CHAPTER ONE

INTRODUCTION

1.1 Background Information

The quest to satisfy human wants and needs results in the conversion of resources; both natural and anthropogenic to suitable forms for human consumption and survival. Wastes, which are the unwanted material results as such from the transformational as well as the consumption of these resources. The 1995 Environmental Act of UK defines waste as 'any substance or object which the holder discards or intends to discard'. A 'holder' means the producer of the waste or the person who is in possession of it (Williams, 1998). With continuous economic development and an increase in living standards, the demand for goods and services is increasing quickly, resulting in an increase in per capita generation of solid waste (Narayana, 2008).

Rapid population growth, urbanization and industrial growth have led to severe waste management problems in the cities of developing countries like Ghana. Waste problems have great effects on the quality of the environment as well as human life. This can lead to human diseases such as cholera, malaria, and typhoid fever. Health and social effects are equally as important as environmental impacts when considering municipal solid waste management. Environmental sanitation is as such of great concern to governments and policy makers in a bid to prevent disease occurrence. It is incumbent upon us then to act now to manage waste properly to avoid the occurrence or incidence of communicable diseases.

The large quantities of waste generated in the Subin Sub-metro necessitate a system of collection, transportation and disposal. It requires knowledge of what the wastes are comprised of, and how they need to be collected and disposed. Successful waste management requires the participation of citizens, local governments, and private entrepreneurs. The solution to waste management is not merely technical, but also organizational. There is a great need to move away from the disposal-centric approach and toward the recovery-centric approach of waste management. This paradigm shift requires some level of public participation by regulating and monitoring waste generation and disposal (Narayana, 2008).

The method of waste disposal employed normally depends on several factors which include the waste stream, equipment capacity, finance and so on. For many people, the way to dispose of waste is to simply drop it someplace. Open, unregulated dumps are still the predominant method of waste disposal in most developing countries. Although, most countries forbid open dumping, at least in metropolitan areas, illegal dumping is still a problem. This results in choked drains which breed mosquitoes, produces stench and presents an eye sour. Other people dump waste into the ocean with the notion of the ocean having infinite capacity to cleanse itself. Until recently, many cities in the United States dumped municipal refuse, industrial waste, sewerage, and sewage sludge in the ocean (Cunningham and Cunningham, 2002). They however, forget that the ocean has a critical level above which its quality will be degraded.

Other methods of waste management include source reduction/minimization which aims at minimizing waste at the point of generation through efficient use of resources so that

less waste will be left to manage. Reduction of waste at source can be achieved by developing clean technologies and processes that require less material in the end products and produce less waste during manufacture. This method however, cannot eradicate waste completely since there will be leftover to manage. Some components of the wastes can be collected and re-used, for example doorstep milk delivery in the UK involves collection, cleaning and re-use of glass bottles. Re-use in some cases can be very attractive. However, it may not be desirable in all cases since the environmental and economic cost of re-use in terms of energy use, cleaning, recovery, transportation etc. may outweigh the benefits (Williams, 1998).

Some components of waste that are recyclable can be recycled. This involves the recovery of materials from waste and processing them to produce a marketable product, for example, the recycling of glass and aluminium cans. Energy can also be recovered from the waste through incineration and composting.

Waste which poses a lot of problems to societies including health problems can be seen as "money" to generate income for waste management firms and workers as well as generation of resources such as electricity, biogas and compost.

1.2 Problem Statement

General congestion in Subin Sub-Metro has led to uncontrollable generation of waste which could lead to some constraints on the health of residents. The relatively high incidence of sanitation related diseases such as malaria, cholera, typhoid fever, and dysentery are attributable to improper management of solid waste. According to the Kumasi Metropolitan Assembly DHMT Annual Report (2006), out of all the cholera cases reported to health facilities, about 50% came from Subin Sub-Metro where solid waste management is perceived to be worst. Filth and foul smell emanating from the heaps of rotten refuse are another cause of worry. According to the Environmental Unit of KMA, the number of tourists to the Kumasi Zoological Gardens, some hotels and recreational facilities in the area could be reduced considerably as a result of stench coming form chocked gutters and heaps of uncollected solid waste at the Sub-Metro.

Outstanding among the problems stated, people constantly litter the streets, pavements and lawns without any hesitation as a result of inadequate public education and sensitization programmes. According to a Health Education Unit of the Metropolis, public health education programme are repeatedly carried out and whether it is making the impact on the attitudes and practices of the citizenry has not been ascertained (NHLMC Annual Report, 2007).

According to the Metropolitan Waste Management Department Annual Report (2006), some of the contracted solid waste service providers in the Metropolis do not have the requisite equipment holding capacity to ensure effective collection, storage and transporting of solid waste to the final disposal site at Dompoase.

According to the Metro DHMT Annual Report (2007), the relatively high incidence of water borne diseases like typhoid fever, cholera, dysentery and other gastro-intestinal infections prevalent in some nearby communities are attributable to the pollution of the streams which serve as source of drinking water to them with waste from the Subin River.

1.3 Rationale of Study

The Annual Report of the Metro DHMT (2007) indicates that the relatively high incidence of malaria and water borne diseases like typhoid fever, cholera, dysentery and other gastro-intestinal infections may be attributed to the pollution of the streams which serve as a source of drinking water to the nearby communities with waste from the Subin River. According to the DHMT Annual Report (2006), out of the cholera cases reported to health facilities in the study area, 50% came from Subin Sub-Metro where solid waste management is perceived to be worst. Since the above consequences on the inhabitants of the Subin Sub-metro are as a result of improper solid waste management, it is appropriate for this study to be undertaken.

The study presents a comprehensive assessment of the methods of municipal/domestic solid waste management in the Sub-metro and the factors that affect waste management and the inhabitants such as geographical assess to dumping sites, public education and sensitization, equipment holding capacity of KMA and private service providers, and public health effects and make some recommendations to authorities, private sanitation

agents and other stakeholders in improving the management of refuse in the Sub-Metro Area.

The relevance of the appropriate recommendations and suggestions made in the research to the various officers of health and appropriate stakeholders will stimulate and encourage the policy makers at the Metropolitan and Regional levels to formulate comprehensive strategies to improve upon the current improper municipal solid waste management in the sub-metro and beyond.

1.4 Hypothesis / Conceptual Framework

Solid waste management which lies in the core is the main subject of the research work and it involves the collection, transportation, deposition and eventual management of the waste. All the methods of solid waste management mentioned above can effectively prevent the problems of waste if well managed. The factors which affect solid waste management in the Sub-Metro include geographical assess to dumping sites, equipment holding capacity, and education and sensitization. The management of the waste also has an effect on public health of the inhabitants. The table below shows the conceptual framework.

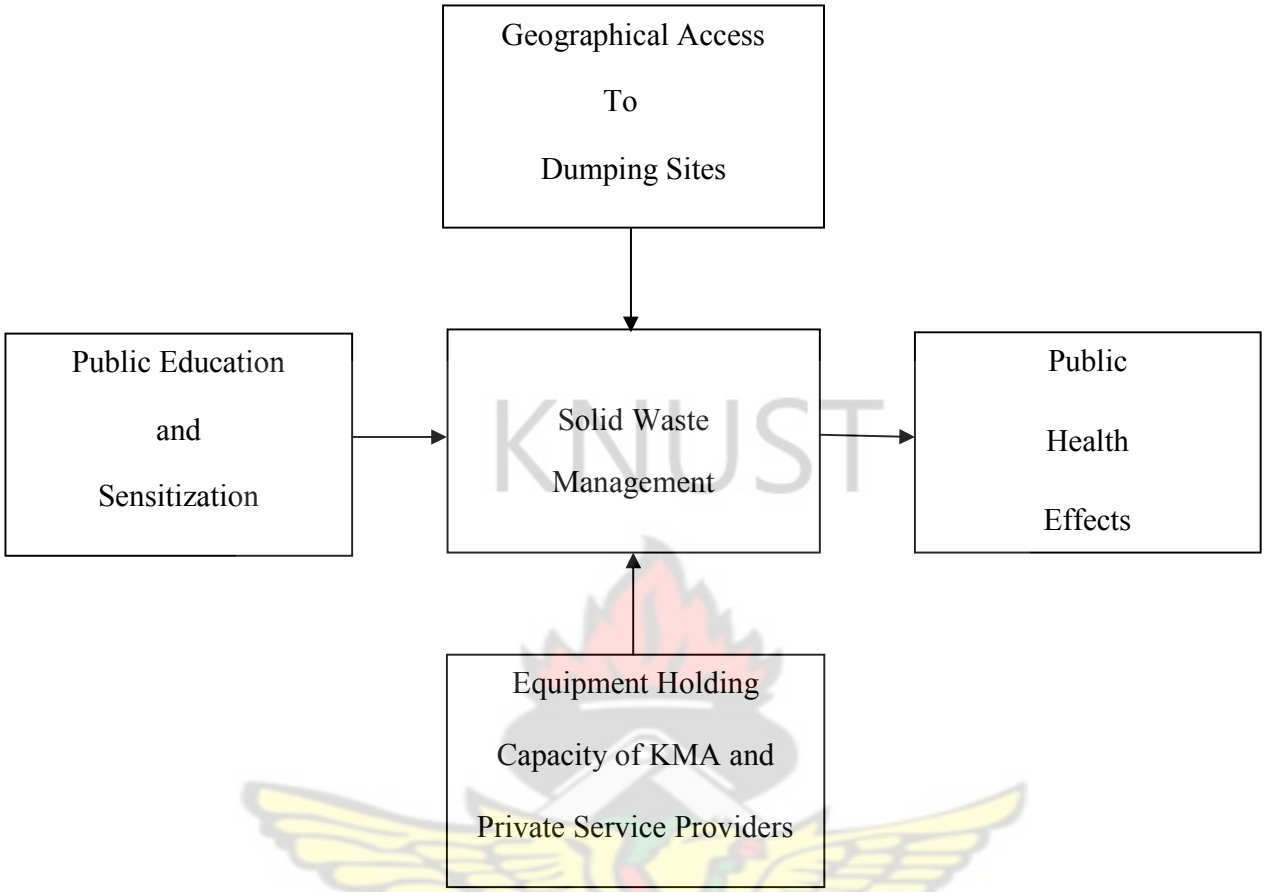


Figure 1: Conceptual framework of the study.

Generally, most people in the Sub-Metro will have a strong incentive to send waste to a centralized collection system if the distance to the dump site is not far and easily assessible. This mentality of the people as well as illegal dumping can be effectively eradicated through public educational programmes which aim at sensitizing the people on the effects of improper solid waste disposal and the need to embrace proper management of waste. The problems of waste can partly be attributed to the inadequate equipment holding capacity of KMA and private service providers which hinders effective collection

and management of waste in the Sub-Metro. Waste, if well managed will eradicate many sanitation diseases but the health of inhabitants will be at risk if poorly managed.

1.5 Research Questions

The research questions that guided the study were as follow:

1. What was the distance to cover to the nearest dump site in the Subin Sub-metro?
2. How effective were the quarterly Public Health Educational Programmes organized in the Sub-Metro?
3. Were private service providers in the Metropolis having the requisite equipment?
4. What were the Public Health effects of improper solid waste management in Subin Sub-Metro?

1.6 Objectives

The main objective of the study is to examine ways of improving solid waste management in the Subin Sub-Metro of Kumasi Metropolitan Assembly (KMA).

However, the specific objectives of the study are to;

1. Determine the geographical location and accessibility of dumping sites (Landfills) in the Metropolis.
2. Examine public education and sensitization programmes on sanitation in Subin Sub-Metro of KMA.
3. Outline how KMA and other private service providers are equipped in management of solid waste in Subin.
4. Assess the Public Health effects of improper disposal of solid waste.

5. Make the necessary recommendations to authorities, private sanitation agents and other stakeholders in improving the management of solid waste in the Sub-Metro Area.

1.7 Profile of Study Area

Subin Sub-Metro is located in the heart of the Kumasi Metropolis and covers an area of 180 square kilometers. The Metropolis lies between 6.35" – 6.40" and longitude 1.30" – 1.35". Administratively, Subin Sub-Metro District Council was established by legislative instrument 1614 with other four (4) Sub-Metro Councils in KMA in the year 1995 (Korboe and Tipple, 1995). Subin, largely known and referred to as the City of Kumasi is divided into ten (10) residential zones which include: Adum, Adum-Nsuase, Asafo, Asem, Anlo Fante Town, Baamu-Dominase, Dadiesoba, Fante New Town, Ministries and Pampaso.

1.7.1 Climate and Vegetation

The Metropolis falls within the wet sub-equatorial type of climate with an average minimum temperature at about 20.5 ^{o}C and maximum around 30.7 ^{o}C. The average humidity is about 84.6% at 0900 GMT and 60% at 1500 GMT. The moderate temperature and humidity and maxima rainfall regime (214.3 mm in June and 165.2 mm in September) have a significant bearing on the population growth and the environment.

The area falls within the moist semi-deciduous South-east Ecological Zone. There are dotted patch of vegetation reserves within the metropolis that has led to the development

of the Kumasi Zoological Gardens and the well managed Parks and Gardens by which the city is code-named “The Garden City”.

1.7.2 Population

Subin is the most densely populated area in the Metropolis with current estimation of 2,000,000 at a growth rate of 5.4% (Statistical Service Reports, 2006). The unique central location of the City (Subin) as transversing point from and to all parts of the country makes it a special place in terms of social, economic, cultural and political life of Ghana.

1.7.3 Socio-cultural Activities

The Sub-Metro is endowed with the National Cultural Centre and a theatre where rich culture of Asante and Ghana as a whole in weaving, curving, clay, cane and straw crafts, music and dance respectively are portrayed. The Sub-Metro has other tourism potentials such as the Babayara Sports Stadium, the Kumasi Zoological Gardens with some prominent hotels which depicts the true Ghanaian culture in the hospitality, recreational and entertainment industry.

1.7.4 Occupation/Economic Contribution

Subin Sub-Metro has a budding industrial sector with both formal and informal industries dominated by foreigners and their Ghanaian counterparts. The booming economy of the area cannot be underrated with the presence of the Kumasi Central Market which is one of the largest in West Africa. This is the biggest market for second-hand clothing and

electronic items in the Sub-zone. Also, the locally produced footwear and handbags from the Central Market finds markets in the nearby countries.

Adum, the biggest area in Subin is the main commercial/business centre for wholesale, retail and distribution of goods imported from Europe, Japan, China and Malaysia (Developing Plan for Kumasi Metropolitan Area, 2002-2006).

The area of study is easily accessible because of its nearness to Kejetia/Central Lorry Station and that of Asafo where the largest frozen foods (meat and fish) markets are located.

1.7.5 Transportation

Subin has a superb road networks which link the Metropolis to all other regions in Ghana. Almost all the roads here have been tarred with asphalt. According to the Development Plan for Kumasi Metropolitan Area, 2002-2006, Urban Public Transport is currently offered by "trotros" (Mini-buses) and taxis for people without private means of transport. These "trotros" or shuttle commuters are the major carriers of passengers, accounting for more than 60% of passenger kilometers within the Metropolis. Now, the Inter-city Metro (large/long) buses are introduced to argument public passenger transportation in the Metropolis.

1.7.6 Health

The Sub-Metro is endowed with a lot of health care facilities both public and private. They include the Komfo Anokye Teaching Hospital which is second to Korlebu in Accra,

the Maternity and Child Health Care Hospital, and the KMA Clinic located in Subin are the major health care service providers in the Metropolis. Though there are other District and Public Hospitals together with Health Centres, the Metropolis has about 60 private hospitals and maternity homes that cater for health care service in the city as well as the region.

The prevalent diseases in the area are Malaria, Cholera, Typhoid Fever, Hepatitis B, Diabetes, Hypertension, Tuberculosis, Diarrhoea, Sexually Transmitted Infections, HIV/AIDS etc. (Public Health Directorate Annual Report, 2006).

1.7.7 Religion

The major religious groups in the Metropolis are Christianity, Islam, Traditional, few Buddhist, Rastafarians and other small faith based sects.

1.7.8 Education

The Sub-Metro has a good number of educational facilities such as Pre-School, first and second cycle institutions including Technical, Vocational, Business and a Teacher Training College. At tertiary level, the Kumasi Polytechnic, the Institute of Languages are both located in Subin with one or two Islam Arabic/English Schools. The informal educational system is a common phenomenon where skill training programmes are offered in fitting, sewing, hairdressing, beautification/decoration, carpentry and joinery, construction and so on.

1.7.9 Electricity and Water Supply

Subin Sub-Metro is connected to the National grid and significant proportion of houses have benefited from regular supply of electricity.

The main source of water supply is pipe-borne and every residential area in the Sub-Metro has access to safe and adequate water supply from two (2) nearby plants. Other sources of safe water include bore-hole stands and deep wells.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

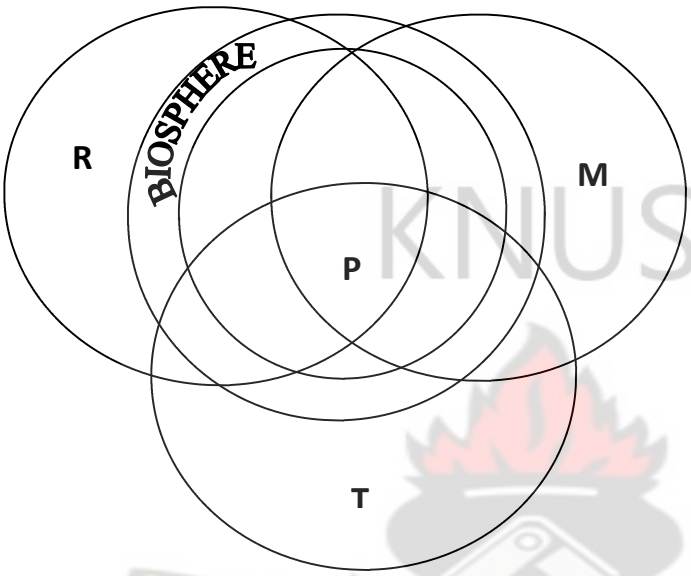
As people search for better life, improved and higher standard of living, they tend to consume more goods and generate more waste. These wastes create problems in the society which include health problems. Consequently, society is searching for improved methods of waste management and ways to reduce the amount of waste for quality health.

Solid waste management starts with disposal activities that start from point of waste generation to dumping. Hill (1997) describes the world as finite and that the continued pollution of environment will if not controlled be difficult to rectify in the future, hence the subject of solid waste management is both timely and important. The overall objective of solid waste management is to minimize the adverse environmental effects caused by the indiscriminate disposal of solid waste, especially hazardous wastes.

The overview of the study could not separately clarify these activities but only identify them as initial disposal, storage collection, transportation, treatment and final dumping. The systems of waste management go beyond these disposal activities to management of the waste which includes recovery of energy from the waste.

Beale (1980) stated, "Science has made a mess of this planet but given the money, science can clear it up". Thus, scientific and technological cleverness alone are inadequate to solve the problems of population growth and explosion, wasteful resources, exploitation, pollution and degradation. The products of modern society come from the

application of technology to resources. The impact of this on the biosphere strongly depends on the quality of the management applied to effect the combination, as illustrated schematically in fig. 1.



Product of Society (P)
= Resources (R) × Technology (T)

Impact on biosphere depends on quality of Management (M)

To buttress his point, Beale further stated that environmental management is not "management of environment". It is the management of activities within tolerable constraints imposed by the environment itself, and with full consideration of ecological factors. The objective is to meet basic human needs within the potentials and constraints of environmental systems.

According to Kreith (1994), solid waste management has become a major concern in the United States and majority of Americans in their public opinion polls support an integrated waste management system. This consists of source reduction, recycling, composting, waste-to-energy (incineration) and landfills. These and other legally accepted traditional methods of disposal constitute management methods.

Williams (2000) reported that the Environmental Protection Act of 1990 sets out the waste management strategy of UK introduced the system of Integrated Pollution Control (IPC). Part I of the EPA deals with prescribed process, including waste incineration, and Part II deals with disposal of waste on land, including landfill.

The late 1980s and 1990s therefore saw further development of waste management and much of the legislation introduced had its source in European Directives, which set out European Community-wide objectives and standards which member states implements through individual state legislatures.

With much efforts of the UK EPA (2000), according to Williams (2000), the increasing concern for the environment and the toxic waste dumping incidents led to demands for tighter legislative controls on waste disposal.

2.2 Waste Disposal Management Methods

2.2.1 Composting

On average, over 50% of municipal solid waste in developing countries can be readily composted (Hoornwegeted, 2007). According to Flintoff (1984), the alternative to tipping (landfill) and incineration is composting. He also reports that 88 % of the contents of Indian refuse are acceptable for composting. The figures from Mexico and Britain are 65% and 64% respectively. According to Environmental Protection Agency (EPA), the U.S. produces 11 billion tons of solid waste each year and nearly half that consists of

agricultural waste which are generally recycled into the soil as fertilizer for improved crop production (Cunningham and Cunningham, 2002).

Due to rapid increases in urban population, municipal solid waste and sewage sludge have increased dramatically in the past 20 years. Environmental pollution caused by municipal solid waste and sewage sludge becomes a serious social problem which hinders urban development, especially for large cities in developing countries, such as Shangai. According to Kanat et al. (2006), it is critical that we find ways to effectively reuse such wastes and reduce their impact on the environment. The organic content of waste is generally higher in developing countries; therefore, composting is an appropriate alternative for management. According to Cunningham and Cunningham (2002), composting is a good way to convert yard waste, vegetables, scraps, and other organic materials into useful garden mulch.

Composting which is a form of recycling organic waste may be defined as aerobic rather than anaerobic degradation of biodegradable organic waste such as food and garden waste. Anaerobic composting is the digestion and referred to as fermentation or putrefact without the presence of air or oxygen. It is the process by which organic muds are broken down by bacteria in marshes, producing marsh gas, consisting mainly of methane (CH_4), but also of ammonia (NH_3) and various sulphur containing gases, which smell-unpleasantly.

It has several advantages over other methods of waste management options (Withiams, 2002). According to Banegas *et al.* (2007), composting not only helps to solve the problem of waste disposal but also produces as useful bioamendment agent (compost).

Composting also generally plays an important role in China. This may be driven by the value of carbon emission reductions, the high percentage of organic waste in municipal solid waste, and the potential market for finished compost (The World Bank, 2005).

According to Feachem et al. (1983), the agricultural value of composting is greatest if refuse or thrash is composted with suitable quantities of right soil or sludge. They confirmed this with how Indian cities and greater number of villages in China use this method for improved food production and security. Kalou and Yaldiz (2004) also established that the highest organic matter degradation and temperature values of composting can be obtained at an aeration rate of 00.4 air $min^{-1}kg^{-1}$ in a study of the composting of agricultural wastes. In a study of the composting of diary manure with rice straw, it was found that an aeration of 0.251/min kg Vs was capable of achieving the highest composting temperature.

2.2.2 Landfills

Land filling is one of the reliable "disposal" methods of managing municipal solid waste. It is also most economical, especially in developing countries where it typically involves pitching refuse into depression or closed mining site (Daskalopoulous et al., 1998). A landfill is an area of land onto which waste is deposited. The aim is to avoid any contact between the waste and the surrounding environment, particularly the groundwater.

There are four different types of landfills as recognized and accepted under specified conditions in the Government of Ghana Landfill Guideline (2000). They are Sanitary landfill, high density aerobic (HAD) landfill, mechanical improved dumping and manual

improved dumping. Under operation and maintenance, landfill sites shall be operated better than an open dump and a simple well organized operation and disposal plan prepared during the site design shall be used to guide the operation of site. The nature of the terrain, availability of equipment and personnel shall be the governing factors.

Williams (2000) establishes that landfill is the predominant route for waste disposal in the UK, and throughout Europe and North America. Biological processes within landfill ensure that over a period of time, the waste is degraded, neutralized and stabilized to form an essentially inert material and others which result eventually in recovered land. According to E/I Fadel et al. (1997), landfill gases (LFGs), produced when methanogens decompose complex molecules, are primarily methane and carbon dioxide (up to 90%, but also include CO, N_2, alcohols, hydrocarbons, organosulfur compounds, and heavy metals.

Currently, the combustion of landfill gas to produce energy in the form of electricity or power generation or district heating has become the norm for modern landfill. Incineration on the other side has seen a decrease as waste disposal option following the closure of many plants which cannot comply with new legislation on emission limits (Williams, 2000). To buttress his point, Williams (2000) stated that the current situation in the UK is that still by far the majority of waste disposed of in landfill sites, accounting for 90% of domestic waste, 85% of commercial waste and 73% of industrial waste (Department of Environmental and Welsh Office, 1995).

Cunningham (2002) stated that landfills are the most common method for majority of municipal waste in the US. Health and ecological problems makes landfills to be sited away from streams, rivers, lakes, floodplains, and aquifer recharge zones simply to avoid leachate from entering them.

2.2.3 Incineration

It is still necessary to dispose of residue, normally by tipping (landfills) but a large volume and weight is greatly reduced by incineration where most plant nutrients in the refuse have been lost so that the residue is of negligible value to agriculture. An advantage of this method is that it can be carried out relatively close to the centre of a city, thus saving in transport costs (Cairncross et al., 1983). Cunningham (2002) also stated that due to the growing piles of garbage and lack of available landfills at any price, public officers (in the US) have recognized and accepted the combustion of waste as an option to the municipal solid waste management methods.

Incineration as technology implies, is also referred to as energy recovery or waste-to-energy, because the heat derived from burning refuse is useful either in heating or generating electricity (Peavy et al., 1985).

Internationally, well over 1,000 waste-to-energy plants in Brazil, Japan and Western Europe generate much needed energy while also reducing the amount that needs to be landfilled. In the US more than 110 waste incinerators burn 45,000 tons of garbage daily (Cunningham and Cunningham, 2002).

Health and social side effects are equally as important as environmental impacts when considering MSW management. For people in developing countries, bodily well-being is a far more pressing concern than the fact that, open burning of garbage contributes to acid rain or global warming. Outrage over health issues of poor waste management could therefore be motivating factor towards sustainable in Drczk's discourse on green rationalism.

The EPA, which generally supports incineration, acknowledges the health threat of incinerator emissions but holds that the danger is very slight. It was estimated that dioxin emissions from typical municipal incinerator may cause on death per million in 20 years of operation while critics hold to 250 deaths per million in 20 years (Cunningham and Cunningham, 2002).

Cairncross et al. (1983), holds the view that efficient incineration requires sufficiently combustible refuse and a fairly expensive incineration plant which is reliably operated. A common problem he indentified is the difficulty of keeping collected refuse dry in wet weather. Even in dry weather, the refuse collected in many tropical cities require large land prohibiting expensive amounts of fuel oil for its incineration.

2.2.4 Recycling

The US EPA Office estimated that Americans dispose 54 millions of household appliances every year inconsiderate of how long they have been used. This calls for demanufactoring or the assembly and recycling of such obsoletes and thus serving a pool of both skilled and unskilled labourers who need job (Cairnoross et al., 1983).

In term of SWM, Cunningham (2002) defines recycling as processing of discarded materials into new, useful products. For instance, old tyres are shredded and turned into rubberized road surfacing, news papers become cellulose insulation, while kitchen wastes become valuable soil amendment (compost) and steel iron becomes new automobiles or construction materials. Under the topic remanufacturing convertibility, Hill (1997) stated that the product components are designed in a way that allows them to be put to a different use. For example, a copier part may find a second life in an electronic printer. Proctor Gamble, an industrialist as another example, found upon analyzing energy consumption over the life time of its laundry detergents, that the most energy-intensive step is the heating of washing machine water. Consequently, they began to design detergents that work effectively in cold water or when less water is used.

Japan has the most successful recycling program in the world. As claimed by Cunningham (2002), half of all Japan's household and commercial waste are recycled, while the rest are about equally incinerated or landfilled. By comparison, the US landfills more than 60 % of all SW. Japanese diligently separate wastes into as many as seven categories in different coloured containers, each picked up on a different day for a very easy recycling system.

Recycling can also pose health and environmental risks. Sorting materials contain high concentration of dusts, bio aerosols and metals. Workers and scavengers commonly experience itching eyes, hands if unprotected, sore throats and respiratory diseases (Gladding, 2002). Environmentally speaking, recycling uses a large amount of energy resources (Daskalopoulous et al., 1998).

Scavengers thus picking or selecting items for reuse or recycling are unavoidable on tip, and are more easily controlled than avoided. It provides employment, generates income for the poorer members of a community, and reduces cost of refuse collection. For example, it is estimated that 60 % of the poorer sections of Japan find themselves in scavenging and recycling jobs (Williams, 2000).

2.3 Factors Affecting Waste Disposal Management

The solution to the mounting problems in the management and disposal of MSW lies in the efficient application of a variety of waste management technologies and the adequate use of integrated waste management methods. The study therefore wishes to consider problems emerging from geographical accessibility of dumpsites, public education and sensitization programmes, the equipment capacity of service providers in the study area and health effects from improper waste disposal.

2.3.1 Education and Sensitization of Residents

The inability of people in developing countries, especially those in Sub-Sahara Africa to properly dispose and manage waste is the result of high illiteracy rate. The increased rate in attitudes that lead to improper waste disposal and lack of technology in recycling waste products, have led to the generation of unattended large quantities of waste. Increased affluence and crave for foreign products and second hand goods by developing countries have also led to serious no-stop waste generation.

According to Barrow (1995), in less developed countries where illiteracy is predominantly high, municipal and domestic waste are less likely to be put into good use or recycled because dwellers consider it less significant. A little knowledge on composting would have boost up their agricultural products. This was confirmed by Chowder (1995) that SW generated in communities with higher percentage levels of illiteracy exceeds all other wastes in the less endowed countries. To buttress this same point, Clark (1953) revealed that wastes generation in less developed countries are high because of the improper education on the use of agricultural waste and even the last residue from the food they eat. He however pointed out that theory must go hand-in-hand with attitudinal practice for better result. This really goes with the Chinese adage "I hear and I forget, I see and I remember but I do and understand".

Education in this context is to change human attitude, so it is better when applied at an early stage of life. According to Kreith (1994), the USA EPA in 1992 published "The Consumer's Handbook for Reducing SW to help consumers understand their vital role in source reduction of waste through reuse and recycling. He also echoed in his publication

that EPA in 1989 published a comprehensive educational package for kindergarten school teachers up to grade 12 (American educational system). The package provides course and resource materials on the importance of reducing and recycling of waste. The same year EPA launched a quarterly newsletter "Reusable News" to help raise awareness and foster improvement of SWM to Native American tribes. Finally but not least, the EPA in 1985 made an effort to educate the general public and built consumer confidence by providing funds to help the Environmental Defense Fund (EDF), launched nationwide advertising campaign to promote recycling.

Olufunke et al. (2001) in their publication confirmed a research work conducted by IWM where resident in Ghana for the metropolitan people of Tamale, Accra and Kumasi were sensitized on how to change agricultural garbage and faeces into compost fertilizer for increased vegetables production for food security. This was done in an intensive capacity building programme organized in partnership with municipal authorities, WM2s, farmers, researchers, market sellers, etc.

2.3.2 Public Health Effects from Improper Wastes Disposal

The available information regarding studies of landfill and the direct effects on the health of local populations has been reviewed and Elliot et al. (2001) provides quantitative estimates of excess risk of congenital anomalies, still births and low and very low birth weights in population living within 2 km of a landfill. The Government of Ghana (2000) in a Draft on Landfill Guidelines stressed that health and safety procedures are very important if undue attraction of the public attention is to be avoided on SW issues. In general, service providers, drivers of haulage trucks and accomplices need to be

sensitized and alert on site to avoid accidents and prevention of other adverse physical health problems. They should be trained, and use care in off-loading containers and tipping vehicles.

As of the end of 1992, about 160 municipal SW incinerators were operating in the United States, with the capacity to burn approximately 110,000 tons of waste per day (Kreith, 1995). Although incineration is often referred to as a waste disposal method, it is more of accurately described as a waste processing technology. While it provides the important benefit of reducing the amount of waste requiring disposal, it creates range in air pollution concerns and leaves behind its substantial burden of toxic ash residues that must be managed and disposed of properly.

Open dumps or uncontrolled incinerators can release to air wide range of pollutants at levels that may pose significant risks through direct inhalation of the emission. Kreith (1995) supports this, that virtually all US residents now carry measurable levels of these pollutants in their bodies, in some populations, existing levels of exposure and body burdens are already in a range associated with detectable adverse impacts. Barrow (1995) pointed out that the burning of waste at an uncontrollable dump sites destroys the soil, and the organic filled smoke sometimes distorts visibility which may lead to vehicular accidents.

According to World Health Organisation (WHO), more than 5 million children aged 14 and below die from illness and other conditions caused by the environment in which they live, learned and play. This shows that the hazards caused by improper SW disposal and other human activities in the environment are immense.

According to Hill (1997), many heavy metals present in MSW incinerators by-products have well-defined health effects that have been demonstrated in numerous studies of exposed human population. Several are carcinogenic (cancer-causing), but these and others can also exert adverse effects in humans, animals, plants and aquatic life.

Adzoba (1989) stated that due to poor disposal of human waste, the environmental quality has been affected with prevalent cases of sanitation related diseases such as cholera, typhoid, and malaria in Ashiaman residential area.

2.3.3 Access to Dump Sites

Open dumping of MSW is not the best in MSW management due to its immediate adverse side-effects on public health. Open dump sites are nuisance and need to be avoided in disposition of waste in the urban cities. Just as any other city in developing countries, Subin in the heart of Kumasi faces the problem of better location and accessibility of approved dump sites or landfills. The people therefore depend and deposit all their waste at the nearest KMA dumpsites located at the farthest ends of Kumasi.

According to the Government of Ghana Landfill Guidelines Draft (June, 2000), there is an up sage in concern for the management of MSW due to the escalating rate of SW generated especially in the cities. Based on the estimated population of 20 million and an average daily waste production per capita of 0.45 kg, Ghana produces annually about 3.3 million tons of SW. The Guidelines draft also revealed that all kinds of wastes (MSW), regardless of their nature, are being dumped indiscriminately without due regard to the nuisance or harm caused to the environment, in depressions, low spots such as sand pits,

old quarries, beaches, drains and even in certain areas, along streets and roads. To buttress this point, the Ghana Landfill Guidelines: Draft, June 2000 stated that in most developing countries (and indeed developed countries, e.g. USA 70%, UK 85%) disposal of waste into land remains the main route of final disposal.

Dump sites shall be operated in a simple well-organized operation and disposal plan prepared during site design shall be used to guide the site operation. Local access and operations shall vary as conditions of the individual sites vary. The nature of the terrain, availability of the right equipment, transport facilities and personnel shall be governing factors.

For full accessibility; as one of the objectives of the study calls for, dump sites especially landfills need to be well designed and sited at a manageable distance and should meet such additional conditions as Access Roads and minimum Transport Running Costs. According to a research conducted by Nyang'echi (1992), residents who cover more than 250 m (farther distance) are likely to dump refuse into drains, open spaces, streams, immediate surroundings, etc. Another work done by Heijman and Langendijk (1992) revealed that the shorter the dump sites or storage points, wastes generated are well disposed resulting in a healthy environment. Beale (1980) in his study stressed that the farther the dump site, the more expensive it becomes to fuel and maintain trucks and equipment involved in the management process.

2.3.3.1 Access Roads

Lack of motorable roads make evacuation of waste from transfer station to final disposal sites difficult, hence the spillage and its attendant public health hazards. If access roads are unmotorable, most especially during rainy season, transportation of waste become a problem to service providers situation which may easily lead to adverse on the health of people.

For easy access to dump site, there should be a two-way traffic for easy flows of vehicles. Such roads need to be well graveled and must be 38 m in width. All temporary access roads constructed within site should have a firm base and should be covered with suitable material to allow adequate traction, particularly during the wet season. For easier tipping, access roads should be kept in good condition, regularly maintained and repaired to allow vehicles to off load / deposit their waste quickly and efficiently. Road inspection and maintenance-clearing, grading, filling of potholes-shall be done on regular basis.

2.3.3.2 Equipment Capacity of Service Providers

The SWD and other service providers mostly have minimal capacity of machines and equipment which leads to inefficient MSW management. Because of this, when KMA was to introduce Public Private Partnership (PPP), they inspected the equipment holding capacity of all the solid waste contractors before awarding them contracts. Some of the equipments inspected and the required number were two compactor trucks, two skips and a payloader and four trucks. This was done with the view that inadequate holding capacity would affect the level performance of the service providers and hence, public health consequences (KMA DHMT Annual Report, 2006).

Nationally, the Ghana Landfill Guidelines: Draft, 2000 has this to offer as equipment capacity for MSW management and this could be applied elsewhere.

When selecting suitable vehicles, waste generation rates and densities need to be considered along with: areas they need to access (e.g. Access roads, narrow alleys or uneven paths) and distance between collection and disposal points. For example, a wheel barrow could collect waste from approximately 50 individuals before requiring emptying (WHO, 2005).

2.3.3.3 Transport Running Cost

Vehicles especially trucks and other machines need to be maintained at a high running costs for continuity of disposal activities. If not well planned, such machines and vehicles may run down or not function due to lack of funds for fuel and replacement of damaged parts. The transport section of every SWD must be well organized, planned, controlled and managed for absolute continuity of work both on site and outside. The initial costs of machines, vehicles and equipment are very high hence the need for good maintenance for continuous service delivery.

CHAPTER THREE

METHODOLOGY

3.1 Study Method and Design

A descriptive cross-sectional study was used to gather data on the methods of solid domestic waste management in the Sub-metro and the factors that affect waste management and the inhabitants such as geographical assess to dumping sites, public education and sensitization, equipment holding capacity of KMA and private service providers, and public health effects and make some recommendations to authorities, private sanitation agents and other stakeholders in improving the management of refuse in the Subin Sub-Metro. Focus Group Discussions were organized to elicit information on consequences of improper solid domestic waste management and suggestions offered to improve solid domestic waste management.

3.2 Study Population

The study population involved individuals and institutions in the Subin Sub-Metro with specific reference to government and private institutions who usually supervise or direct the daily handling of sanitation in the home and twenty (20) key informants.

3.3 Sample Size

A sample size of two hundred and forty-six (246) was used in the study. The following statistical formula was used based on the fact that the study population was more than 10,000:

$$n = \frac{z^2 pq}{d^2}$$

Where n = the desired sample size (when population is greater than 10,000)

z = the reliability coefficient for 95% confidence level usually set at 1.96

p = the proportion in the target population estimated to have a particular characteristic.

50% was used because there was no reasonable estimate. (i.e. 0.625)

$$q = 1.0 - p$$

d = degree of accuracy desired, usually set at 0.05

$$n = \frac{(1.96)^2(0.20)(0.80)}{(0.0625)^2}$$

$$n = 246$$

The total sample size came up to four hundred and twenty-seven (246) after the careful consideration of non-response.

3.4 Study Variables

The study variables included types of receptacles for waste, frequency of disposal, distance of refuse dump, type of refuse dump, availability of community storage receptacles, disposal methods and methods of waste transport, attitude and behaviour towards sanitation, public education and sensitization, equipment holding capacity and public health effects. The methods of municipal solid waste management was the dependent variable whiles the others were independent.

3.5 Sampling Technique

Multistage, purposive and simple sampling techniques were used. Multipurpose sampling technique was chosen because the study involved a large scale survey and purposive sampling technique was also chosen because the study subjects had in-depth information which will give optimal insight into the issue under investigation. A sample of ten suburbs within the Subin Sub-Metropolis was selected. These constituted the first stage sampling units.

According to the number of sampling units in the Sub-Metro, 30 individuals were selected from Adum since it is the most populated suburb and twenty-four from each of the remaining nine suburbs which include Adum-Nsuase, Asafo, Asem, Anlo Fante Town, Baamu-Dominase, Dadiesoba, Fante New Town, Ministries and Pampaso by simple random probability sampling.

These 246 individuals became the second stage sampling units of the multistage technique. Twenty (20) key informants including teachers, Department of Solid Waste (KMA), chiefs/community leaders, dispensing chemists and the Assemblymen of the Sub-Metro were selected by the purposive sampling technique.

3.6 Data Collection Techniques and Tools

The main data collection tool was a structured questionnaire backed by interview. The main issues that were addressed in the design of the questionnaire included the respondents' educational background, socioeconomic and cultural backgrounds, knowledge level on solid waste management, attitude and behaviour towards sanitation programmes, types of receptacles used to collect solid domestic waste, frequency of

emptying storage receptacles, methods of transport of solid waste, method of refuse disposal, proximity to dump site and availability of community storage receptacles, public health, equipment holding capacity and public education and sensitization.

Focus Group Discussions were conducted to elicit suggestions from respondents for improving municipal solid waste management and consequences of improper solid domestic waste management.

The questions were both closed and open-ended. Interviews and observation as regards how the respondents collect, store, transport and finally dispose of their solid domestic refuse were employed to find out more relevant facts about how solid municipal refuse is being managed in the study area.

Collection of data was done from November to December, 2008. Since some of the respondents were illiterates, their responses were recorded in English after the questions had been interpreted in the local language to them. For the literates, the questionnaire was handed over to them and they were requested to use four days to complete the items. The response rate for the self-administered questionnaire was 100%. The data collected by the questionnaire were recorded in tables expressed as frequencies and percentages.

3.7 Data Handling / Analysis

The data obtained from the survey were entered into a computer and analyzed with Statistical Package for the Social Sciences (SPSS) version 14 and Microsoft Excel 2007. The relevant information was retrieved in a standard form using tables, figures, frequencies and percentages for analysis and interpretation of the information.

3.8 Pre-testing

It was necessary for the study to be conducted in a similar area with similar characteristics to enable the instruments to be redesigned if need be. The pre-testing was therefore done in a sub-metro with similar environmental features. The sub-metro which was identified to be close and share similar characteristics is the Asawasi. After the pre-testing, some of the questions were modified and added. The respondents had the questions in a logical sequence and the questionnaire was made as short as possible. The questionnaire thus became ready for administration in the next stage of the research.

3.9 Ethical Consideration

Ethical clearance for the study was obtained from the School of Medical Sciences, Kwame Nkrumah University of Science and Technology (KNUST) and the Director of the Waste Management Department of KMA.

The nature, purpose and procedure of the study were explained to each participant and they were made aware that they were free to refuse to answer any questions or drop out of the study at any time and will not affect them. Participants were assured of the confidentiality of personal information and written materials. There are no known risks to

who take part in this study. Participants will rather benefit from the study since they have an opportunity to express their views and experiences with regards to solid domestic waste management.

3.10 Limitations of Study

The study did not cover the entire Sub-Metros in the Metropolis due to inadequate resources such as financial support, time and personnel. The depth of the study was not reached accordingly.

3.11 Assumptions

All responses and information provided by the respondents were assumed to be accurate and a true representation of the study area.

CHAPTER FOUR

RESULTS

4.1 Introduction

This chapter presents details of the findings of 246 respondents which consist of household heads or substitutes, students, key informants and a focus group. The presentations are made in the form of figures and tables with frequencies and percentages for ease of comprehension.

Table 4.1: Social characteristics of respondents

Variables		**Frequency N = 246**	**Percentages (%)**
Sex	Male	118	48.0
	Female	128	52.0
Type of occupation			
Government		54	22.0
Private		36	14.6
Self-employed		86	35.0
Student		66	26.8
Chief		2	0.8
Housewife		2	0.8
Educational level			
None		26	10.6
Primary		16	6.5
JHS / Middle Form 4		52	21.1
SHS/Vocational/Technical		38	15.4

Tertiary	114	46.3
Income level		
High (GH 400and above)	30	12.2
Average(GH 200-400)	74	30.1
Low(below GH200) /Unemployed	142	57.7
Marital status		
Married	90	36.6
Single	108	43.9
Divorced	12	4.9
Separated	14	5.7
Widowed	22	8.9
Number of children		
None	124	50.4
1 – 3	66	26.8
4 – 6	40	16.3
7+	14	5.7
Family Size		
Alone	116	47.2
With children	54	22.0
With spouse	20	8.1
With children and spouse	56	22.8
Religious affiliation		
Christian	206	83.7
Muslim	38	15.4
Hinduism	2	0.8

Source: Field Survey, 2009

4.2 Social Characteristics of Respondents

The average age of the respondents was 37.5 years with a standard deviation (SD) of 14.5. The minimum age was 12 years and the maximum 90 years. About ten percent (10.6%) of the respondents had no formal schooling at all and 6.5% had Primary education. Tertiary education level had the highest percentage of 46.3 %. 51.4% went through Secondary/ Vocational/ Technical Institutions with 21.1% having had JHS education. Twenty-two percent (22%) were government employees, 14.6% had private employment and 35.0% were self-employed, 26.8% were students, a chief and housewife. Majority had low income (52.8%) and 30.1% had average income and 12.2% are high income earners. 36.6% of the respondents were married and 43.9% single. 4.9%, 5.7% and 8.9% were divorced, separated and widowed respectively. Christians formed the majority of respondents (83.7%), 15.4% were Muslims and 0.8% being Hinduism. This is illustrated in table 4.1.

4.3 Type of Waste Generated

Different types of wastes are generated within the sub-metro which includes domestic, commercial, office and industrial wastes. Domestic waste recorded the highest value (85.4%) whiles official waste recorded the lowest (3.3%). Commercial and industrial wastes recorded 6.5% and 4.9%. This is shown in the table below.

Table 4.2: The type of waste generated by the respondents

Type of Waste	Frequency	Percentage (%)
Office	4	3.2
Industrial	6	4.9
Commercial	8	6.5
Domestic	105	85.4
Total	123	100

Source: Field Survey, 2009

4.4 Sources of Information and Knowledge on Solid Waste Management

The knowledge level of the respondents on solid waste management ranged from low to high. From the figure below, the highest value (50.4%) was recorded by respondents who have moderate knowledge level whiles those with high level recorded the lowest (19.5%). The low knowledge level also recorded 30.1% as shown in table 4.2.

Information sources on solid waste treatment within the Subin sub-metro vary. From figure 3 below, the source with the greatest value (36.6%) is school whiles health inspectors recorded the lowest value (0.8%). KMA Education Unit, mass media, parents/relatives and none recorded 12.2%, 27.6%, 21.1% and 1.6% respectively.

From the field survey as presented in figure 4 below, 82.1% of the respondents said proper solid waste treatment means storing, transporting and disposing of refuse hygienically. 6.5%, 8.9% and 2.4% of the respondents said keeping the house neat or clean, sweeping the house and throwing refuse away and others respectively. This is shown in the table below.

Table 4.3: Sources of Information and Knowledge on Solid Waste Management

Knowledge level on solid waste management		
Knowledge Level	**Frequency**	**Percentage (%)**
Low	37	30.1
Moderate	62	50.4
High	24	19.5
Total	123	100
Sources of information on proper solid waste treatment		
Source of Information	**Frequency**	**Percentage (%)**
Health inspectors	1	0.8
None	2	1.6
KMA Education Unit	15	12.2
Parents/Relatives	26	21.1
Mass media	34	27.6
School	45	36.6
Total	123	100
Meaning of Proper Solid Waste Treatment		
Meaning	**Frequency**	**Percentage (%)**
Sweeping the house and throwing the refuse away	11	8.9
Keeping the house neat or clean	8	6.5
Storing, transporting and disposing of refuse hygienically	101	82.1
Others	3	2.4
Total	123	100

Source: Field Survey, 2009

4.5 Attitude and Behaviour of Respondents

The attitude and behaviour of occupants of a community affects the management of domestic solid waste in that community. On the attitude and behaviour of the respondents, 77.2% of them get close toward sanitation programmes whiles 22.8% stay away.

56.9% of the respondents undertake communal method of waste collection, 42.3% door to door method and 0.8% have none. The above is shown in the table below.

Table 4.4: Attitude and Behaviour of Respondents

Reaction Towards Sanitation Programme		
Reaction	**Frequency**	**Percentage (%)**
Get close	95	77.2
Stay away	28	22.8
Total	123	100
Methods of Waste Collection		
Method	**Frequency**	**Percentage (%)**
Door to door	52	42.3
Communal	70	56.9
None	1	0.8
Total	123	100

Source: Field Survey, 2009

4.6 Types of Receptacles Used

From the results of the field survey and the interview conducted, it was realised that 66.7% of the respondents had storage receptacles in their suburbs within the Subin Sub-metro but 33.3% of them had no storage receptacles as shown in figure 7. Most of the respondents (46.3%) interviewed stored their waste in plastic bins with lid. 22.0% of them stored theirs in plastic bins withoud lid whiles 21.1% stored theirs in public storage container. 1.6%, 1.6%, 3.3%, and 2.4% store their waste in dug-out hole in the house, heap at corner in the house, heap outside near the house, plastic bag, private incinerator and sack respectively. This is presented in the table below.

Table 4.5: Types of Receptacles Used

Presence of Storage Receptacle		
Presence	**Frequency**	**Percentage (%)**
Yes	82	66.7
No	41	33.3
Total	123	100
Storage Containers of Waste		
Container	**Frequency**	**Percentage (%)**
Plastic bin with lid	57	46.3
Plastic bin without lid	27	22
Public storage containers	26	21.1
Heap at a corner in the house	2	1.6
Heap outside near the house	4	3.3
Others	7	5.6
Total	123	100

Source: Field Survey, 2009

4.7 Methods of Transport of Solid Waste to Dump Site

Different means are used to transport solid waste in the suburbs to the dump site within the Sub-metro. In the suburbs of 33.3% of the respondents, automatic compactor trucks are used to transport waste to the dump site and 25.2% of them recorded skips as means of transport. 13.0%, 4.9%, 0.8% and 0.8% used wheel barrow system, tricycle, personal vehicle and manual means respectively. 0.8% of the respondents on the other hand do not transport their waste but instead burn them as illustrated in table 4.5.

35.0% of the respondents personally conveyed their refuse to the dump site whiles 15.4%, 23.6%, 0.8%, 2.4%, 22.0% and 0.8% had their wastes conveyed to the dump sites by contractors, hired labourer, house neighbour, kid siblings, children and wives respectively.

A great percentage of the respondents (61.8%) finally dispose of their waste at a storage point whiles a small percentage of them finally dispose theirs on farms (0.8%), on road to dump site (0.8%), by incineration (0.8%) and burning of the waste (0.8%). 25.2% of the respondents dispose their refuse on a nearby open dump and 3.3% of them have no final dump site. 3.3% of them also have no knowledge of the final dump site of their suburbs as shown in figure 11 below. The final dump sites are managed by certain bodies within the suburbs. 57. 7% of the respondent's fnal dump sites are managed by KMA whiles 1.6% them manage the waste themselves. The final dump sites of 4.9%, 7.3% and 28.5% of respondent's wastes are managed by District Council Workers, individual labourers and private contractors respectively. This is illustrated in table 4.5.

62.6% of the respondents pay for refuse disposal in their suburbs whiles 37.4% of them do not pay for disposal of waste. This is illustrated in figure 13 below. Most of the respondets interviewed (44.7%) had one storage dump site of solid waste in their community whiles 12.2% of them had three. 29.0% had two storage dump sites and 13.8% had none as illustrated in table 4.5.

Again, different types of refuse dumps were present in the individual suburbs within the Subin Sub-metro from the field survey and interviews carried out. The highest percentage (46.3%) of respondents have surface dump or open dump at outskirts of their suburbs where waste is deposited whiles 0.8% of them had no knowedge of the the type of refuse dump present in their suburb. 45.5% of the respondents have isolated spots within their suburbs where waste is deposited and 7.3% have none. This is shown in table 4.5.

On the distance to the dump site, 47.2% of the respondents have theirs close to them whiles 1.6 of them have no knowledge. 22.8%, 17.1% and 11.4% have their sites quite far, far and too far respectively. This is shown in table 4.5.

Table 4.6: Methods of Transport of Solid Waste to Dump Site

Methods of Transport of Solid Waste		
Method	**Frequency**	**Percentage (%)**
Personal vehicle	1	0.8
Tricycle	6	4.9
Wheel barrow system	16	13
Automatic compactor truck	41	33.3
Skip	31	25.2
Manual	1	0.8
Others	17	14
Total	123	100
Conveyor of Waste to Dump Site		
Conveyor	**Frequency**	**Percentage (%)**
Myself	43	35
My child	27	22
Hired labourer	29	23.6
Contractor	19	15.4
Others	5	4
Total	123	100
Final Disposal of Refuse		
Site	**Frequency**	**Percentage (%)**
On road to dump site	1	0.8
Storage point	76	61.8
Nearby open dump	31	25.2
Others	15	12
Total	123	100
Number of Storage Dump Sites		
Number	**Frequency**	**Percentage (%)**

None	17	13.8
One	55	44.7
Two	15	29.3
Three	36	12.2
Total	123	100
Type of Refuse Dump		
Type	**Frequency**	**Percentage (%)**
Isolated spots	55	44.7
Surface/open dump	57	46.3
Others	11	9
Total	123	100
Distance to Dump Site		
Distance	**Frequency**	**Percentage (%)**
Close	60	48.7
Quite far	28	22.8
Far	21	17.1
Too far	14	11.4
Total	123	100

Source: Field Survey, 2009

4.8 Knowledge on Methods of Solid Waste Management

Many waste management methods are employed within the Sub-metro. Surface/open dumping method (38.4%) is the method greatly used in the Sub-metro whiles reuse (0.8%) is the least patronized method of solid waste management. 4.9%, 13.05%, 33.3% and 8.1% of the respondents use composting, incineration, landfill and recycling methods respectively. 1.6% of them have none of the methods practiced in their suburbs.

However, 34.1% of the respondents recommended landfill as the most suitable method of solid waste management for the Sub-metro, followed by recycling which had 28.5%. 13.8% and 15.4% went in for composting and incineration. The least suitable method from the survey is surface or open dumping. This is illustrated in the table below.

Table 4.7: Knowledge on Methods of Solid Waste Management

Solid Waste Management Method Practiced		
Method	**Frequency**	**Percentage (%)**
Surface/open dump	47	38.2
Landfill	41	33.3
Incineration	16	13
Recycling	10	8.1
Composting	6	4.9
Others	3	2.5
Total	123	100
Suitable Waste Management Method		
Method	**Frequency**	**Percentage (%)**
Composting	17	13.8
Incineration	19	15.4
Landfill	42	34.1
Recycling	35	28.5
Surface/open dump	10	8.2
Total	123	100

Source: Field Survey, 2009

4.9 Land Availability for Dump Site

A great percentage of the respondents (72.4%) have no land available in their suburbs for construction of dump sites of waste whiles 27.6% have land available in their suburbs as illustrated in figure 19. Most of the respondents surveyed (82.1%) have their suburb leaders unwilling to release land for dump sites whiles only 17.1% are willing to do so. 0.8% of them however have no knowledge on the willingness of leaders to release land for dump site as illustrated in figure 20.

From the field survey, most of the respondents (56.9%) had high cost of land and its economic value within the sub-metro as the reason for non-release of land for dump sites whiles 1.6% of them attributed it to the unavailability of land. 10.6%, 13.8% and 17.1% of the respondents also attributed the reason to fear of disease outbreak, fear of polluting the suburb and none of the reasons stated respectively.

CHAPTER FIVE

DISCUSSION

5.1 Introduction

This chapter considers the findings gathered on the sample from the study population and discusses it in line with the objectives, literature review, and the key variables of the research.

5.2 Type of Waste Generated

The type of waste generated in the Subin Sub-metro varies. Generation rates vary considerably according to seasons, diets and even the day of the week (WHO, 2005). They range from domestic, the type generated most (85.4%) in the Sub-metro to office, commercial and industrial wastes.

Although a small portion of Subin, basically Adum and Adum-Nsuase are dominated by commercial activities, the other suburbs are all made up of residences. Since a great portion of the Sub-metro is made up of residences, it is expected that most the wastes generated will be domestic waste which comprises mostly of organic waste. Unlike that of western countries, the solid waste of cities in developing countries is often comprised of 70 – 80% organic matter, dirt and dust. Composting is considered to be the best option to deal with the waste generated (Narayana, 2001). However, studies have determined that composting is difficult because the waste arrives in a mixed form and contains a lot of non-organic material. When mixed waste is composted, the end product is of poor quality (Narayana, 2001). Only few small-scale and medium-scale industrial activities are

located within the Sub-metro and hence small waste generated from these activities. Official source recorded the least because less waste is generated from offices although there are many offices in the Subin-metro.

5.3 Sources of Information and Knowledge on Solid Waste Management

Information sources as well as the knowledge on solid waste management affect the management of solid wastes within the Subin Sub-metro.

5.3.1 Knowledge Level on Solid Waste Management

From the results of the field survey, a greater portion of the respondents have moderate knowledge (50.4%) on solid waste management whiles only a small portion (19.5%) have high knowledge. About 30.1% of them also have low knowledge on solid waste management. Due to the inclusion of some information of solid waste management in the Ghanaian syllabus at the Basic, Secondary and Tertiary Education, most people as such would have gained some knoweldge before completing basic education and most of the respondents had basic and secondary education. There is however a lack of appreciation by the public of what is involved in waste management. A study by the National Society for Clean Air and Environmental Pollution in 2001 noted that "*public understanding and awareness of waste issues is currently very poor"* (www.defra.gov.uk).

5.3.2 Sources of Information on Solid Waste Treatment

It is important for participating communities to understand how good solid waste management can be achieved and can benefit their health (WHO, 2005). The results of the field survey revealed that, sources of information on solid waste treatment are available to 81.3% of the respondents whiles information sources are not available to 18.7% of them.

The various sources of information available to the respondents include school, mass media, parents/relatives, KMA Education Unit and health inspectors. School recorded the highes value (36.6%) since informatiion on solid waste management are included the academic syllabus of Ghanaian Schools. Due to the importance of educating the public on good practices of solid waste management, most if not all media houses engage in disseminating information to the public through programs held on air, seminars, news papers, e.t.c. Parents and relatives also teach their children as well as family members to keep their surroundings clean if they want to stay healthy. This does not often solve the problem of improper solid waste disposal since wastes are cleared but improperly deposited most of the time which can have reciprocting effect by spreading diseases such as malaria and cholera. KMA Education Unit and Health Inspectors also educate the public but do not reach a number of them.

5.3.3 Meaning of Proper Solid Waste Treatment

From the result of the field survey, 82.1% of the respondents understand proper solid waste treatment as storing, transporting and disposing of refuse hygienically. This attest to the fact that greater portion of the respondents are exposed to education on solid waste management within the Sub-metro but understanding does not necessarily means that it is being practiced since there are still problems of solid waste management. About 8.9% of the respondents also understand proper solid waste treatment as sweeping the house and throwing the refuse away. Solid waste management goes beyond throwing refuse away to managing them effectively. Very few people indicated keeping the house neat, collecting waste and separating them appropriately, putting wastes at storage point and mechanism put in place to transform waste into useful products as meaning of proper solid waste management.

5.4 Attitude and Behaviour of Respondents

The reaction of people towards sanitation programmes indicates their preparedness to learn and apply the principles of proper solid waste management since that forms part of those programmes. About 77.2% of the respondents get close to sanitation programmes whiles 22.8% of them see no reason in wasting their time getting close and hence stay away during those programmes.

About 56.9% of the respondents undertake communal methods of waste collection whiles 42.3% undertake door to door and 0.8% has none. The communal system involves deposition of waste in a centralized collection points which are later emptied by

management bodies. The door to door system also involves provision of collection containers by management bodies to household which are daily emptied by the bodies. The two methods can generate problems depending on the frequency of generation of waste as well as emptying of the containers. Delay in emptying the containers can generate bad odour, mosquitoes and subsequently spread diseases such as malaria, cholera and dysentery. The situation can worsen if the rate of generation of the waste is very high.

5.5 Types of Receptacles Used

A key aspect of effective waste management is proper waste storage on the premises where the waste is generated (Oluwande, 1984). About two-thirds (66.7%) have storage receptacles present in their suburbs whiles one-third (33.3%) have no storage receptacle in the suburb. The suburbs that undertake door to door method of waste collection had no storage receptacles since they are not needed.

Most of the respondents (46.3%) interviewed stored their waste in plastic bins with lid. This is supported by Solid Waste Management in Emergencies by WHO, 2005 which says in the home, plastic bags or a small container with a lid make suitable storage containers. This prevents the production of bad odour as well as generation of flies. About 22.0% of the respondents store their waste in plastic bins withoud lid which can produce bad odour, generate flies and subsequently spread diseases. 21.1% stored theirs in public storage container. Very few people store their waste in dug-out hole in the house, heap at corner in the house and heap outside near the house. On-site household

disposal is suitable where space is not too limited and where waste has a high organic content (as it will decompose and reduce in volume). It is also useful in areas where access is difficult (WHO, 2005). These are not proper ways of storing wastes since they can easily results in disease outbreak.

5.6 Methods of Transport of Solid Waste to Dump Site

Collection of solid waste is carried out by using various types of vehicles, with the type of vehicle depending on the type of collection bin and width of the road (Chiplunkar *et al*., 1981). Different means can be used to transport solid waste from residences and communities to the final dump site where they are managed . In the suburbs of 33.3% of the respondents, automatic compactor trucks are used to transport waste to the dump site and 25.2% of them recorded skips as means of transport. 13.0%, 4.9%, 0.8% and 0.8% used wheel barrow system, tricycle, personal vehicle and manual means respectively. When selecting suitable vehicles, waste generation rates and densities need to be considered along with areas they need to access and the distance between collection and disposal points (WHO, 2005).

About one-third (35.0%) of the respondents personally convey their refuse to the dump site whiles 15.4%, 23.6%, 0.8%, 2.4%, 22.0% and 0.8% have their wastes conveyed to the dump sites by contractors, hired labourer, house neighbour, kid siblings, children and wives respectively.

A great percentage of the respondents (61.8%) finally dispose of their waste at a storage point whiles a small percentage (0.8%) of them finally dispose theirs on farms which can

function as organic manure when the components of the wastes are organic. Since not all domestic wastes are organic, other components such as plascits and metals which are not biodegradable can harm plants, affects soil organisms as well as its composition. Others dump their waste on road to dump site (0.8%) which can choke drains and breed mosquitoes and by incineration (0.8%) and burning of the waste (0.8%). This process can pollute the air if the waste contains hazardous chemicals. 25.2% of the respondents dispose their refuse on a nearby open dump and 3.3% of them have no final dump site. 3.3% of them also have no knowledge on the final dump site of their suburbs.

The final dump sites are managed by certain bodies within the suburbs. 57. 7% of the respondent's fnal dump sites are managed by KMA whiles 1.6% of them manage the waste themselves. The Kumasi Metropolis has a landfill site where all the wastes generated are transported for management. The final dump sites of 4.9%, 7.3% and 28.5% of respondent's wastes are managed by District Council Workers, individual labourers and private contractors respectively. These bodies in actual fact do not wastes but transport them to the landfill where they are managed.

One of the ways of curbing improper disposal and ensuring efficiency in the use of resources is charging for its use. If polluter pays prinicple is adopted, then whoever generates the waste has to take the majority of the responisiblity for cleaning it up. This serves as an incentive to the use of resources efficiently which tends to generate less waste. 62.6% of the respondents pay for refuse disposal in their suburbs whiles 37.4% of them do not pay for disposal of waste. Some people however secretly dump their waste

improperly because they have to pay for refuse disposal. This problem can be solved if monitoring is done and culprits are punished to serve as deterrent to others.

Most of the respondets interviewed (44.7%) had one storage dump site of solid waste in their community whiles 12.2% of them had three. 29.0% had two storage dump sites and 13.8% had none. The number of dump sites in the individual suburbs depends on the volume waste generated as well as frequency of emptying of the waste.

Again, different types of refuse dumps were present in the individual suburbs within the Subin Sub-metro from the field survey and interviews carried out. The highest percentage (46.3%) of respondents have surface dump or open dump at outskirts of their suburbs where waste is deposited whiles 0.8% of them had no knowedge of the the type of refuse dump present in their suburb. 45.5% of the respondents have isolated spots within their suburbs where waste is deposited and 7.3% have none.

On the distance to the dump site, 47.2% of the respondents have their dump sites close to them . This enhances easy convey of waste to the dump site since most people had their childeren as conveyours of waste to the dump site. This can however cause health problems if the site is not well managed. A research work carried out by the Department for Environment, Food and Rural Affairs, UK revealed that health effects in people living near waste management facilities were either generally not apparent, or the evidence was not consistent or convincing. However, a few aspects of waste mangement have been linked to health effects in local people (www.defra.gov.uk). 22.8%, 17.1% and 11.4% have their sites quite far, far and too far respectively. Siting dump sites far away does not

encourage people to dispose their waste there but instead alternative sources such as disposing them in streams and rivers as well as on the way to the dump sites.

5.7 Knowledge on Methods of Solid Waste Management

Many waste management methods are employed within the Sub-metro. Ironically, the least supported option of waste management methods hierarchy surface/open dumping method, is the method greatly used (38.4%) in the Sub-metro. Waste management and disposal is a pressing issue facing developing countries today, since about 90% of waste is currently disposed of by open dumping (Narayana, 2001). Reuse (0.8%) on the other hand is the least patronized method of solid waste management. 4.9%, 13.05%, 33.3% and 8.1% of the respondents use composting, incineration, landfill and recycling methods respectively. 1.6% of them have none of the methods practiced in their suburbs. Incineration is not usually a favourable option for solid waste management as it requires a large capital input and care for operation and management to ensure non-polluting bone (WHO, 2005).

However, 34.1% of the respondents recommended landfill as the most suitable method of solid waste management for the Sub-metro. This method is recommended since sorted disposal is not encouraged for recovery methods. Municipal landfill sites however produce leachate that contains concentrated toxic chemicals (Denison and Ruston, 2000). Landfill leachate has been responsible for contaminating groundwater supplies and surface water ecosystems in communities all over the world (Farquhar, 1989). This was followed by recycling which had 28.5%. 13.8% and 15.4% went in for composting and incineration. Resource could be recovered from the waste through recycling, composting

and incineration but these cannot be done without sorted disposal. The least suitable method from the survey is surface or open dumping because of its accompanying health problems as well as other environmental impacts.

5.8 Land Availability for Dump Site

A great percentage of the respondents (72.4%) have no land available in their suburbs for construction of dump sites of waste whiles 27.6% have land available in their suburbs as illustrated in figure 19. Most of the respondents surveyed (82.1%) have their suburb leaders unwilling to release land for dump sites whiles only 17.1% are willing to do so.

From the field survey, most of the respondents (56.9%) had high cost of land and its economic value within the sub-metro as the reason for non-release of land for dump sites whiles 1.6% of them attributed it to the unavailability of land. 10.6%, 13.8% and 17.1% of the respondents also attributed the reason to fear of disease outbreak, fear of polluting the suburb and none of the reasons stated respectively. The health and environmental risks of waste management have been the subject of controversy and contradictory informatin – e.g. from the waste industry and environmental pressure groups (www.defra.gov.uk).

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

In this research work, two hundred and forty-six (246) respondents were interviewed on the assessment of the methods of solid domestic waste management in the Subin Sub-metro of Kumasi Metropolitan Assembly through multistage, purposive and simple random sampling.

The research revealed that the type of waste generated is mostly domestic. Domestic waste is also largely composed of organic waste and hence most of the waste can be composted to generated organic fertilizer for agriculture.

Most of the respondents had knowledge on solid waste management due to sources such as school, parents/relatives, KMA Education Unit and health inspectors. Again, most of the respondents understood solid waste management as storing, dumping collection transporting and disposing of refuse hygienically but solid waste management goes beyond disposing refuse to their management.

Many suburbs within the Subin Sub-metro engage in communal method of waste collection whiles few engage in door to door method. Most of the respondents however get close towards sanitation programmes which indicate their readiness to be educated on sanitation issues.

Most of respondents had storage receptacles present in their suburbs whiles very few had no receptacle they undertook door to door system. Most of them stored their waste in

plastic bin with lid whiles others stored in plastic bi without lid and public storage container. Few people also burnt their waste whiles others buried their waste in pits.

The most widely used means of transport of waste to the final dump site is the automated compactor truck. The skip, tricycle and wheel barrow systems are also used. A great portion of the respondents deposit their waste at storage point managed by KMA. Others also deposit their waste on open dumps and on road to dump site. Many suburbs had one dump site whiles few had two, three and even some had none. Apart from KMA, Individual labourers and private contractors such as Zoomlion Ghana Limited are also involved in collection and management of waste. A great percentage of the respondents pay for depositing waste. Most of them also had their dumping sites close to them whiles few had theirs far, quite far or too far.

Waste management methods such surface/open dumping, landfilling, incineration, recycling and composting are practiced in the Subin-metro but the most widely used method is surface/open dumping method. This method is ranked the least/bottom on the hierarchy of waste management methods and can lead to health implications of the people in the Sub-metro. The highly recommended method of management by the respondents is landfilling.

Most of the respondents have their leaders unwilling to release land for dumping site largely due to high cost of land and its economic value. The reason for the non-release of land can also be attributed to fear of polluting communities and fear of disease outbreak.

The management of solid waste in the Subin Sub-metro is generally not the best and must be carefully considered to avert the accompanying problems of improper solid waste management.

6.2 Recommendation

This study has revealed that solid domestic waste management is not very proper and healthy in the Subin Sub-metro of the Kumasi Metropolitan Assembly and the following measures are recommended for action by all stakeholders.

In consideration of the current municipal solid waste management status, source separation should be a key priority. Waste needs to be sorted at the source as much as possible to encourage composting since great content of MSW is organic and also to reduce the amount of waste requiring disposal.

Source separation and collection of MSW is not well implemented in Subin Sub-metro. Consistent national policies on MSW legislation are needed. Policies should be adopted to encourage cross-jurisdiction and inter-agency coordination and to facilitate implementation of economic instruments for improving waste management. The supervision of private enterprises should be strengthened by regulations. An integrated sustainable waste management system from generation to final disposal is needed. The system should enhance the planning and decision making process and take a holistic view of the entire system: waste collection, transfer, resource recycling and disposal.

Additionally, there should be improved education by the various agencies and agents such as schools, KMA Education Unit, health workers and parents/relatives to enhance the understanding of waste management and consequences of improper disposal. This can help transform the attitude and behaviour of residents in the sub-metro towards the application of proper waste management practices.

Moreover considering the volume of waste generated in the suburbs within the Sub-metro, the Waste Management Department of KMA and private contractors should be adequately resourced in terms of personnel and equipment.

Furthermore, the government should encourage markets for recycled materials, such as waste trade platforms. The recycling industries needs to be improved through increased professionalization, improved product standards, market development and better operating standards.

Areas for future research

Research and educational institutions should research into the possible means of encouraging sorted disposal, local use of solid domestic waste and better methods for solid domestic waste management.

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APPENDICES

Appendix 1: Questionnaire Administered

This questionnaire seeks to elicit information on the assessment of the methods of solid waste management in the Subin Sub-Metro of Kumasi Metropolitan Assembly of the Ashanti Region of Ghana. Purposely, it is for an academic exercise. Please you are respectfully required to complete the items as dispassionately as you can. Your responses will be made confidential.

Name of respondent: …….

Suburb: ……

Age: ……

House Number:…….. Place of work: ……..

Demographic and Socioeconomic Features

1. Sex
   - Male [ ]
   - Female [ ]

2. Marital status
   - Married [ ]
   - Single [ ]
   - Divorced [ ]
   - Separated/Widowed [ ]

3. Number of children
   - None [ ]
   - 1 – 3 [ ]
   - 4 – 6 [ ]
   - 7+ [ ]

4. Family size

With spouse	[ ]
With children	[ ]
With spouse and children	[ ]
Alone	[ ]

5. Type of occupation

Private	[ ]
Government	[ ]
Self employed	[ ]
Student	[ ]

Others (please specify) ……..…….....

6. Income level

High (400 Cedis or more)	[ ]
Average (200-400 Cedis)	[ ]
Low (200 Cedis and below)	[ ]

7. Level of education [ ]

Primary	[ ]
JHS/Middle Form 4	[ ]
SHS/'O' Level	[ ]
Tertiary	[ ]
None	[ ]

Others (specify) ……....……

8. Religion

Christian	[ ]
Muslim	[ ]
Traditional	[ ]

Buddhist [ ]

Rastafarian [ ]

Others (specify) …….

9. Type of waste generated.

Domestic / food waste [ ]

Industrial waste [ ]

Commercial waste [ ]

Office waste [ ]

Clinical waste [ ]

Others (please specify)……

Sources of Information and Knowledge on Solid Waste Management

10. Knowledge level on solid waste management

High [ ]

Moderate [ ]

Low [ ]

11. Availability of sources of information on solid waste management

Yes [ ]

No [ ]

12. Information source on proper solid waste treatment

Parent/Relatives [ ]

School [ ]

KMA Education Unit (Quarterly Programmes) [ ]

Health worker (specify) ……

Others (specify) …….

Mass media [ ]

13. Awareness of consequences of bad solid waste disposal

Yes [ ]

No [ ]

14. If yes, indicate some of the effects of improper solid waste management.

……

……..

15. Meaning of proper solid waste treatment to you

Sweeping the house and throwing refuse away [ ]

Keeping the house neat or clean [ ]

Storing, transporting and disposing of refuse hygienically [ ]

Others (specify) ……

……

Attitude and Behaviour

16. Reaction towards sanitation programmes

Get close [ ]

Stay away [ ]

17. Methods of waste collection

Door to door [ ]

Communal [ ]

Types of Receptacles Used

18. Presence of storage receptacles in the suburb

Yes [ ]

No [ ]

19. In what do you store your waste?

Heap at a corner in the house [ ]

Heap outside near the house [ ]

Old basket/bucket without cover [ ]

Old basket/bucket with cover [ ]

Plastic bin without lid [ ]

Plastic bin with lid [ ]

Public storage container [ ]

Others (specify) ……

Methods of Transport of Solid Waste

20. What method do you use to transport your refuse to the dump site?

Tricycle [ ]

Wheel barrow system [ ]

Automatic compactor truck [ ]

Skip [ ]

Others (specify) ……..

21. Who conveys your refuse to the dump site?

Myself [ ]

My child [ ]

Hired labourer [ ]

Contractor [ ]

Others (specify) ……

……

22. Where do you dispose of your refuse finally?

On the road to dump site [ ]

Into a river/stream/pond/gutter (underline that which applies)

Storage point [ ]

On a nearby open dump [ ]

Others (please specify)……

23. Which body managed and controls the final dump site or landfill in your community?

Individual labourer(s)	[ ]
Private contractors	[ ]
District Council Workers	[ ]
Metropolitan Assembly (KMA)	[ ]

24. Do you pay for a load of refuse collected or deposited?

Yes	[ ]
No	[ ]

25. How many storage dump site are in your community?

One	[ ]
Two	[ ]
Three	[ ]
None	[ ]

26. Do you know where the final dump site is?

Yes	[ ]
No	[ ]

Mention that and any other dump place ……

27. Type of refuse dump in your community

Isolated spots within the community	[ ]
Surface dump or open dump at the outskirts of town	[ ]

Others (specify) ……

28. What do you have to say on the distance to the dump site?

Too far (250 m and above)	[ ]
Far (200 – 250 m)	[ ]
Quite far (150 – 200 m)	[ ]

Close (100 – 150 m) [ ]

Knowledge of Other Methods of Solid Waste Management

29. Have you heard of any other method of solid waste management?

Yes [ ]

No [ ]

30. Which solid waste management methods are practiced in your community?

Surface/Open dump [ ]

Landfill/tipping [ ]

Incineration [ ]

Recycling [ ]

Composting [ ]

Others (specify) ……

31. Which type do you suggest is suitable for your community?

Surface/Open dump [ ]

Landfill/tipping [ ]

Incineration [ ]

Recycling [ ]

Composting [ ]

Other (specify) ……

Availability of Land for Dump Site

32. Is land available for refuse dump site?

Yes [ ]

No [ ]

33. Are community leaders willing to release land for dump site construction?

Yes [ ]

No [ ]

34. If no why not?

Fear of polluting communities [ ]

Fear of disease outbreak [ ]

High cost of land and its economic value [ ]

Others (specify) ……

Consequences of Improper Refuse Management

35. Are you aware of some of the common problems associated with improper refuse management within the community?

Yes [ ]

No [ ]

36. If yes, write down some of the of the problems

……

……

……

……

……

……

37. Which health institutions do people within the community report for treatment when sick?……

……

……

……

……

……

38. List some of the common diseases that you know affect the community members (specify)

……

……

……

……

……

……

39. What suggestions could you offer for the improvement of municipal solid waste management in your community? Write down suggestions

……

……

……

……

……

……

……

Thank you.

Appendix 2: Table of variables

Type of variable	Variable	Operational Definition/Indicator	Scale of measurement	Data collection tool	Data collection technique
Dependent variable	Method of domestic solid waste management	Type of waste manag't in action	Nominal 1.proper 2.improper	Questionnaire	Interview
Independent variable	Level of education	Last level attained	Ordinal 1.Primary 2.Middle/JHS 3. SHS/'O' Level 4. Tertiary 5. None	Questionnaire	Interview
	Type of receptacle for refuse	Type of receptacle used by respondent	Nominal 1.Plastic bin with lid 2.Plastic bin without lid 3. Public storage container	Questionnaire	Interview Observation
	Community storage receptacle	Present/Absent	Binary 1.Yes 2.No	Questionnaire	Interview
	Method of waste collection	Type of method used for collection	Nominal 1.door to door 2.communal 3.other	Questionnaire	Interview
	Method of waste transport	Method used to transport waste	Nominal 1.tricycle 2.by wheelbarrow 3. automatic compactor truck 4. skip 5.other	Questionnaire	Interview Observation
	Place of waste disposal	Site where waste is disposed of	Nominal 1. on the road to refuse dump 2. into a river/stream/ pond/gutter 3. storage point 4. on a nearby open dump 5. others	Questionnaire	Interview
	Refuse dump	Type of refuse dump used	Nominal 1. isolated spots within community 2. dump at town outskirts	Questionnaire	Interview Observation

			3. others		
	Proximity to dump site	Distance to dump site	Ordinal 1. too far(250+m) 2. far(200-250m) 3. quite far(150-200m) 4. close(100-150) 5. too close(less than 100m)	Questionnaire	Interview
	Availability of land for dump site	Present/Absent	Binary 1.yes 2.no	Questionnaire	Interview
	Community storage receptacle	Present/Absent	Binary 1.yes 2.no	Questionnaire	Interview Observation
	Information/Know-ledge on waste management	Source of information	Nominal 1. Home 2. School 3. KMA 4. Health worker 5. Mass media 6. Others	Questionnaire	Interview

Appendix 3: An Automated Compacted Truck Off-loading Waste

Appendix 4: A Skip Loaded with Waste

Appendix 5: Conveyors in a queue to off-load waste at Dompoase Landfill

Appendix 6: Storage Container of Waste at Asem

Appendix 7: Storage Containers at Central Market