6	4	1.200	0.005	240	0.300
7	1	0	0	0	0
8	5	1.600	0.005	320	0.320
9	2	0	0	0	0
10	2	2.400	0.01	240	1.200
11	4	2.860	0.013	220	0.715
12	4	2.900	0.009	322.22	0.725
13	7	2.980	0.007	425.71	0.426
14	5	1.600	0.005	320	0.320
15	2	2.100	0.007	300	1.100
16	10	2.920	0.013	224.61	0.292
17	5	1.950	0.005	390	0.390
18	9	2.680	0.008	335	0.298
19	10	2.700	0.009	300	0.270
20	7	3.200	0.011	290.90	0.457
21	6	2900	0.006	483.33	0.483
22	5	2.550	0.008	318.75	0.510
23	5	2.700	0.008	337.5	0.540
24	5	2320	0.011	210.90	0.464
25	3	2.040	0.009	224.44	0.673
26	2	1.020	0.003	340	0.510
AVERAGE				**301.11**	**0.499**

House No.	Family size	Weight of sample (kg)	Volume (m3)	Density of solid-waste (Kg/m3)	Generation rate (Kg/capita/day)
1	4	2.100	0.006	350	0.525
2	5	2.750	0.008	343.75	0.550
3	4	2.500	0.005	500	0.625
4	7	1.750	0.01	175	0.250
5	5	2.700	0.01	270	0.540
6	4	2.000	0.008	250	0.500
7	1	0	0	0	0
8	5	0	0	0	0
9	2	2.500	0.005	500	1.250
10	2	2.000	0.005	400	1.000
11	4	0	0	0	0
12	4	2.500	0.006	416.67	0.625
13	7	2.150	0.01	215	0.307
14	5	2.000	0.008	250	0.400
15	2	1.820	0.005	364	0.910
16	10	2.550	0.006	425	0.255
17	5	2.000	0.006	333.33	0.400
18	9	2.500	0.007	357.14	0.278
19	10	2.500	0.004	625	0.250
20	7	0	0	0	0
21	6	0	0	0	0
22	5	2.400	0.001	218.18	0.480
23	5	2.200	0.007	314.28	0.440
24	5	1.850	0.008	231.25	0.370
25	3	2.200	0.008	275	0.733
26	2	1.500	0.005	300	0.750
AVERAGE				**273.6**	**0.439**

House No.	Family size	Weight of sample (kg)	Volume (m^3)	Density of solid-waste (Kg/m^3)	Generation rate (Kg/capita/day)
1	4	1.800	0.008	225	0.450
2	5	2.620	0.008	327.5	0.524
3	4	3.400	0.015	226.67	0.850
4	7	2.400	0.01	240	0.343
5	5	3.600	0.013	276.92	0.720
6	4	2.000	0.006	333.33	0.500
7	1	0	0	0	0
8	10	0	0	0	0
9	2	1.900	0.006	316.667	0.950
10	2	0	0	0	0
11	4	0	0	0	0
12	4	0	0	0	0
13	7	0	0	0	0
14	5	1.850	0.009	205.56	0.370
15	2	2.100	0.005	420	1.050
16	10	2.000	0.007	285.71	0.200
17	5	1.700	0.008	212.5	0.340
18	9	2.400	0.008	300	0.267
19	10	0	0	0	0
20	7	0	0	0	0
21	6	2.600	0.005	520	0.433
22	5	2.000	0.01	200	0.400
23	5	0	0	0	0
24	5	0	0	0	0
25	3	1.800	0.005	360	0.600
26	2	0	0	0	0
AVERAGE				**171.00**	**0.307**

House No.	Family size	Weight of sample (kg)	Volume (m^3)	Density of solid-waste (Kg/m^3)	Generation rate (Kg/capita/day)
1	4	2.150	0.011	195.45	0.538
2	5	1.700	0.006	283.33	0.340
3	4	3.000	0.008	375	0.750
4	7	2.000	0.008	250	0.286
5	5	3.200	0.01	320	0.640
6	4	2.400	0.007	342.85	0.600
7	1	0	0	0	0
8	10	0	0	0	0
9	2	2.120	0.008	265	1.060
10	2	0	0	0	0
11	4	0	0	0	0
12	4	2.450	0.007	350	0.613
13	7	1.800	0.005	360	0.257
14	5	2.000	0.01	200	0.400
15	2	2.500	0.008	312.5	1.250
16	10	1.900	0.007	271.42	0.190
17	5	2.200	0.01	220	0.440
18	9	3.000	0.008	375	0.333
19	10	2.700	0.012	225	0.270
20	7	2.550	0.009	283.33	0.364
21	6	3.000	0.013	230.76	0.500
22	5	2.100	0.008	262.5	0.420
23	5	2.500	0.006	416.67	0.500
24	5	2.450	0.009	272.22	0.490
25	3	2.000	0.006	333.33	0.670
26	2	1.500	0.007	214.28	0.750
AVERAGE				**244**	**0.448**

House No.	Family size	Weight of sample (kg)	Volume (m^3)	Density of solid-waste (Kg/m^3)	Generation rate (Kg/capita/day)
1	4	0	0	0	0
2	5	1.500	0.004	375	0.300
3	4	3.200	0.009	355.55	0.800
4	7	2.200	0.007	314.28	0.314
5	5	2.050	0.005	410	0.410
6	4	2.850	0.008	356.25	0.713
7	1	0	0	0	0
8	5	1.500	0.005	300	0.300
9	2	2.220	0.009	246.67	1.110
10	2	1.600	0.005	320	0.800
11	4	2.100	0.006	350	0.525
12	4	2.100	0.011	190.90	0.525
13	7	2.350	0.008	293.75	0.336
14	5	1.600	0.005	320	0.320
15	2	2.650	0.008	331.25	1.325
16	10	1.800	0.006	300	0.180
17	5	2.400	0.008	300	0.480
18	9	2.800	0.011	254.54	0.311
19	10	2.950	0.009	327.77	0.295
20	7	2.180	0.008	272.5	0.311
21	6	2.900	0.008	362.5	0.483
22	5	2.250	0.005	450	0.450
23	5	0	0	0	0
24	5	2.300	0.006	383.33	0.460
25	3	2.400	0.005	480	0.800
26	2	0	0	0	0
AVERAGE				**280**	**0.444**

House No.	Family size	Weight of sample (kg)	Volume (m^3)	Density of solid-waste (Kg/m^3)	Generation rate (Kg/capita/day)
1	4	2.400	0.010	240	0.600
2	5	1.960	0.007	280	0.392
3	4	3.000	0.006	500	0.750
4	7	1.200	0.004	300	0.171
5	5	2.400	0.007	342.85	0.480
6	4	1.200	0.004	300	0.300
7	1	0	0	0	0
8	5	0.800	0.002	400	0.160
9	2	0	0	0	0
10	2	0	0	0	0
11	4	0	0	0	0
12	4	0	0	0	0
13	7	1.200	0.005	240	0.171
14	5	0	0	0	0
15	2	1.800	0.007	257.14	0.900
16	10	1.500	0.005	300	0.150
17	5	1.850	0.008	231.25	0.370
18	9	2.100	0.006	350	0.233
19	10	1.900	0.008	237.5	0.190
20	7	3.000	0.008	375	0.428
21	6	2.700	0.008	337.5	0.450
22	5	2.780	0.006	463.33	0.556
23	5	0	0	0	0
24	5	0.900	0.002	450	0.180
25	3	2.400	0.006	400	0.800
26	2	1.300	0.005	260	0.650
AVERAGE				**240**	**0.305**

Appendix: H

Table A.6: Characteristics of solid waste generated from middle income group

House No.	Family size	Weight of sample (kg)	Volume (m^3)	Density of solid-waste (Kg/m^3)	Generation rate (Kg/capita/day)
1	5	1.560	0.008	195.00	0.312
2	3	1.700	0.007	242.85	0.567
3	3	2.400	0.007	342.85	0.800
4	5	0	0	0	0
5	4	4.650	0.015	310.00	1.163
6	4	1.480	0.006	246.70	0.370
7	4	3.220	0.009	357.77	0.805
8	2	2.760	0.007	394.28	1.380
9	5	2.450	0.007	350.00	0.490
10	1	0	0	0	0
11	3	2.800	0.008	350.00	0.933
12	3	2.550	0.011	231.82	0.850
13	4	2.100	0.006	350.00	0.525
14	1	0.500	0.002	250.00	0.500
15	2	1.700	0.005	340.00	0.850
16	4	0	0	0	0
17	4	2.300	0.005	460.00	0.575
18	3	2.450	0.007	350.00	0.817
19	5	2.900	0.009	322.22	0.580
20	2	1.250	0.005	250.00	0.625
21	2	1.880	0.006	313.33	0.940
22	3	1.680	0.005	336.00	0.560
AVERAGE				**272.4**	**0.620**

House No.	Family size	Weight of sample (kg)	Volume (m^3)	Density of solid-waste (Kg/m^3)	Generation rate (Kg/capita/day)
1	5	2.160	0.005	432.00	0.432
2	3	2.200	0.008	275.00	0.733
3	3	1.720	0.005	344.00	0.573
4	5	3.280	0.011	298.18	0.656
5	4	2.550	0.009	283.33	0.637
6	4	3.600	0.013	276.92	0.900
7	4	2.450	0.008	306.25	0.613
8	2	1.500	0.008	187.50	0.750
9	5	2.480	0.010	248.00	0.496
10	1	0.860	0.004	215.00	0.860
11	3	1.600	0.006	266.67	0.533
12	3	1.250	0.006	208.33	0.417
13	4	1.980	0.008	247.50	0.495
14	1	0.950	0.004	237.50	0.950
15	2	2.000	0.007	285.71	1
16	4	1.850	0.007	264.28	0.4625
17	4	0	0	0	0
18	3	0	0	0	0
19	5	2.050	0.005	410.00	0.410
20	2	0.920	0.003	306.67	0.460
21	2	1.350	0.007	192.85	0.675
22	3	2.100	0.007	300.00	0.700
AVERAGE				**253.89**	**0.580**

House No.	Family size	Weight of sample (kg)	Volume (m^3)	Density of solid-waste (Kg/m^3)	Generation rate (Kg/capita/day)
1	5	2.820	0.008	352.50	0.564
2	3	1.850	0.010	185.00	0.617
3	3	1.200	0.005	240.00	0.400
4	5	2.250	0.010	225.00	0.450
5	4	2.100	0.006	350.00	0.525
6	4	2.950	0.015	196.67	0.738
7	4	0	0	0	0
8	2	2.150	0.007	307.14	1.075
9	5	2.620	0.009	291.11	0.524
10	1	1.050	0.005	210.00	1.050
11	3	2.000	0.008	250.00	0.667
12	3	1.520	0.006	253.33	0.507
13	4	2.080	0.006	346.67	0.520
14	1	1.050	0.004	262.50	1.050
15	2	3.100	0.011	281.82	1.550
16	4	2.700	0.007	385.71	0.675
17	4	0	0	0	0
18	3	1.360	0.008	170.00	0.453
19	5	2.400	0.010	240.00	0.480
20	2	1.160	0.005	232.00	0.580
21	2	1.600	0.005	320.00	0.800
22	3	2.800	0.012	233.33	0.933
AVERAGE				**242.39**	**0.640**

House No.	Family size	Weight of sample (kg)	Volume (m^3)	Density of solid-waste (Kg/m^3)	Generation rate (Kg/capita/day)
1	5	1.950	0.007	278.57	0.390
2	3	2.680	0.013	206.15	0.893
3	3	0	0	0	0
4	5	0	0	0	0
5	4	2.260	0.006	376.67	0.565
6	4	1.420	0.005	284.00	0.355
7	4	2.300	0.009	255.56	0.575
8	2	1.620	0.005	324.00	0.810
9	5	2.850	0.008	356.25	0.570
10	1	0.350	0.002	175.00	0.350
11	3	1.260	0.009	140.00	0.420
12	3	1.850	0.005	370.00	0.617
13	4	1.180	0.007	168.57	0.295
14	1	0.680	0.002	340.00	0.680
15	2	1.960	0.005	392.00	0.980
16	4	1.820	0.008	227.50	0.455
17	4	1.360	0.004	340.00	0.340
18	3	1.950	0.007	278.57	0.650
19	5	3.480	0.015	232	0.696
20	2	1.450	0.008	181.250	0.725
21	2	0	0	0	0
22	3	0	0	0	0
AVERAGE				**223.91**	**0.471**

House No.	Family size	Weight of sample (kg)	Volume (m^3)	Density of solid-waste (Kg/m^3)	Generation rate (Kg/capita/day)
1	5	0	0	0	0
2	3	1.650	0.005	330.00	0.550
3	3	2.360	0.005	472.00	0.787
4	5	2.880	0.008	360.00	0.576
5	4	1.150	0.011	104.55	0.287
6	4	2.980	0.007	425.71	0.745
7	4	1.960	0.005	392.00	0.490
8	2	3.080	0.012	256.67	1.540
9	5	2.600	0.005	520.00	0.520
10	1	1.180	0.010	118.00	1.180
11	3	1.860	0.007	265.71	0.620
12	3	2.450	0.007	350.00	0.816
13	4	1.300	0.012	108.33	0.325
14	1	1.550	0.008	193.75	1.550
15	2	1.350	0.006	225.00	0.675
16	4	2.900	0.008	362.50	0.725
17	4	1.980	0.008	247.50	0.495
18	3	1.600	0.005	320.00	0.533
19	5	1.660	0.005	332.00	0.332
20	2	2.450	0.01	245.00	1.225
21	2	1.700	0.004	425.00	0.850
22	3	2.750	0.009	305.56	0.916
AVERAGE				**289**	**0.715**

House No.	Family size	Weight of sample (kg)	Volume (m^3)	Density of solid-waste (Kg/m^3)	Generation rate (Kg/capita/day)
1	5	0	0	0	0
2	3	2.080	0.008	260	0.693
3	3	1.520	0.005	304	0.507
4	5	2.750	0.01	275	0.550
5	4	2.000	0.007	285.7	0.500
6	4	2.360	0.01	236	0.590
7	4	1.800	0.008	225	0.450
8	2	2.300	0.012	191.667	1.150
9	5	2.460	0.01	246	0.492
10	1	0	0	0	0
11	3	1.800	0.01	180	0.600
12	3	1.200	0.007	171.4	0.400
13	4	2.200	0.01	220	0.550
14	1	0.850	0.005	170	0.850
15	2	1.100	0.008	137.5	0.550
16	4	0.500	0.003	166.7	0.125
17	4	1.520	0.007	217.1	0.380
18	3	1.050	0.005	210	0.350
19	5	1.300	0.008	162.5	0.260
20	2	0	0	0	0
21	2	0.450	0.002	225	0.225
22	3	1.600	0.005	320	0.533
AVERAGE				**191.1**	**0.440**

Appendix: I

Table A.7: Statistical data for low income model

Model

Regression Statistics	
Multiple R	0.636829
R Square	0.405551
Adjusted R Square	0.379705
Standard Error	0.174047
Observations	26

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.475327	0.475327	15.69127	0.000619
Residual	24	0.696726	0.030292		
Total	25	1.172053			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.73855	0.086742	8.514325	1.45E-08	0.559111	0.91799	0.559111	0.91799
HOUSEHOLD	-0.06195	0.01564	-3.96122	0.000619	-0.09431	-0.0296	-0.09431	-0.0296

Appendix: J

Table A.8: Statistical data for middle income model

MODEL

Regression Statistics	
Multiple R	0.681058
R Square	0.463839
Adjusted R Square	0.437031
Standard Error	0.151316
Observations	22

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.396163	0.396163	17.30226	0.000484
Residual	20	0.457932	0.022897		
Total	21	0.854096			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.940955	0.092835	10.13575	2.52E-09	0.747304	1.134606	0.747304	1.134606
HOUSEHOLD	-0.11064	0.026598	-4.1596	0.000484	-0.16612	-0.05516	-0.16612	-0.05516