KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY,

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DEPARTMENT OF THEORETICAL AND APPLIED BIOLOGY

DOMESTIC SOLID WASTE MANAGEMENT PRACTICES IN THE BEKWAI MUNICIPALITY IN THE ASHANTI REGION OF GHANA

BY

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(BSc. NATURAL RESOURCES MANAGEMENT)

A THESIS SUBMITTED TO THE DEPARTMENT OF THEORETICAL AND APPLIED BIOLOGY, IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF SCIENCE DEGREE IN ENVIRONMENTAL SCIENCE

AUGUST, 2016

DECLARATION

I hereby, declare that this submission is my own work towards the MSc. Environmental Science degree award and that, to the best of my knowledge, it contains no material previously published by another person nor material which has been accepted for the award of any other degree of the University, except where due acknowledgement has been made in the text.

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DATE

DEDICATION

This work is dedicated to my dear mother, Madam Rose Pianim for her great care and sacrifices that have contributed greatly to my life. It is also dedicated to my lovely nieces, Abena Serwaa Kyeremateng, Adwoa Amponsaah Kyeremateng and Afia Achiaa Kyeremateng and the entire Kyeremateng family.

ACKNOWLEDGEMENTS

I am most grateful to the Almighty God for His grace and mercies throughout the writing of this thesis.

My sincere gratitude goes to Mr. Marin Abed Arkoh my supervisor, for his guidance and constructive comments, which have been very useful for the success of this work and all the lecturers in the Department for their input.

I also thank my dear family for their prayers and encouragement throughout my programme at the university.

I would like to specially acknowledge the support from Mr. Gregory Domfeh, Mr. Paul Dery, Prince Owusu Sekyere, Lois Karikari and Priscilla Konadu Appiah for making this dream a reality.

ABSTRACT

Solid waste management is a challenge in the cities and towns of the developing countries that have rapid growth patterns. This study investigates how the domestic solid waste management system in the Bekwai Municipality works. Data were obtained through questionnaires, administered to respondents from 150 randomly selected households and supporting information obtained through personal interviews and direct field work. The study showed that key components of the domestic solid waste generated in the study area were paper, food waste (organic materials), plastic and dust/ashes. Food waste and dust/ashes were the components with the highest and lowest quantities generated respectively. Out of the 150 respondents interviewed, 140 of them were using the communal system of waste collection, while only 10 respondents used the house-tohouse system. It was also shown that, only 1 out of the 4 zonal council sampled, used a combination of the two systems. The other 3 zonals used only the communal system. Respondents disposed of their domestic solid waste in skips, bush, backyard and open dumpsites. Sixty five percent of respondents indicated inadequate disposal sites as a key limitation to waste management in the municipality. In addition, 30% of respondents mentioned inadequate collection services as a major constraint with 5% attributing bad attitude of the people of the municipality towards the poor solid waste management. The local authority cited inadequate equipment, inadequate funds, poor roads and inadequate trained staff as the key constraints in the management process. Land filling was the only management method available. The local authority needs to educate the inhabitants to reduce waste generation and to desist from disposing waste at unapproved sites. As food waste formed the highest domestic waste component, the Bekwai Municipal Assembly should consider the option of composting the food waste for commercial purposes and encouraging households to compost their organic waste for use in backyard gardens.

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LIST OF ABBREVIATIONS AND ACRONYMS

EPA	-	Environmental Protection Agency, Ghana
BMA	-	Bekwai Municipal Assembly
MLGRD	-	Ministry of Local Government and Rural Development
GSS	-	Ghana Statistical Service
SWM	-	Solid Waste Management
UNEP	-	United Nations Environmental Programme
USEPA	-	United States Environmental Protection Agency
USPS	-	Urban Sector Programme Support Secretariat

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

In many parts of the African continent especially in Ghana, environmental problems have revealed to create a great challenge in society. This is especially seen in the section of solid waste management in several countries of the region. While the quantity of waste produced in cities continue to increase daily, the effectiveness of the means of handling waste in terms of collection and disposal remains relatively low. According to the World Bank estimates of 2012, between 1.10 and 3.70 kg per capita of waste is produced every day in developed countries' urban areas and approximately 0.09 to 3.00 kg is produced in the cities of developing countries. In a country like Ghana, the sanitation challenge can best be described by the fact that in all major cities, 50–75% of the municipal budget is used to tackle the persistently increasing waste generation problem while related revenues cannot pay for the cost incurred in waste (Danso *et al*., 2005).

Waste is anything that comes from the activities of man, which at a specific location and time, is considered to be of no value or use to the one that owns it, and it is hence discarded (Pongr´acz and Pohjola, 2004). Tchobanoglous *et al*. (1993), however, described solid waste as any substance that emanates from animal and anthropogenic activities and which is often discarded as being without value. Solid waste is material, which is not in liquid form, and has no value to the person who is responsible for it (Zurbrugg, 2003). Solid waste could also be a non-harmful material, which is usually generated through commercial, domestic and industrial activities and may include household organic trash, waste from construction works, street sweepings and institutional rubbish (Zerbock, 2003).

Solid waste management could refer to the collection, transfer, recycling and disposal of solid wastes (Cointreau-Levine, 1994). However, for the purposes of this study, solid waste management refers essentially to a process of collection, transfer and disposal of wastes generated in cities, and includes the institutional structures and arrangements for the efficient disposal of solid wastes. Poor waste management practices can result in ill health in communities. Indiscriminate dumping of wastes has a serious impact on air, land and water pollution and causes a dramatic increase in health hazards in the urban environment (Colon &Fawcett 2006). For instance, it has been reported that poor sanitation is likely to cause diarrhoea (Henry *et al*., 2006). Waste management issue is a more critical problem because it is directly linked with protection of public health, safety and the environment. Waste generation therefore tends to increases with rapid trends in population growth especially in developing countries and economic growth which together add up to the problem of waste management posed not only on the environment but also on the public health (Environmental Protection Agency of Ghana (EPA), 2005).

Consumption of inorganic materials (such as glass, plastics and metals) becomes high as a country urbanizes and inhabitants become wealthier, while the relative organic portion decreases. Waste composition is influenced by various factors, such as level of economic growth, cultural norms, climate, geographical location and energy sources. Generally, waste stream for the urban centers in middle-income countries have a high proportion of organic matter (Al Seadi *et al.*, 2013). Mixed wastes from municipalities are frequently dumped in a landfilled site. When they are left in landfill sites to degrade naturally, the organic components from municipalities and households bring about negative impact on the environment since have very high methane production potential. Substantial efforts are

being made to minimize the general production and the harmful effect of waste, and to reduce the negative effect of waste on the environment and on human and animal health, as well as to reduce the financial costs involved in the management of waste (Al Seadi *et al.*, 2013).

Separation of wastes at source, including source separation and anaerobic digestion (AD) of the digestible waste portion from households, forms a vital part of such efforts, leading to a recovery of value from the separated waste portions through the production of cleaner, enhanced quality materials for energy recovery and recycling. Source separation aids in diverting organic wastes from landfill and from incineration by reducing the overall emissions of greenhouse gases and the negative environmental and health effects which are linked to these waste disposal methods. Increased public awareness and active commitment and participation of citizens in local collection schemes are required (Al Seadi *et al.*, 2013).

1.2 Problem Statement

Solid waste management currently remains as one of the most challenging task in urban centres, especially in the cities and towns of the developing world that have rapid growth patterns(Foo, 1997).Within the past 10 years Ghana's population has increased by 30.4% (Ghana Statistical Service, 2012). Therefore, given the increasing population and the urban nature of the Bekwai Municipal Assembly, it is likely to have solid waste problems, considering the current high trend of population growth and urbanization. Less than 40% of urban Ghanaian residents receive solid waste management services, resulting in the indiscriminate disposal of a greater proportion of the solid waste generated in the urban centres (EPA, 2005).

Indiscriminate dumping of wastes has a serious impact on land, air and water pollution and causes a dramatic increase in health hazards in the urban environment (Colon & Fawcett, 2006). The Bekwai Municipal Area, the study area is urban area with a fast growing population. Areas of this nature are usually associated with waste management problems. This is therefore part of the motivation for the study to investigate how the solid waste management system is working in the study area.

1.3 Justification

Good domestic solid waste management practices are therefore important in preventing sanitation related diseases. Solid waste management has become a major environmental challenge in Bekwai Municipal Assembly in recent times. Not much work has been done on domestic solid waste management, thus creating a gap in knowledge that this study seeks to contribute to filling. The importance of waste collection, transfer and disposal cannot be overemphasized. Apart from the issue of aesthetics, uncollected wastes constitute a health risk which can be a serious consideration in low-income residential areas.

1.4 Main Objective

To evaluate the domestic solid waste management practices in the Bekwai Municipality.

1.4.1 Specific Objectives

- To identify the major components of solid waste generated by households in the study area

- To determine the means of disposal of solid waste by households;
- To examine the frequency of solid waste collection;
- To identify the challenges to effective solid waste management in the municipality and propose possible interventions.

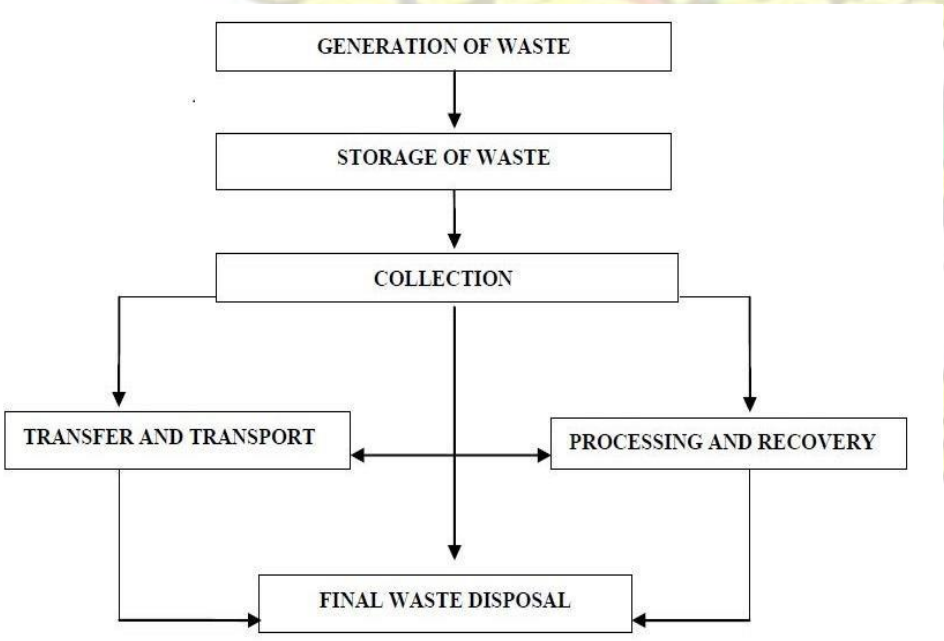
CHAPTER TWO

LITERATURE REVIEW

2.1 Solid Waste Management

Currently, the world is faced with the challenge of dealing with issues of solid waste, and a typical solid waste management system in developing countries is affected by a lot of problems, including low collection coverage and irregular collection services, open dumping and burning without air and water pollution control, the breeding of flies, and the handling and control of informal waste picking or scavenging activities (Ogawa, 2000).As urbanization continues to take places, solid waste management becomes a major environmental and public health problem in urban areas. These problems are caused by technical, financial, institutional, economic, and social factors which affects the development of effective solid waste management systems (Ogawa, 2000).

2.1.1 Solid Waste Management Processes



(Tchobanoglous *et al.*, 1993)

Figure 1: Elements of Solid Waste Management

As shown in Figure 1, solid waste management involves some key processes. With the required resources and good organisation, these processes can be used to effectively deal with solid waste problems in communities. This section therefore offers a brief discussion of these processes. Generation of the waste is the first process. Waste generation involves all activities that yield materials, which are of no value to the owner and for that reason, are thrown away or gathered together and subsequently disposed of (Momoh and Oladebeye, 2010).The quantity of municipal solid waste generated worldwide in 2006 alone was 2.02 billion tonnes, representing an annual increase of 7% from 2003 (UNEP, 2009). Another important activity in the process of solid waste management is the collection and subsequent storage of solid waste. This normally follows the generation of waste. Before the collection of household solid waste to disposal destinations, it is necessary to have a temporary storage for it (Tchobanoglous *et al.*, 1993). Usually, skips and dustbins are used for this temporary storage to prevent indiscriminate dumping of solid household waste (Kreith, 1994).

In some areas, concrete-made receptacles are used for solid waste from residential and commercial areas. These are strategically positioned, and the waste is conveyed by trucks at periodic intervals to prevent overflow of waste (USPS, 2000). Kreith (1994) explains this conveyance (transfer and transport) of solid waste as comprising two stages which include waste relocation from smaller collection vehicles to relatively larger trucks as the first stage. The second stage involves the hauling of the waste, generally covering longer distances to the final sites of disposal. In some developed countries such as the United States, residential facilities are linked to collection services mostly in the form of curb, "setout-setback" and "backyard carry". As appropriate as these systems are, huge financial

commitments are required to put them in place and this may pose a challenge to a less developed country such as Ghana.

Processing and recovery of solid waste are essential processes in solid waste management. It incorporates all the various technologies, and facilities used to make other operations more efficient. It also involves the resources and technologies for the recovery of reusable materials, manufacturing new products or generating energy from the solid waste (Tchobanoglous *et al.*, 1993). The process of recovery comprises separating the different components of the solid waste during which valuable resources are recovered from the solid wastes at transfer stations or solid waste processing plants (Enayetullah *et al.*, 2005).

In most solid waste management systems, solid waste, regardless of its type usually ends up in landfill sites. There are many solid waste management practices, which differ with respect to types of waste and prevailing local conditions. These conditions also affect the choice of final disposal practice in a given situation (Centre for Environment and Development, 2003). This process (solid waste disposal), and for that matter what happens at the disposal sites is very vital since careless handling of waste at such site can result in health problems for the public (Henry *et al.*, 2006).

2.2 Modern Methods for Managing Solid Waste

There has been improvement in the ways used in disposing solid waste as a result of modern innovations. Some of these new ways of solid waste management include incineration with reduced-emission (Pattnaik and Reddy, 2010). Other methods include reduction in the quantity of the solid waste generated, recycling of waste and composting organic components (Marshall and Farahbakhsh, 2013). These methods serve as

improvement on traditional ways that people employed in the disposal of solid waste, which did not take into consideration the health implications. In Kenya for example, it has been reported that in some peri-urban areas, the use of crude ways for solid waste disposal, including dumping into water bodies and public places has resulted in outbreak of diseases such as diarrhoea, which is usually associated with bad sanitary conditions (Henry *et al.*, 2006). These methods are further discussed in the following subsections.

2.2.1 Reduction in waste quantities

This involves bringing down the quantity of waste that is generated by the public. The process may include reducing bulky packaging to thinner ones and also switching to reusable products (Kreith, 1994). Avoiding the use of packaging where possible could also aid in reducing waste since many such packages are thrown away as waste after their use. The reduction of waste quantity is acknowledged to be the best method in confronting waste problems globally by Urban Sector Programme Support Secretariat and especially in developing countries where the problems associated with waste management are more advanced (USPS, 2000). This is a key method that a proper waste management system must embrace, especially because it can be accomplished without any cost. Reduction could be realized when people cut down the quantity of products they consume, and also sticking to the reusing of materials where possible, and reducing the use of disposables (USPS, 2000).

2.2.2 Composting

This is an organic process whereby microorganisms are allowed to break down organic solid waste substances under human-made conditions that allow for harmless storage and application on farms as evidenced by United Nations Environmental Programme (UNEP,

2009). In Ghana where backyard gardens are common, composts could be used to maximize crop yield. Composting of solid waste can help reduce the quantity of solid waste that must be sent to a combustor or landfill, thereby reducing disposal costs. However, for composting to be possible, the waste material should be putrescible to permit the action of decomposers on such materials (Ogwueleka, 2009). Since the technology applied in this method is not exceptionally difficult, it serves as an opportunity for developing countries. This is because developing countries have more than half of their solid waste being organic component and with their economies usually agriculture based (UNEP, 2009).

2.2.3 Recycling

Recycling deals with all the needed processes that could assist in converting waste materials into useable forms to produce economic benefits to human. It also reduces the negative effect that the natural environment would have experienced if the solid wastes were disposed of directly into the environment as indicated by United States Environmental Protection Agency (USEPA, 1999). This helps in preventing the discharge of pollutants and waste into the environment. This provides the opportunity in using the resources that would have been used to manage such waste or pollutants for other developmental projects to enhance economic growth (Parrot, 2009).

Recycling has not been generally used by many of the developing countries, the reason in many cases being lack of clear policies to that effect (Pattnaik & Reddy, 2010). Recycling involves the separation of solid waste into the different components for easy access to recyclable materials. However, the public in developing countries usually do not do the separation before disposal (Ogwueleka, 2009; Pattnaik & Reddy, 2010). In such

circumstances, all kinds of solid waste forms are gathered into a common vessel without efforts to group them into various categories for waste management purposes. This situation leads to extra cost (for separation into different components) to waste management institutions wishing to recycle such unsorted solid waste and also to waste generator where the generator bears the cost of waste management (Manaf *et al.*, 2009).

2.2.4 Incineration

Modern incineration practice leads to the conversion of unwanted solid substance to gaseous state in a controlled environment, in order to decrease the quantity to only the proportion that cannot readily burn (Centre for Environment and Development, 2003). Even though this method may produce some by-products that may require its disposal at landfills, it reduces the amounts of inorganic solid waste by about 90%, leading to a reduction in the cost of transportation as a result of reduced size (Sakai *et al*., 1996). In spite of this possible benefit, other factors including high moisture content and high energy requirement of solid waste could be the reasons for its minimal usage in the developing countries (Achankeng, 2003).

Although incineration could be essential in managing solid waste, it has some challenges that need to be dealt with in order to make it beneficial to both human and the environment. For instance, the ash residue from the incineration process might contain toxic substances such as heavy metals and therefore need to be treated before final disposal (Karagiannidis *et al.*, 2013). Incineration also has the possibility to contribute to global warming through the emission of carbon dioxide into the atmosphere (Mendes *et al.*, 2004). Poisonous gases including hydrogen sulphide (H_2S) and sulphur dioxide (SO_2) could also be emitted into the atmosphere, a situation which can potentially cause health problems for human as these

gases are inhaled (Mendes *et al.*, 2004). It is however possible to lessen the release of these harmful gases into the atmosphere significantly using efficient gas purification process during incineration (Mendes *et al.*, 2004).

2.2.5 Land filling

This is the process of dumping of waste in an enclosed area with soil layers covering the compressed layers of waste at regular levels to deprive the refuse of oxygen, which could cause burning (Centre for Environment and Development, 2003). The other operational methods of waste management commonly produce residual materials and might require the use of a landfill to make them work efficiently (Kreith, 1994). The landfills need to be well engineered to prevent the outbreaks of any disease resulting from pollution of water bodies which is usually caused by leakages of contaminants from landfills (Manaf *et al.*, 2009). The types of waste sent to a landfill define the potential pollutants that can be produced and hence the potential environmental risk. Since the waste is usually dumped directly into the ground, there is a potential for soil and ground water contamination (Mato, 1999). This is caused by the release of leachate from the landfill which usually has high amount of pollutants (Vilar *et al.*, 2011).

To reduce the chances of ground water pollution, leachate from the landfill can be channeled to a collection point and treated before it is released back into the environment (Renou *et al.*, 2008). Separate cells can be created within the landfill and lined with an impermeable material for where known hazardous substances are to be disposed (Mato, 1999). This can help avoid the release of pollutant into the soil and possibly into ground water or nearby water bodies. However, the high capital needed in building sanitary and engineered landfills has made many less developed countries continued with the use of the unwholesome open dumps or controlled dumps, without the appropriate lining and

compacting facilities (Kumar *et al.*, 2009). A few African countries such as Ghana, Egypt and South Africa have however introduced programmes to upgrade gradually all their landfills to sanitary and engineered ones (Achankeng, 2003).

2.2.6 Integrated Solid Waste Management (ISWM)

Integrated Solid Waste Management (ISWM) is a comprehensive waste prevention, recycling, composting, and disposal program. An effective ISWM system takes into consideration how to prevent, recycle, and manage solid waste by methods that most effectively protect human health and the environment. ISWM involves identifying local needs and conditions, and then selecting and using the most appropriate waste management activities for those conditions. The major ISWM activities are waste prevention, recycling and composting, combustion and disposal in properly designed, constructed, and managed landfills as indicated by (United States Environmental Protection Agency (USEPA, 2002).

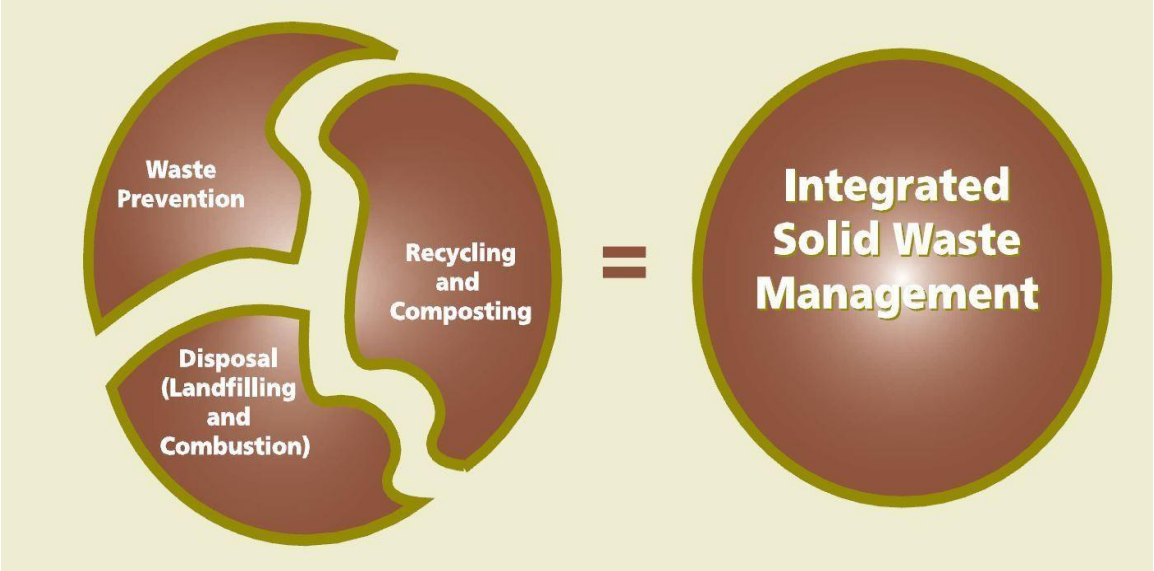


Figure 2: Integrated Solid Waste Management

The use of a single method in managing solid waste may not yield the needed result. In spite of the substantial amounts (about 60% of waste management budget) of money being spent on the solid waste management, less developed countries are unable to collect all their urban solid waste and less than half of the population is served (UNEP, 2009). If recycling and reuse of the waste that is generated could be increased, then final quantities of waste would be reduced, and recovered materials used to generate revenue (Sakai *et al*., 1996). This might be a good method for many countries since it brings together all individual solid waste management methods viable for a particular situation, in order to achieve the best result.

2.3 Domestic Solid Waste Collection: Practices in Some Developed Countries

Waste collection is the collection of solid waste from point of production (residential, industrial commercial, institutional) to the point of treatment or disposal (Hoornweg *et al*., 2012). Although the systems of domestic solid waste collection differs with regards to the types of materials collected, containers and vehicles used and collection frequency, it is common to have separate collections for recyclable and waste organic in many European countries. Varying forms of waste collection and disposal exist in different parts of a region or a country as a result of the fact that each country or municipal area within a country needs to adapt to its own situation in terms of factors such as socioeconomic and infrastructural conditions (Timlett and Williams, 2011).

In England, for instance, where two-tier authorities operate, it is the responsibility of the Waste Collection Authorities to collect domestic solid waste, while Waste Disposal Authorities take care of waste disposal. The Unitary authorities are also responsible for both collection and disposal of domestic waste (Williams and Cole, 2003). Currently, in

an effort to have cost reduction and a considerable increase in the quantity of waste recycled, many Local Authorities in the United Kingdom (UK) have adopted an „ “alternate weekly collection (AWC)” of recyclable and residual wastes. In this system the collection of recyclable and/or organic (for composting) components alternates on a weekly basis, with residual waste incinerated or disposed of in landfill. A few Local Authorities also have separate schemes for garden waste and food waste collections (Williams and Kelly, 2003). For instance, in United States, collection services mostly available to residential facilities are curb, “setout-setback” and “backyard carry”. In the “setout-setback” system, a special team carries containers from backyards to the curb where they are emptied by a collection crew (Whitman, 2005).

The containers are then taken back to their original locations of storage by the special team. In the “backyard carry” system, the collection crew actually enters the client’s property to collect waste. The container is then sent directly into a truck, emptied and taken back to its original location, or emptied into a cart and taken to the vehicle to speed up the process (Whitman, 2005).

2.4 Domestic Solid Waste Management in Developing Countries

In urban areas of most developing and least developed countries generated Municipal Solid Waste (MSW) is at best collected and dumped at indiscriminate dump sites that mostly lack the appropriate norms. Such disposal involves collecting, transport and dumping into the nearest open space area. In other countries solid waste is dumped into water bodies and wetland whilst some part of the waste is burned to reduce its volume (Imad, 2011). Such practices have their hostile environmental impacts including polluting the natural resources and the creation of health problems which might turn into long-term public health

problems (Imad A., 2011). Substantial reforms in the management of MSW are still not attained even though lots of significant efforts have been made in the last few decades in many developing countries supported technically and financially by developed countries and international organizations (Imad, 2011).

2.5 Generation of domestic solid waste

Waste generation is a natural process and commonly increases with per capita income. Mostly, municipal wastes are not well managed in developing countries, as municipalities and cities are unable to cope with the accelerated pace of waste production. In most cases, many developing countries have similar characteristics regarding population growth trends, economic activities and education, as well as consumption and production.

These features have the tendency of affecting the generation of household solid waste. Therefore, in considering the solid waste management in an urban centre in a developing nation such as Ghana, there is the need to study the situation in other parts of the developing world. The mean quantity of solid waste that a household produces differs along the social and economic strata even in the same country, and the average quantities produced increase with increasing income level (Sujauddin *et al.*, 2008). As a result, settlements of residents with higher incomes have the tendency to produce more solid waste due to their high purchasing power resulting in higher consumption (Sujauddin *et al.*, 2008). In addition, households are known to generate over 30% of the total quantity of municipal solid waste in Asian countries (World Bank, 2012). For instance in Bangladesh, the estimated average quantity of solid waste generated by a person on a daily basis is 0.15 kg, and this figure is expected to increase greatly, considering the high rate of population increase (World Bank, 2012).

2.5.1 Composition and Characteristics of domestic solid waste

The physical composition of domestic solid waste varies from region to region. The key factors that influence physical composition are similar across locations, and these factors include, but not exclusively limited to, types of food eaten, the climate and cultural practices of people (Enayetullah *et al*., 2005). The knowledge of both the quantities generated and the composition is necessary for effective planning of solid waste management (U.S Environmental Protection Agency, 1989). This is because the type of disposal method employed is influenced by the composition of solid waste. Domestic solid waste with similar components and proportions are generated in urban centres in developing countries, usually with the highest proportion being organic and readily decaying especially in the areas with residents of lower socioeconomic standings

(Sha'ato *et al*., 2007).

For instance, a study carried out in Bangladesh reveals a wide range of percentage (47 – 88%) as a proportion of household solid waste, which is in the form of food material. Although there is a variation along the socioeconomic strata, the food waste proportion maintains high percentages among other components like plastics, cans or metals, dirt and paper at all levels of the strata (Sujauddin *et al*., 2008). The variations detected resulted from the differences in purchasing abilities among residents, with the percentage of proportions attributable to food component decreasing as the economic standings of residents increase (Sujauddin *et al*., 2008). Low class settlements generate higher quantities of dust components compared to those generated in the higher class settlements resulting from the fact that neither pavements nor lawns exists in most houses of the low class residences. Bare ground is therefore swept almost every morning, which accumulates

large quantities of dust and other small particles such as ashes in waste collection containers (Sha'ato *et al.*, 2007).

Metals, plastics, paper, polythene, glass, cans and textiles are the other materials that form part of the solid waste in the household. Other packaging materials may also be present though usually in smaller portions of the total solid waste generated (Enayetullah *et al*., 2005). In Algeria for example, the proportions of the components of domestic solid waste generated in urban areas showed similar trends, with the highest proportion(between 53 and 77%) of the solid waste being putrescible material (Naïma *et al*., 2012). Other materials such as plastics, papers, glass, fine matter (e.g. dust, ashes) and metallic substances, comprise the remaining percentage of the domestic solid waste.

Textile waste was present but only in small quantities (Naïma *et al*., 2012).

2.6 The General State of Solid Waste Management

2.6.1 Solid Waste Management Institutions

In several African cities, the inability of the state to provide satisfactory solid waste management services to the general public, has led to the wide spread of several private entities in this sector, many of which are not formal. In some instances, community based and Non-Governmental organizations are also involved (Tukahirwa *et al*., 2012). In Nairobi, contracts are given to private entities through competitive bidding for the collection of solid waste (Tukahirwa *et al.*, 2012).

However, the inability of these companies to perform their duties well has led to the springing up of many others such as the community based organizations whose work is not fully regulated (Tukahirwa *et al.*, 2012).The community based organizations dominate

in urban settlements in the lower socioeconomic class. This situation in Nairobi is comparable to those of many other cities in Africa, such as Accra (Boadi and Kuitunen, 2004), Kampala and Yaoundé (Tukahirwa *et al.,* 2012). Unlike Nairobi and Kampala, a more organized system of combining efforts of different types of solid waste management institutions exist in Dares Salaam, where community based organizations and privately owned companies are contracted by the local government to provide solid waste management services to the public with each institution being allocated an area of operation (Tukahirwa *et al.,* 2012). Municipalities often license private operators and may designate collection areas to encourage collection efficiencies.

2.6.2 Domestic Solid Waste Disposal Practices

There are many other unconventional methods adopted by urban dwellers of many developing countries in spite of the formal means of domestic solid waste disposal. This usually leads to a limited access to waste management services. There are many other unconventional methods adopted by urban dwellers of many developing countries in spite the formal means of domestic solid waste disposal. This is usually leads to limited access to waste management services. For example in Yaoundé, an average of about 67% of the total domestic solid waste produced is disposed of using formal means (collected in trucks and/or waste bins) whereas the remaining fraction is disposed of through crude means (Parrot *et al.,* 2009).These crude methods include burying, burning, discarding in streets, gutters, bushes and water bodies (Parrot *et al*., 2009).

In spite of the health hazards that open dumping of domestic solid waste pose to the public, its practice is prevalent in most developing countries (Kansal, 2002). Open dumps are the most commonly used means for disposing domestic solid waste in Nigeria as it is the case in many developing countries. Other means such as engineered landfills, household

collections and skips are also used, although only in limited areas (usually city centres) (Ogwueleka, 2009). Open dumps are also present in almost all the cities of India (Kumar *et al*., 2009). The open dumps, which have become common, pose threats to human health as they are not covered and the material in them is frequently burnt to reduce volume (Ogwueleka, 2009).For many developing countries, some modern solid waste management and disposal methods such as sanitary landfills, incineration, recycling and composting exist.

However, they are usually limited to a few areas and a small portion of the populations. For example, incineration, which is one of the formal means of disposal, is usually used by hospitals in Nigeria where it is practiced on the small scale (Ogwueleka, 2009).
Similar situation exists in the Cameroonian capital, Yaoundé and in other cities such as Bamenda (Achankeng, 2003). Composting is considered less costly and therefore fits into the economic and social condition of most developing countries. This is especially because more than half of the total volumes of domestic solid waste that is generated in the towns of such countries are putrescible and their economies are mostly agriculturally based (Ogwueleka, 2009). Composting fits into the economic and social condition of most developing countries since is considered less costly. This is especially because more than half of the total volumes of domestic solid waste that is produced in the towns of such countries are putrescible and their economies are mostly agriculturally based
(Ogwueleka, 2009).

Composting fits into the economic and social condition of most developing countries since is considered less costly. This is especially because more than half of the total volumes of domestic solid waste that is produced in the towns of such countries are putrescible and their economies are mostly agriculturally based (Ogwueleka, 2009). Recycling is also not

a common practice in many developing countries, the basic reason being lack of separation of recyclable material at the point of the solid waste generation (Pattnaik& Reddy, 2010). In certain cities in India, scrap collectors separate recyclable materials from the combined solid waste at disposal sites for onward sale to companies that need them for processing into new products and this serves as a source of livelihood to many locals (Pattnaik & Reddy, 2010). Similar to the situation in India, Nigeria has no well-defined programmes to recycle solid waste and so a maximum of 30 scrap collectors could be found at dump sites gathering recyclable material (mostly metals, plastics and papers) for the market in Lagos and other cities in Nigeria (Kofoworola, 2007).

Land filling is considered a necessary component of all solid waste management systems. This is evident in the fact that even advanced methods of disposal produce residue which still need to be disposed of in landfills (Rushbrook, 1999). It is good to engineer landfills properly for the prevention of diseases which could result from pollution of water bodies by leaked contaminants from landfills (Kumar *et al.,* 2009). However, the need for high initial funding for the construction of such standard landfills has made many less developed nations continued with the rather unhygienic open dumps or controlled dumps which barely have provisions for compacting and lining (Kumar *et al.,* 2009). Ghana and other African countries, including Egypt and South Africa, have initiated programmes to have their landfills upgraded to sanitary types (Achankeng, 2003). About 27% of the cities in India have sanitary landfills, whereas Nigeria, which is the most populated country in Africa, has only two sanitary landfills in Abuja and Lagos, which is an indication of how depraved the situation is in some parts of Africa (Vij, 2012).

2.7 Constraints to Solid Waste Management

As a result of the similar socioeconomic structures which exist amongst developing countries, they are likely to face similar challenges in their efforts to manage domestic solid waste effectively. This section, therefore, considers some of the fundamental challenges. In most cases, inadequate funding, institutional obstacles as well as inappropriate logistics and infrastructure have been revealed as the main constraints (Parrot *et al.,* 2009).

2.7.1 Funding

For many of the developing countries, the government through special taxes and development levies regularly provides money for solid waste management but the funds given by governments normally happen to be far below the needed amounts (Parrot *et al.*, 2009). Solid waste management in Cameroon and Nigeria, for instance, is funded through sanitation and waste collections taxes respectively (Parrot *et al.,* 2009). In some cases, the central governments offer an amount of money to support the revenue from the taxes which are usually administered by the local governments (Agunwamba, 1998).

For instance, in some countries, waste collection fees are collected directly from households and this system has often led to low collection in areas of low socioeconomic status (Al-Khatib *et al.,* 2007). Often inadequate fees charged and insufficient funds from a central municipal budget cannot finance adequate levels of service. These systems are mostly ineffective because they do not take into consideration the different solid generation levels of individuals (Parrot *et al.,* 2009). Moreover, the small budgetary allocation for solid waste management is often for collecting and transporting the waste without considerations of recycling and treating it (Vij, 2012). It has been detected that

governments' provision of waste management services to the public have usually not worked well, hence the need to involve private entities (Kinley, 1992).

2.7.2 Institutional constraints

This constraint usually results from the unclear assignment of duties to institutions in the sector. This leads to overlapping responsibilities and confusion in the course of executing work (Parrot *et al.*, 2009). In most cases, agencies involved in this service provision are owned by the state and are inefficient (Agunwamba, 1998). Well-trained labour is lacking in this sector and so making effective solid waste management hardly attainable in the developing world (Agunwamba, 1998).

2.7.3 Logistics and infrastructure

The low collection rates of solid waste in the less developed countries could partly be attributed to the absence of well built and maintained roads, a situation which usually results in increased collection time *per* area (Parrot *et al.*, 2009). These delays in operation obviously deprive some areas from enjoying collection services since working hours may be over by the time collectors get to these zones. The collection and transport vehicles face frequent breakdowns sometimes reaching up to 80% for all the municipal vehicles being out of service. This leads to many zones being left out of the daily solid waste collection and consequently causes overflowing rubbish skips (Parrot *et al.*, 2009). Moreover, the use of inappropriate equipment is sometimes experienced whilst the good ones are not well-maintained and so cause frequent breakdowns, a situation that is a key contributing factor to the low collection rates (Agunwamba, 1998).

2.8 Management of Solid Waste in Ghana

2.8.1 Solid Waste Disposal

In Ghana, the residents of Accra (Ghana's capital) dispose of their domestic solid waste in various ways. The means of waste disposal used by the residents are burying, burning, dumping in gutters and other places, the use of public dump and waste collection by agents (Anomanyo, 2004). Figure 3 shows the estimated proportion of domestic solid waste that is disposed of by each of the mentioned means of waste disposal.

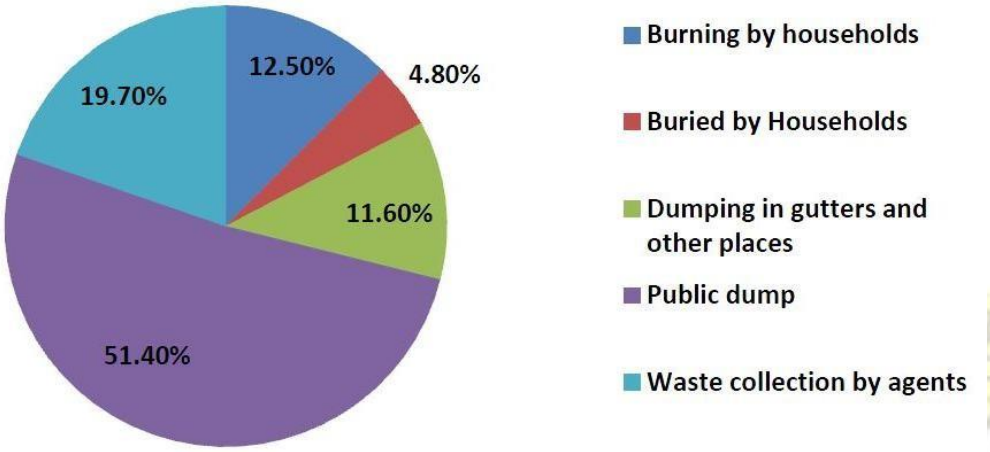


Figure 3: Waste Disposal of Households in Accra Metropolitan Area, 2004 (modified from Anomanyo, 2004).

Out of the nearly 1800 tonnes of waste generated in Accra (in 2004), about 28.9 % was disposed of informally (i.e. burning and burying by households, dumping into gutters and other unapproved sites) as shown in Figure 3. This situation has the potential of causing nuisance and health hazards to residents (Anomanyo, 2004). In addition, most people in the city of Accra have resorted to unapproved methods of dumping waste, because the existing approved methods for dumping solid waste have not measured up to the needs of the existing population of the city (Boadi and Kuitunen, 2004). In most cities in developing

countries, collection rates remain low and the quality of collection services are poor. Wastes collection services are normally not present in poorer neighbourhoods such as slums (Chandak, 2010). In places where there is involvement of the communities and the private sector in waste management services, there have been some successful examples. However, involvement of these divisions of society is very limited in many cities of developing countries. The wastes collected normally end up in open dumps, where they may be burnt, and in some cases are deposited in illegal dumping sites (Chandak, 2010). There have been some common practices which require special attention due their adverse health effects they pose to people. These include dumping of waste into gutters and water bodies and backyard burning of waste (Anomanyo, 2004).

2.8.2 Policy and Regulation on Solid Waste Management

In spite of the fact that Environmental Protection Agency (EPA) of Ghana wield the legal obligation to control the activities related to solid waste, the duty of the Local Government in waste management is carried out through the in the various districts assemblies, municipalities and metropolises using their various sections purposely assigned for managing waste (Ministry of Local Government and Rural Development (MLGRD), 2004). A national environmental sanitation plan was developed about a decade ago with the main objective of creating a healthy environment within the various communities. As a result, the various local governments were empowered to come up with strategic policies for achieving the activities recommended by the policy (Japan International Cooperation Agency, 1999). Presently, the Pesticide Control and Management Act of 1996, the Environmental Protection Agency Act of 1994 and also the Act instituting the local governance system are some key legislation that deals with the management and disposal of hazardous waste in Ghana (MLGRD, 2004). One essential

guideline for wastes management in Ghana is The National Environmental Sanitation Policy (NESP), and the Environmental Action Plan which helps as the mother document from which all these regulations come from (MLGRD, 2009). Considering the various laws and policies put in place by the government and its regulatory agencies, it appears Ghana has an effective waste management. However, because of problems and issues relating to the implementation of policies such as, inadequate funds, unskilled and weak institutions, garbage continues to be a serious urban problem in Ghana (Asase *et al*., 2009).

2.8.3 Problems of Waste Management in Ghana

Inadequate financial and human resources, combined with the presence of feeble institutions are the main challenges which solid waste management in Ghana is being faced (Boadi and Kuitunen, 2004). In many parts of the less developed world, funds for the management of solid waste is usually provided through development levies and special taxes but the monies provided by the governments of these developing countries are usually insufficient (Parrot *et al*., 2009). The major difference amongst diverse sessions of settlements leads to a condition in which solid waste collection from household is only accessible to a few high class and middle class settlements. (i.e. well organised settlements with residents mostly being of high socio-economic statuses) that form the minority of the public (Asase *et al.*, 2009).

There is lack of access to solid waste collection services particularly for the greater proportion of people who dwell in low class settlements. This situations leads to a lot of irresponsible waste disposal behaviours (Boadi and Kuitunen, 2004). In brief, it could be said that lack of well-planned solid waste management activities coupled with limited equipment and technology are part of the main challenges that the management of solid

waste in Ghana is being faced with (MLGRD, 2004). Inadequate sites and lack of appropriate facilities for proper solid waste disposal, inadequate personnel with expertise in managing solid waste and a bad attitude of the public as far as environmental sanitation is concerned are the other key challenges to waste management (MLGRD, 2004).

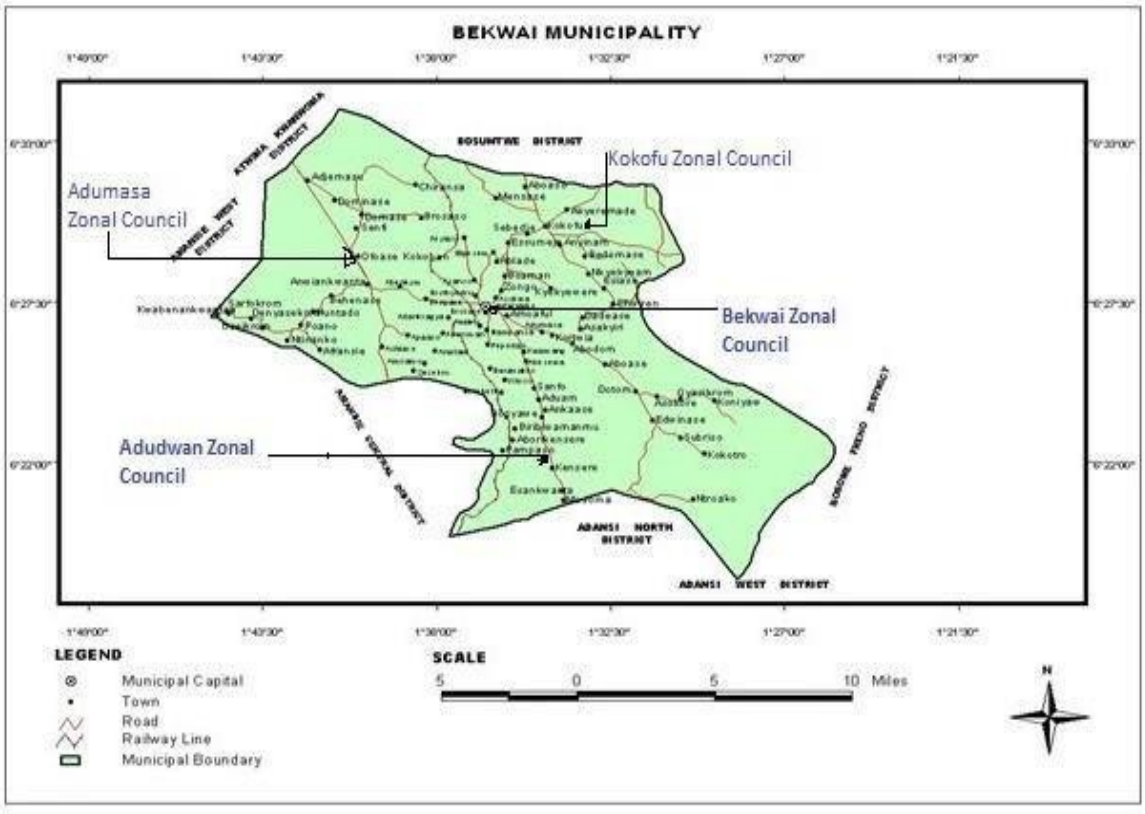
CHAPTER THREE

MATERIALS AND METHODS

3.1 Profile of Study Area

The study was carried out in the Bekwai Municipal area in the Ashanti Region of Ghana. The Municipality lies within the forest dissected plateau physiographic region with an average height registering between 150 metres and 300 metres above sea level. The Municipal has 8 zonal councils with a population of 118,024 (GSS, 2012). The area is

drained by the Oda River and its tributaries including Dankran which portrays a dendritic pattern. The mean annual rainfall is between 1600m – 1800mm. It has a fairly high and uniform temperature ranging between 32 C in March and 20° C in August. Relative humidity is fairly moderate but high during the rainy season. It ranges between 70 and 80 percent in the dry season. The occupational distribution in the Bekwai Municipal Assembly shows agriculture as the dominant occupation followed by the service sector, commerce and industry. Agriculture still remains the dominant sector over last plan period. The Municipal industrial sector is dominated by private individuals who are mostly engaged in industrial establishment in the areas of agro-processing, metal-based, wooden based, textile, garments, leather works and food processing (Ministry of Local Government and Rural Development (MLGRD, 2004).



Map of Bekwai Municipality indicating the sampling zonal councils

3.2 Data Collection

Primary data was collected through preliminary field investigation, questionnaire administration (for households), solid waste characterization and personal interviews with selected stakeholders whose views were considered relevant for the study. These stakeholders were mainly the Environmental Department, which is the key local government department in charge of waste management in the Bekwai Municipal, and Assemblymen within the study area. The primary data collection through the interviews and observations has been important because in a Bekwai municipal Assembly which is used as the study area, issues concerning solid waste management have received little authentic data. This research is founded on qualitative method of data collection. However before gathering qualitative data, studies from relevant literature and identified theories and concepts most relevant to the study was carried out.

3.2.1 Interviews

There was informal interaction with the Bekwai Municipal Area Environmental Management Department. These interactions were basically discussions on issues such as the extent of operations and the problems these institutions face in discharging their solid waste management duties. Similar discussions were also held with Zoomlion Ghana Limited, a private waste management institution which operates within the study area. This process helped to gather some data, which was included in the final discussions of findings and were also helpful in the formulation of questionnaires and interview schedule. For instance, some information on the kind of facilities available for solid waste collection within the area was obtained.

These institutions in the study area were formally interviewed later in the survey. The informal discussions held earlier helped to arrange for the formal interviews. The

interviews were used to collect data to support those acquired through the administration of questionnaires, which were the key source of data for the study.

3.2.2 Filed Observation

There was a field observation which was undertaken by scanning through the study site to find out the following:

- presence of dustbins in the study area (outside houses);
- dump sites;
- landfill sites, and
- Communal waste skips.

Field investigation helped in examining the problem on the ground.

3.2.3 Questionnaire Administration

Questions were organised for simple understanding. Here, some open-ended questions were asked which gave room for the interviewees to express themselves. They were, however, guided to stay within the particular subject under consideration. Some of the questions involved their awareness frequency of waste collection, means of disposal of domestic solid waste.

3.2.4 Characterization of Domestic Solid waste

Ten households from the study area were selected for waste sorting and weighing of the key components. This was done by the researcher with co-operation from the various households. This was to provide supporting information to that generated through questionnaire administration. The composition of household waste was obtained by the sort-and-weigh method. This involved sorting the waste into each of the major components considered under the study and weighing them individually. The equipment used included

weighing scales (top pan balances), plastic waste bins of empty mass of 0.15kg and safety equipment including gloves and nose masks. This was done in 5 continuous days and the average for both the total household waste and each component was determined.

3.3 Sample Size

There are 27,258 households in the municipal (GSS, 2012). The mathematical formula used for the determination of the sample size for the survey is shown below: Sample size

ss= $\frac{Z^2 * P * 1-P}{C^2}$, (Survey Systems, 2012)

where Z = z value (1.96 for 95% confidence level)

P = percentage picking a choice, expressed as decimal (0.5 used for sample size needed)
C = confidence interval expressed as decimal (0.08 = ± 8)

Substituting figures into the formula, ss = $\frac{1.96^2 * 0.5 * 1-0.5}{0.08^2}$ = 150.0625

Correction for finite population;

In situations where the population from which the sample is drawn is finite, the sample derived from the above equation is further adjusted or corrected to suit the population using the formula below (Survey Systems, 2012):

New (corrected) ss = $\frac{SS}{1+\frac{SS-1}{pop}}$, where pop =population.

= $\frac{150.0625}{1+(\frac{149.0625}{27258})} = \frac{150.0625}{1.00546} =$ 149.247

Sample size ss = 150 households

The sample size for the studied population was therefore 150. The accuracy of the data is partly dependent on the percentage of the sample that picks a particular answer (**P**-percentage picking a choice, expressed as decimal)

3.3.1 Selection of Respondents

There are eight zonal councils in the study area. Out of this number, four zonal councils were randomly picked for the study. The names of the 8 area councils were written on separate pieces of paper. Each of the pieces of paper was folded and placed in a container. The container was then shaken to mix the pieces of paper bearing the names of the zonal councils. Out of the total of 8 pieces of papers, 4 were picked to obtain the zonal councils that were considered for the study. A total of 18 communities were selected for the study. With a sample size of 150 household, 60 respondents were selected from Bekwai zonal council which is the biggest while 30 respondents were selected from each of the other three zonal councils, namely Adumasa zonal council, Kokofu zonal council and Adudwan zonal council.

For each community or settlement, the number of samples was randomly picked from the list of house numbers for that community that were obtained from the municipal Assembly office. The calculated sample size was approximately 150.

3.4 Data Processing and Analysis

The statistical methods used in this research consisted of descriptive statistics of frequency count and percentage. Microsoft Excel was used to process the quantitative data obtained through the questionnaire administration and interview.

Responses to the questionnaire were pooled, edited and scored.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1 Components of Domestic Waste Generated in the Municipality

Major components of wastes were found to be plastic, food waste (organic materials), papers and dust/ashes. The respondents were asked to rank their choices, 1 to 6 (for the 6 options provided), with 1 indicating the component that is mostly generated in terms of quantity (see Appendix I for transcript of interview).

Table 1: Major Components of Domestic Waste

COMPONENT	RANKING	NUMBER OF REPONDENTS
PLASTIC	1	10
	2	42
	3	3
FOOD WASTE	1	148
	2	4
	3	0
PAPER	1	4
	2	29
	3	25
DUST/ASHES	1	0
	2	20
	3	18

Even though the rank provided was from 1 to 6, all respondents made a maximum of three choices, so limiting their ranks to 1 to 3. As shown in Table 1 above, most respondents ranked food waste (organic materials) number 1 in terms of the quantity of waste generated. The organic materials consisted of food scraps, yard or green waste (leaves, grass and brush) and wood. The second ranked component was plastic which was followed by paper. Dust and ashes were the least ranked. Since the main occupation of the people in the Municipal area is agriculture, they are likely to generate high quantities of food waste. As indicated by Shalaby (2011), the generation of food waste as portion of the solid waste with highest quantity among respondents from all communities is likely to be as a result of the social economic status, eating habit and general practices.

Naima *et al.,* (2012) and Shalaby (2011) reported these components of waste shown in Table 1 in urban centers in developing countries. However, other components were observed by the mentioned studies that were not identified in this current study. These components were textile, metal and glass. Respondents did not point to these as part of the components generated, and they were not observed in the field visit. Respondents did not point to these as part of the components of the waste they generate, probably because they only considered what made a significant amount of their waste, since the questionnaire asked about the major components.

4.1.1 Characterization of Domestic Solid waste

Ten households were selected and for each household the total solid waste generated per day was sorted and each major component weighed individually. The estimated average mass of solid waste generated by each household was 2.554kg /day.

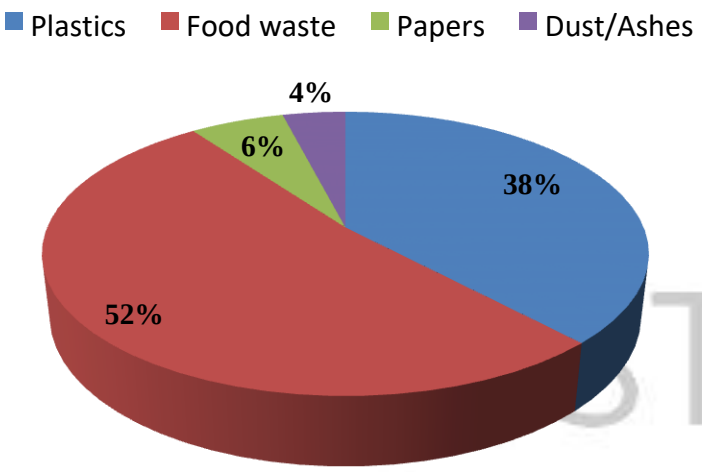


Figure 4: Proportions of key components of domestic solid waste

On the average, solid waste from households was found to be dominated by food waste (organic materials) which was 52%. This was followed by plastics representing 38% of the proportion of solid waste (Figure 4). The other components (paper and dust/ashes) had 6% and 4% respectively. Sha'ato *et al.*, (2007) indicated that usually organic components form the highest proportion of solid wastes in the areas with residents of lower socioeconomic standings. Al Seadi *et al.*, (2013) reported that the global municipal solid waste composition in 2009 indicated that a large share of the global MSW was categorised as organic waste. This confirms the ranking of solid waste components in Table 1 in terms of quantity generated by respondents in this current study.

4.2 Sorting of Domestic Solid Waste

None of the respondents sorted their waste before disposal. The respondent's reason for not sorting the waste into the different components was that they were not required by the Local Council (Authority in charge of waste management) to do so. An interview with an official of the Environmental Department of the Municipal area confirmed that residents were not required to sort their waste (see Appendix II for transcript of interview). This was

because there was no other formal disposal method (such as recycling incineration or composting) besides the landfill, which received the mixture of all solid waste components. In addition, sorting is for the purpose of giving different management treatment to the different components (Ogwueleka, 2009). Although respondents were not required to sort solid waste, however 79 respondents out the 150 indicated their willingness to do so should this be required. This could be an opportunity for the Municipal authorities to develop additional management methods such as recycling and composting, which would require sorting or separating solid waste into the different components.

4.3 Means of Disposal of Solid Waste Disposal

Two systems of solid waste collection/disposal were identified in the study area. They were communal and house-to-house (also called door-to-door) systems.

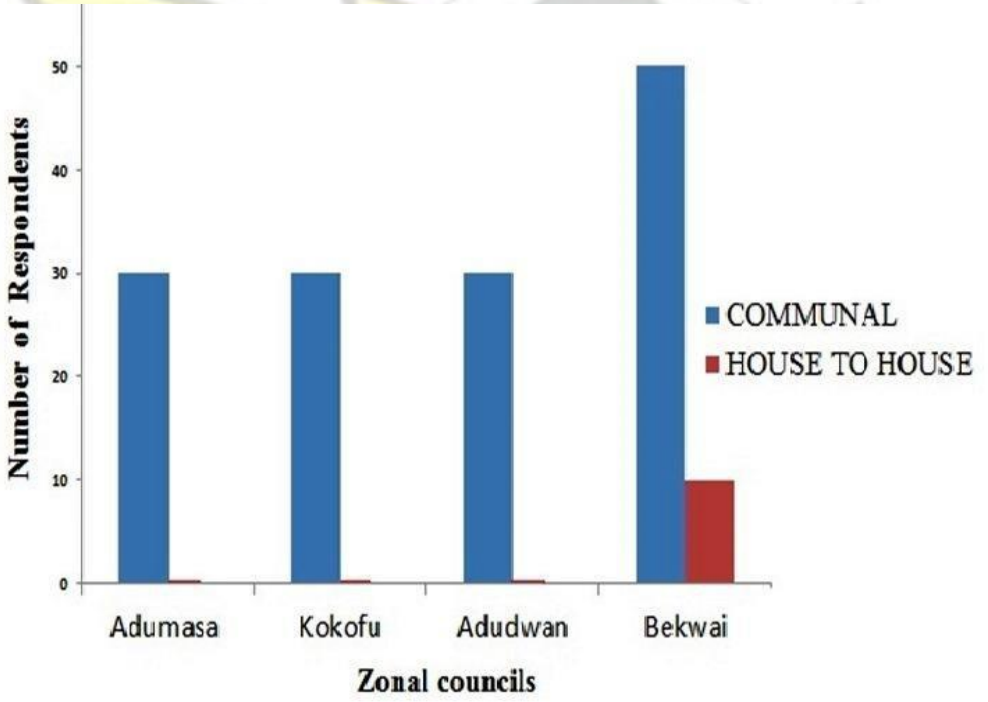


Figure 5: Means of Disposal of solid waste

As shown in Figure 5, it was revealed that a total 140 respondents used the communal system, while only 10 respondents used house-to-house system as a means of solid waste collection/disposal. For the communal system, large containers usually skips were placed at vantage points to serve as a dumping receptacle for residents in a vicinity of the suburbs in the study area (Plate1). In some cases, the communal system was an open dump, from where waste was excavated and hauled to the landfill or either burnt by the communities (Plate 2). The house-to-house system involved collection of waste from individual houses (at their doorsteps) by waste collection services providers. The houseto-house system was only identified in the Bekwai zonal council as shown in Figure 5.

These two systems identified by the study were also reported by Asase *et al*. (2009), which compared the solid waste management systems in the cities of Kumasi Ghana, and London, Ontario, Canada. Figure 5 shows the various zonal councils with their corresponding number of respondents that used the communal system and those that used the house-to house system. With the exception of Bekwai zonal council which had a combination of respondents that used the communal and house-to-house system, all the other zonal councils used communal system. The greater number of people using the communal system could be as result of the higher cost involved in the house-to-house system. The Municipal office in charge of waste management admitted that the collected services by the private company (Zoomlion Ghana Limited) have not been extended to some Zonal Councils like Adudwan.

Plate 1: Skips found in Bekwai Zonal Council

Plate 2: Open Dump in Kokofu Zonal council

4.3.1 Places Used for Disposal of Solid Waste

Respondents used skips, bush, open dumpsites and backyard for disposing their solid waste generated at home.

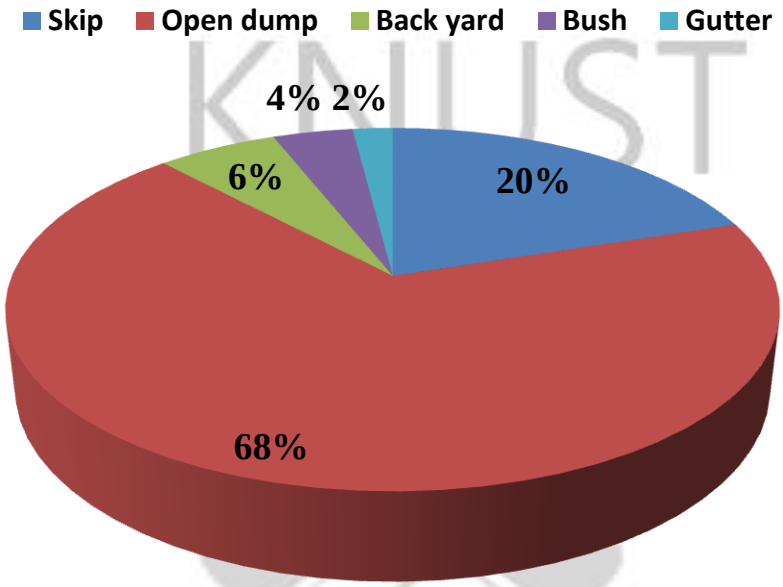


Figure 6: Disposal sites of solid wastes the Municipality

As shown in Figure 6, most respondents (68%) in the Bekawi Municipality deposited their waste in open dumpsites whilst 20% of the respondents deposited them in skips (Plate 1 and 2). The skips were found in communities like Nampansa, Brofoyedru and Asokwa all in the Bekawi Zonal councils. It was observed that the other zonal councils did not have skips but had open dump sites. Some respondents representing 6% and 4% dumped their waste in bushes and back yard respectively, even though these places were illegal sites.

These means of disposal are similar to those which exist in other parts of Ghana, such as Accra (Anomanyo, 2004), and urban centres in other developing countries (Kumar *et al*., 2009; Parrot *et al*., 2009). These respondents were those using the communal system.

Respondents in the Bekwai zonal council who used either the open dump sites or the skips were charged GH¢ 0.20 per bag of waste dumped in system known to them as pay by the bag system.

However, all the respondents from the three other zonal councils namely Adumasa, Kokofu and Adudwan were not charged for dumping wastes in open dumpsites. Waste in these dump sites were periodically burnt by the local people themselves. Chandak (2010) reported that, in most cities in developing countries, collection rates remain low and the quality of collection services are generally poor. Chandak (2010) also indicated that waste collected typically end up in open dumps, where they may be burnt, and in some cases are deposited in illegal dumping sites. This is similar to what this current study revealed.

4.3.2 Temporary Storage of Waste by Households

Before dumping or collection by service providers, domestic solid waste needs a temporary storage that is hygienic.

Table 2: Temporary Storage of Waste by Households

TEMPORARY STORAGE MATERIAL	PERCENTAGE OF RESPONDENTS (%)
DUSTBIN	6
BASKET	50
SACKS	4
POLYTHENE BAG	40
TOTAL	**100**

As shown in Table 2, 50% of respondents temporary stored their wastes in baskets before disposal. These respondents indicated that the basket was cheap and it is therefore easy to acquire them. Forty percent of the respondents also used polythene for storage. The use of

the polythene was high amongst the respondents in Bekwai zonal council. This was as a result of the system known as pay by the bag. In this system, the people are charged by per bag whenever they dump their wastes at either the open dump or the skip. Polythene bags have to be disposed of with waste at each time of dumping but the baskets may last longer. Sacks (4%) and dust bins (6%) were also use by some respondents in the municipal area. Kreith(1994) reported that the use of dust bins were the preferred option for temporary storage in the context of developed countries.

However, what this current study revealed was in contrast to the studies by Kreith(1994). It was discovered in the interview that the prize of the dustbins were considered to be high compared to that of baskets and the sucks.

4.4 Health Issues Related to Domestic Solid Waste Management

All the 150 respondents pointed to fact that they were aware that poor domestic solid waste management practices could cause some health problems for residents. The health problems mentioned by respondents to be associated with poor domestic waste disposal practices were diarrhoea, malaria and respiratory problems as shown in Table 3.

Table 3: Health problems mentioned by respondents

Health problem	Number of respondents
Malaria	80
Diarrhoea	140
Respiratory problems	25
Other (typhoid fever and ring worm)	5

From Table 3 above, 140 respondents said they were aware that poor domestic waste disposal practices could lead to residents having diarrhea, with 80 and 25 respondents stating malaria and respiratory problems respectively as possible effect of improper

disposal of waste. Moreover, 5 of the respondents mention other health conditions which were not part of the choices in the questionnaires. These other conditions are typhoid fever and ring worm.

Malaria was added to the options of possible health problems related to solid waste management because open gutters could be blocked by indiscriminately dumped waste, stagnant water in gutters. This stagnant water could be a breeding site for malariacausing mosquitoes. Henry *et al.* (2006) reported that poor sanitation could cause diarrhea. This is in line with common knowledge of diarrhoea as a potential effect of poor waste disposal which was indicated by 140 respondents in this current study.

4.5 Challenges to Effective Management of Domestic Solid Waste

Most respondents (64%) using the communal system indicated inadequate disposal site as a key constraint while those that used the house-to-house system mentioned inadequate collection service as a major constraint to management of domestic solid waste in the area.

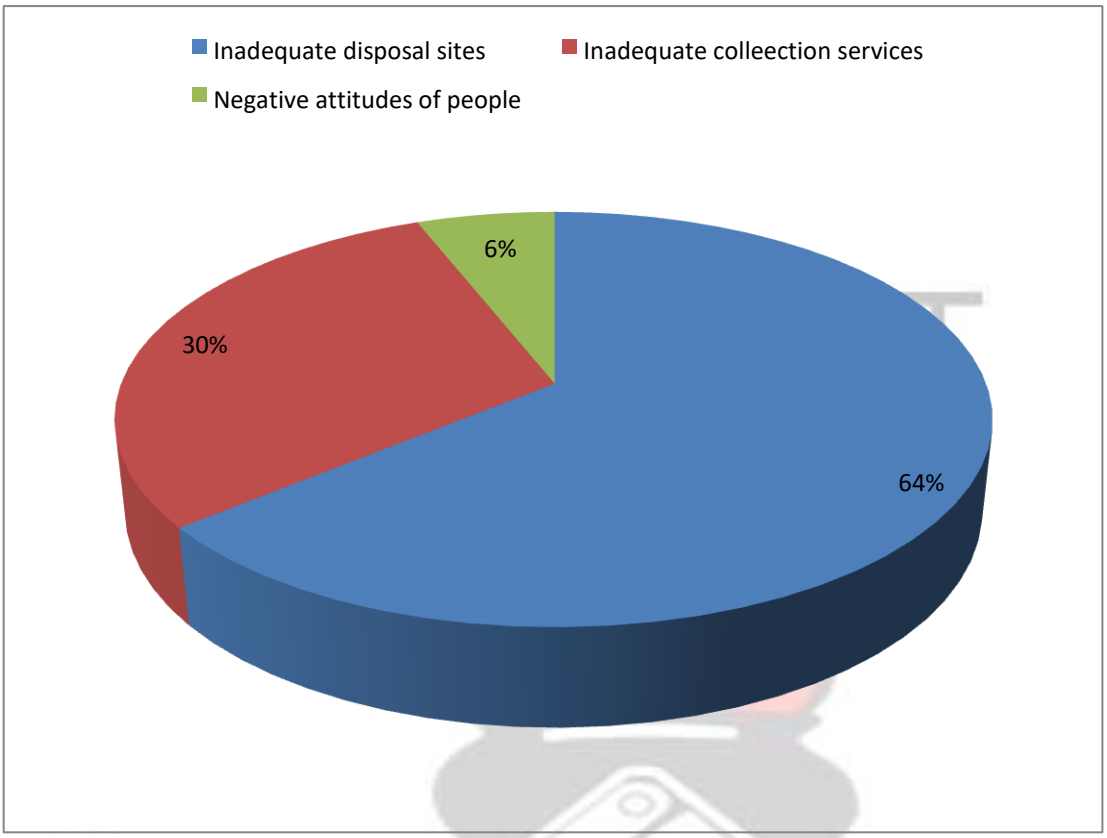


Figure 7: Constraints to effective management by respondents

As show in figure 7, some respondents representing 6% indicated the negative attitude of people towards waste management as one of the challenges to effective management of waste. Inadequate collections services normally results in the disposal of waste at unapproved locations, such as bushes and gutters as mentioned by some respondents. If collection is not regular and thorough, waste will build up at collection points and overflow from containers making those sites unpleasant and hazardous to health. This was observed by Sharholy *et al.* (2007) in their work. Figure 7 shows the constraints to effective management in the area and the respective proportion of respondents that mentioned each.

On the part of the environmental officer in the municipal area, the key constraint faced by the Assembly was inadequate funds to pay contracted waste collectors early (Table 4), a

situation which often resulted in the inability of waste collection institution to cover their allocated zones within the scheduled times. This may have resulted from the residents not being made to bear the commercial cost of waste management. Table 4 show the various constraints mentioned by the waste management officer with their respective ranks of importance (1 indicating the key constraint).

Table 4: Constraints to Effective Waste Management from the Assembly

CONTRAINTS	RANKING
Inadequate funding	1
Inadequate trained staff	2
Inadequate equipment	3
Poor roads	4

Another key challenge that was often overlooked by thlocal authorities was the bad attitude of residents towards the environment. Some respondents (5%) also indicated that beside the inadequate collection service and disposal sites, residents sometimes choose to dump waste at unapproved locations such as bushes even at areas where skips were available for dumping. A typical example of this situation was encountered in Nampansa during the preliminary survey of the study area, where solid waste had been dumped at a spot only about 5 minutes' walk away from an official dumping site (Plate 3).

Plate 3: Solid waste dumped at an unapproved site, which is in close proximity to an official dumping site.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

Households in the study area generate solid waste composed of plastic, paper, food waste (organic material) and dust/ashes. The component with the highest quantity was food waste (organic materials). A substantial number of respondents showed readiness to sort household solid waste in the different components if they are required to do so. Such cooperation from residents in agreeing to sort solid waste would help in separating waste for possible composting. Two main systems of disposal of domestic solid waste (houseto-house and communal) were found to be the practice in the Municipality. In both systems, services offered to residents are inadequate; a situation the local government office confirmed and indicated inadequate funding as a key cause.

The inadequate disposal facilities available to households are the reasons for some households resorting to the dumping of domestic solid waste at unapproved sites such as bushes and gutters. Constraints including poor infrastructure (especially roads) and inadequate funds have contributed to the less effective solid waste management in the area. Inadequate funding makes the Bekwai Municipal Assembly incapable of providing sufficient dumping facilities (e.g. skips) and collection services to residents.

5.2 Recommendations

In order to help improve the domestic solid waste management situation in the Bekwai Municipal Area, some steps need to be taken to change some of the existing situations. For that reason, the following are recommended.

The Local Government authority that is the Bekwai Municipal Area (BMA) also needs to create innovative revenue generating ventures in order to make money readily available for domestic solid waste management activities. In addition, some corporate institutions can be encouraged by the BMA, to offer help in the area of waste management as a means of fulfilling their corporate social responsibility. Change in attitude by the residents is necessary to discontinue the act of dumping waste at unapproved places by some of the residents even where appropriate dumping facilities are available. The Bekwai Municipal Assembly needs to embark on public education on the need to dispose of waste responsibly.

Food waste which was the highest component of solid waste is putrescible and therefore presents a good opportunity for composting. The local government (BMA) should therefore put up a compost plant to process food waste into compost. Farmers will have a reduced cost of production due to lower cost involved in the use of compost as compared to chemical fertilizers.

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APPENDICES

APPENDIX I

QUESTIONNAIRE FOR HOUSEHOLDS

Location ……..... Date ……

_____ **SECTION**

A: Means of Disposal (place of disposal)

Q1. Which solid waste collection mode do you have?

A- House- to- house B- Communal (If A, go to Q12, If B, skip Q12 – Q18)

Q2. Where do you dump your solid waste? (More than one answer allowed)

SITE RANK OF IMPORTANCE (1 - 6) : 1- most important

Skip

Backyard/Bury

Open Dump site

Bush

Gutter

Other, Specify:

Q3. How often do you dump your solid waste per week?

Once Twice Thrice Other, Specify: …….....

Q4a. Are you charged for dumping?

Yes No

Q4b. For which site(s) are you charged? (More than one answer allowed)

Skip Open dump Other, specify; ……

Q5. If YES for Q4a, what is the average fee you pay?

20pesewas 30pesewas 40pesewas 50pesewas

Other, specify: ……

Q6. Are you always able to afford the amount?

Yes No

Q7. If NO, where do you dump the waste in such situations? Please tick.

Burn Gutter Bury Watercourse Bush Other(specify)

Plastic

Metal

Food waste

Paper

Dust /Ashes

Other;

Q8. How long does it take to get to your usual dumping site?

5-10min 11-15min 16-20min 21-25min

More than 25min: State time …….

Q9. Is the distant travelled to the disposal site convenient to you?

Yes No (If Yes, go to Q10)

Q10. If NO, does that lead to disposal somewhere else?

Yes No

Q11. If YES, where?

Backyard/Bury Open Damp site

Bush Gutter

Skip Other, Specify: ……

SECTION B: Solid Waste Composition and Collection

Q12. Are you charged for collection services?

Yes No

Q13. If YES, indicate amount in GH¢ ……

Q14. Are you always able to pay the amount?

Yes No (if YES, go to Q16)

Q15. Please why are you not able to pay?

REASONS IMPORTANCE (1-3); 1- most important reason

Unemployed

Low income

No need to pay

Other, specify: …

Q16. Where do you dispose of the waste in such situations?

Burn Gutter Bury Watercourse Bush Other(specify)

Plastic

Metal

Food waste

Paper

Dust /Ashes

Other;

Q17. How often is your waste collected? (No. of days between collections)

Daily (1) Weekly (7) Twice weekly (3) Thrice weekly (2)

Other, specify: ……

Q18. Where do you keep/store your waste before dumping/collection?

Dustbin Basket Polythene bag Other, specify: …….

Q19. Which of the following types of waste do you generate in your home? (Indicate rank in terms of quantity;, 1 as the highest).

TICK RANK (1 – 6)

Plastic

Metal

Food waste

Paper

Dust /Ashes

Other (specify);

Q20. Do you sort waste into different components before disposing? Yes No

Q21. Give reason(s)

A requirement by local authorities Collectors' requirement

Other, specify; …….....

Q22. Are you willing to support an idea of composting food waste?

Yes No

Q23. Do you have a domestic garden?

Yes No

Q24. If Yes (to Q23), are you willing to compost your food waste for use in your domestic garden?

Yes No

SECTION C: Constraints to effective solid waste management

Q25. What do you think are the key challenges to effective solid waste management in your area? (more than one answer allowed)

Inadequate collection services Inadequate disposal sites

Other, specify; ……

Q26. Suggest ways you can contribute to effective management of solid waste in your area (more than one answer is allowed).

CONTRIBUTION Tick the one(s) you can contribute. (more than one answer is allowed)

Tick the one(s) you are already engaged in. (more than one answer is allowed)

Contributing to buy waste containers

Paying for the disposal and collection of waste

Other (specify): .....

None

Q27. How much (maximum) are you willing to pay?

a. For weekly collection at house ……

b. At collection/dumping sites (per dump) ……

SECTION D: Health Issues

Q28. Are you aware of any health problems that can result from poor management of domestic solid waste?

YES NO

Q29. If YES, mention those ones you know

Respiratory problem Diarrhoea Malaria

Other(s) (specify) ……

Q30. How did you know?

Taught in school. Heard from the media Through community health education. Other (specify) …….

Q31. Have you ever suffered from any of the health problems mentioned above?

YES NO

Q32. If YES, which of them? (more than one choices are allowed)

Respiratory problems Diarrhoea Malaria

Other(s) (specify) ……

Q33. What aspect of the waste do you think caused your health problem?

Smoke from burning waste breeding of mosquitoes in discarded cans/containers

Houseflies spreading germs from waste Other (specify) ……..……..

SECTION E: Personal Information

Q34. Respondent's age (years). Below 20 20-29 30-39

40-50 50+

Q35. What is your main occupation? ……

Q36. What is your highest level of education?

Tertiary Other post-secondary Secondary/Technical /Vocational

Middle/J.S.S/J.H.S Primary None

Q37. What is the size of your household? ……

Q38. Where does your monthly income fall in the following ranges? (All in Ghana Cedis)

Below 100 Between 100 and 150 Between 150 and 200

Between 200 and 250 Between 250 and 300 Above 300

Please, do you have any other information you would like to share concerning domestic solid waste management in this area?

……

……

……

……

APPENDIX II

INTERVIEW TRANSCRIPT FOR WASTE MANAGEMENT DEPARTMENT-BMA

Name of interviewee: Position:

Date: _____

Q1. What is the estimated quantity (tonnes) of solid waste generated in Bekwai Municipal per day? ……..

Q2. What is the per capita quantity generated? ……

Q3. What types of domestic solid waste are commonly generated in the area?

……..

Q4. Do you separate solid waste into different components before disposal?

……..

Q5. What are the reasons? ……..

Q6. What are the key components of domestic solid waste generated in this area? Show their respective percentages.

KEY COMPONENTS	PERCENTAGE (volume/ tonnage)
Paper	
Metal	

Food waste

Glass

Ashes & Dust

Wood

Plastic

Textile

Q7.What is the mode of collection operational in the following areas? Please mention the frequency of collection per week, for area.……

Q8. Where is the final disposal site located? …….

Q9. How far is the final disposal site from the Bekwai Municipal Assembly (in km)?

…….

Q10. Does the distance pose problems? …… Q11. If it poses problems, what are the problems?……..

Q12: How does the issue with distance affect the disposal of waste for the area?

……

Q13. What management method do you use for domestic solid waste generated in the area?……..

Q14. What are the reasons for using the method(s) mentioned above?

…….

Resources

Q15. What waste disposal and collection equipment have you? (e.g. skips, bulldozers, dustbins, trucks)

Equipment	Number available	Number Needed
1. Skips		
2. Roll-on-roll-off		

3. Tipper trucks
4. Tractors
5. 3 wheeled motorised trucks
6. Bulldozer
7. Excavator
8. Pay loaders
9. Compactor for compacting waste at landfill

Q16. How many qualified waste management personnel do you have?

……..

Q17. How many do you require? ……..……..

Q18. What are some of the key problems facing the department in managing domestic solid waste?

……

……

……

……

……

Q19. How do you think the problem can be solved?

……

……

……

……

……

Q20. Please, do have any other information on waste management within my study area?

……

……

……