

**ANALYSIS OF INSTITUTIONAL SOLID WASTE MANAGEMENT PRACTICES:
INSIGHTS FROM TWO GHANAIAN UNIVERSITIES.**

BY

DERY ABEIYEL FLORENCE



**THIS THESIS IS SUMMITTED TO THE UNIVERSITY OF GHANA, LEGON IN
PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF MPhil
ENVIRONMENTAL SCIENCE DEGREE**

JUNE, 2014

DECLARATION

I hereby declare that except for references cited in this study which have been duly acknowledged, this work is the result of my own research towards the award of Master of Philosophy Degree in Environmental Science Program, University of Ghana. Neither in whole nor part of this work has been presented anywhere for the award of another degree.

.....

DERY ABEIYEL FLORENCE

(Student)

Date.....

.....

PROF. MARTIN OTENG-ABABIO

(Principal Supervisor)



Date.....

.....

DR. BENJAMIN D. OFORI

(Co-Supervisor)

Date.....

DEDICATION

This thesis is dedicated to my family, my unborn children and my cherished friends who have supported me in diverse ways towards the completion of this work.



ACKNOWLEDGEMENTS

My wholehearted gratitude to the Almighty God for showing me His favour in circumstances over which I had no control. Without His grace, this work could never have been completed successfully.

My heartfelt gratitude to my supervisors; Dr. Martin Oteng-Ababio and Dr. Benjamin D. Ofori for their guidance and constructive criticism, which improved the content of this thesis. I would like to thank Dr. Francis Nunoo, Mr. Cephas Motey and Mr. Jerry Asaman for their advice. I wish to accord my deepest appreciation to the Office of Research Innovation and Development (ORID), University of Ghana for the BSU-EC MPhil Scholarship award which gave me the impetus to complete my work successfully.

Special thanks to Mr. Emmanuel Bonapart and all the staff of the Waste Management Units of the University of Ghana for their assistance throughout the data collection. I would like to thank all my interviewees especially Mr. Eric Letsu and Mr. Baah of Central University College, Mr Richard Bekai (Zoomlion Ghana Limited) and Mr. Francis Andoh (Super Paper Company Limited), for making this experience a positive one. Their willingness in sharing their rich experiences and information needed for this study was quite commendable and heartwarming.

Many thanks to my family especially Dery Nanko George, Dery Lierfu Gregory, Emmanuel Assibi and Dery Paschal for their encouragement, sacrifices and financial support. Finally, I thank all my friends who have supported me in one way or the other for the completion of the report.

ABSTRACT

Academic institutions produce solid wastes which are not disposed off effectively or economically. The result is littering and accumulation of garbage which cause pollution. This study examined solid waste generation and management practices in public and private institutions. To achieve the above objective, waste audit was carried out over a period of three weeks. Waste management practices of the institutions were also examined through the assessment of the institutional arrangement. Additionally, questionnaires about attitudes and perceptions of current solid waste management were administered.

The study established that during the 2012/2013 academic year, the University of Ghana (UG) generated 488.3 tons of solid waste from academic and administrative units of which 46% contained paper while the Central University College (CUC) generated 27.2 tons of solid waste in academic and administrative units of which 52% was made up of paper. The study therefore revealed that even though both institutions recycle used examination papers, daily paper waste generated are not recycled. UG spend GH¢193,440 to throw away GH¢29,298 value of recyclable waste paper annually while CUC spends GH¢142,776 to throw away GH¢1,632 yearly.

A number of barriers to effective waste management were identified, including: lack of knowledge and awareness of proper disposal practices, political commitment and inadequacy of legislation and enforcement of laws/regulations. In order for the institutions to effectively manage the solid waste, management should incorporate source separation of waste in their institutional planning.

TABLE OF CONTENTS

Content	Page
DECLARATION	i
DEDICATION	ii
ACKNOWLEDGEMENTS.....	iii
ABSTRACT	iv
TABLE OF CONTENTS	v
LIST OF FIGURES.....	ix
LIST OF TABLES.....	x
LIST OF PLATES.....	xi
LIST OF ABBREVIATIONS.....	xii
CHAPTER ONE.....	1
GENERAL OVERVIEW	1
1.0 Background	1
1.1 Research Problem	4
1.2 Objective(s).....	8
1.2.1 <i>The specific objectives</i>	9
1.3 Research Questions	9
1.4 Justification	9
1.5 Organization of Study	10
1.6 Conclusion	11
CHAPTER TWO.....	12
LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK.....	12
2.0 Introduction.....	12

2.1 Literature Review.....	12
2.1.1 Concept of Waste.....	12
2.1.2 Sustainable Development	16
2.1.3 The Concept of Waste Hierarchy	17
2.1.4: Urban Solid Waste Problems in Developing Countries	23
2.2 Conceptual Framework	26
2.3 Conclusion	31
CHAPTER THREE.....	33
STUDY AREA AND RESEARCH METHODOLOGY.....	33
3.0 Introduction.....	33
3.1 An Overview of the Research Locations	33
3.1.1. University of Ghana.....	34
3.1.2. Central University College	38
3.1.3. Waste Management Units.....	42
3.2 Research Materials and Methods	43
3.2.1 Waste Audit	43
3.1.2 Questionnaire Administration	49
3.1.3. Interview.....	51
3.2. Conclusion	52
CHAPTER FOUR	53
SOLID WASTE MANAGEMENT PRACTICES.....	53
4.0 Introduction.....	53
4.1 Institutional Arrangement in SWM	53
4.1.1 Storage, Collection rate and time of collection.....	53
4.1.2 Logistic, Transportation and Disposal Methods.....	56

4.1.3 <i>Units in Charge of Managing Waste</i>	56
4.1.4 <i>Scavenging in Institutions</i>	59
4.2 Implications of Solid Waste Management Practices	62
4.2.1 <i>Impacts of Solid Waste Management Practice on the Environment</i>	62
4.2.2 <i>Health Impacts of Solid Waste Management Practices</i>	64
4.2.3 <i>Impacts on Cost</i>	65
4.3 Conclusion	66
CHAPTER FIVE	67
ANALYSIS OF INSTITUTIONAL WASTE STREAM	67
5.0 Introduction	67
5.1 Waste Audit Outcomes	67
5.2 Implications of Waste Audit	72
5.3 Managing Institutional Waste as a Resource, Cost-Benefit Analysis	75
5.4: Cost of Managing Institutional Solid Waste	77
4.5 Conclusion	79
CHAPTER SIX	81
EXPLORING STUDENTS' KNOWLEDGE, ATTITUDES AND PRACTICES OF SOLID WASTE MANAGEMENT	81
6.1 Introduction	81
6.2 Assessing Respondents' Attitudes	81
6.4 Interrogating Respondents' Knowledge and Practices of Waste Disposal Practices 86	
6.5 Barriers to Managing Waste in Institutions	90
6.5.1 <i>Education/Awareness</i>	91
6.5.2 <i>Management Commitment</i>	93
6.5.3 <i>Inadequacy of Legislation and Enforcement</i>	94

6.6 Conclusion	96
CHAPTER SEVEN	97
SUMMARY, CONCLUSION AND RECOMMENDATION	97
7.1 Introduction.....	97
7.2 Summary and Conclusion.....	97
7.3 Recommendations	99
7.4 Conclusion	101
7.5 Limitations and Suggestion for Future Research	102
REFERENCES	103
APPENDICES	114

LIST OF FIGURES

Figure 2. 1 Waste Hierarchy	18
Figure 2. 2 Pathway to Manage Waste as a Resource (Integrated SWM).....	28
Figure 3. 1 Trends in students' enrolment by gender at ten-year intervals: 1961-2012	34
Figure 3. 2 Satellite Map of University of Ghana Main Campus.....	37
Figure 3. 3 Satellite Map of Central University College, Mataheko Campus	40
Figure 3. 4 Satellite Map of Central University College, Miotso Campus.....	41
Figure 5. 1 Waste Composition of CUC.....	70
Figure 5. 2 Waste composition in percentages (CUC).....	70
Figure 6. 1 Waste type and the frequency of disposal	82
Figure 6. 2 Source and frequency at which information on SWM is received	87

LIST OF TABLES

Table 3. 1	Faculties and population of Staff as at January 2012	36
Table 5. 1	Waste stream composition of UG	67
Table 5. 2	Percentage waste composition in UG.....	68
Table 5. 3	Comparative waste composition in UG/CUC	73
Table 5. 4	Annual waste estimation	74
Table 5. 5	Annual cost of A4 paper consumption.....	75
Table 5. 6	Sources of paper waste	77
Table 5. 7	Total annual cost estimates	78
Table 6. 1	Waste storage methods.....	83
Table 6. 2	Waste disposal methods	84
Table 6. 3	Reasons for the choice of disposal practice	85
Table 6. 4	Preferred Choice of SWM for Different Waste Types.....	88
Table 6. 5	Respondents' opinion on waste separation.....	90

LIST OF PLATES

Plate 3. 1 Waste from offices stored in black plastic bags.....	45
Plate 3. 2 Plastic waste.....	46
Plate 3.3 Paper waste.....	47
Plate 3.4: Method for weighing categories of waste.....	48
Plate 4. 1 Rubbish blown into the gutter by wind	55
Plate 4. 2 Overflowing street bin in U G	55
Plate 4. 3 Indiscriminate disposal practice in University of Ghana	59
Plate 4. 4 Plastic and glass bottles retrieved from waste bins	61
Plate 4. 5 Uncovered container and uncollected waste.....	63
Plate 5. 1 :“Mixed waste” category from the Faculty of Sciences which contain hazardous substances	69

LIST OF ABBREVIATIONS

AMA:	Accra Metropolitan Assembly
CDM:	Clean Development Mechanism
CHF:	Cooperative Housing Foundation
CUC:	Central University College
DESSAPs:	District Level Environmental Sanitation Strategies and Action Plans
EPA:	Environmental Protection Agency
ISWM:	Integrated Solid Waste Management
MCI:	Millennium Cities Initiative
MSW:	Municipal Solid Waste
MSWM	Municipal Solid Waste Management
PPP	Public Private Partnership
SPSS:	Statistical Package for Social Science
SWM:	Solid Waste Management
UG:	University of Ghana
UNDP:	United Nation's Environmental Project
WMD:	Waste Management Department
WCED:	World Commission on Environment and Development
WSU:	Washington State University

CHAPTER ONE

GENERAL OVERVIEW

1.0 Background

Ghana, like most developing countries faces the continuing challenge of increased waste generation due to population growth, rising incomes and increasing urbanization. Consequently, the issue of sustainable and effective Municipal Solid Waste Management (MSWM) is becoming increasingly important. A World Bank report on the state of municipal solid waste in 2012 titled “What a Waste: A Global Review of Solid Waste Management”, projected a sharp rise in the amount of garbage generated from urban residents between now and 2025 (World Bank, 2012). The report revealed that the amount of municipal solid waste (MSW) will rise from the current 1.3 billion tons per year to 2.2 billion tons per year by 2025, with much of the increase coming from rapidly growing cities in developing countries. Ghana, currently with a population of 24million, generates about 4.5million metric tons of solid waste a year. This was made clear by Zoomlion Ghana Limited during a presentation at the UN conference on building partnerships for moving towards zero waste (Agyepong, 2011). The presentation further highlighted the fact that both amount and complexity of waste are increasing in Ghana.

Waste is an inevitable product of society (White *et al.*, 1995). According to the Basel Convention, it is a substance or object which is disposed off or intended to be disposed off or is required to be disposed off by the provision of the law (UNCED, 1992). Managing this waste more effectively is a need that society has to address. Municipal solid waste collection, treatment and disposal are particularly problematic in developing country cities, but many Western cities have also grappled with this problem in the past (and some probably still do) (Jessen, 2002). The same goes for institutions where tons of solid wastes

are being generated. Effective and sustainable waste management is important as the amount and complexity of waste are increasing globally as a result of industrialization and urbanization. Waste, when not managed properly, not only increase financial burden in a form of disposal charges but can pose serious health hazards (Miller, 2000) as well as affect the climate through the emission of greenhouse gases.

The contribution of the waste sector in reducing global greenhouse gas emissions has been underestimated. According to recent studies such as Hansen and Sato (2001), the waste sector contributes about one-fifth of global anthropogenic methane emissions and methane contribution to climate change is about one- third to a half of that of carbon dioxide. Waste sector emissions have grown steadily globally and are expected to increase in the forthcoming decades especially in developing countries such as Ghana. In recognition of this, the Clean Development Mechanism (CDM) established by Kyoto Protocol in 1997, recognized waste and its disposal as one of the sectors identified for greenhouse gas reduction. This therefore suggests that land filling should be the last disposal option since the impacts of poorly managed landfills/dumpsites include odour, explosions and fires, air pollution and ground water pollution (El- Fadel *et al.* 1996). Instead, waste resources should be targeted for reduction, reuse or recycle.

Waste recovery initiatives are significant because the materials recovered not only represent potential revenues and savings from effective resource utilization but also prevent land filling and its associated problems such as reducing global greenhouse gas emission. Separation of waste is one key method employed in developed countries for effective waste resource recovery and promotes access to resources from which value can

be added. Waste resources when removed from the waste stream can also reduce the demand for virgin resources (World Bank 2005).

Studies by Lehmann *et al*, (2009), Velazquez *et al*, (2006) and Zilahy and Husingh, (2009) have revealed the key roles that universities can play when promoting sustainable programs in society. Academic institutions have the capacity of putting into practice strategies for sustainable development which could be incorporated into their academic programs, outreach and facilities operation. Very importantly, of the many environmental problems that must be addressed is the issue relating to the increasing amounts of solid waste in our urban areas which has to be managed effectively and sustainably.

Large institutions, by their very nature, produce more waste due to their large population sizes and they are also single decision-making entities. In decision making, planners may be able to identify and organize groups of individuals, waste stream producers or reduction/reuse opportunities to a greater extent. Thus, institutions can implement resource recovery, reuse and recycling with relative ease resulting in reduced pressure on solid waste disposal sites (Mbuligwe, 2002). However, waste audit is essential for the implementation of reuse or recycling.

Information on the characteristics of MSW is an essential part for the selection of most appropriate waste management system. The per capita waste generation and various waste components are the two most important types of data for decision makers. Characterization of waste enables authorities to audit the waste generated within the community. This information helps in the choice of appropriate disposal methods. This

therefore means that, characterization helps to determine probability of reuse, recycling and the possible final disposal method such as landfill, incineration, etc.

Minimizing waste generation and diverting waste from landfills through reduction, reuse, or recycling methods seem to be crucial steps toward achieving more sustainable waste management practice. With the decrease in operating landfills, more states as well as academic institutions especially in the developed world appear to be supporting the idea of recycling as a waste management alternative to landfill disposal and are even implementing local policies to provide recycling services to households (Kinnaman, 2006). Recycling therefore becomes an economically viable alternative to waste disposal. Separation of waste at source promotes recycling as it prevents contamination and also enables value to be added to the waste resources.

This thesis focuses on waste management practices in two Ghanaian Universities within the Accra Metropolitan Assembly in order to illustrate the potential for and viability of recycling through separation of waste at source. This research therefore aimed to evaluate the volume, nature and the potential for solid waste diversion programs through separation of waste.

1.1 Research Problem

In an era of sustainable development with fast growing concern about threats to environmental quality and increasing pressures on natural resources, there is the need to minimize waste generation. Generation of solid waste is not a new phenomenon. Earlier, the major constituents of solid waste were domestic wastes and agricultural residues which are both biodegradable. Solid waste could be conveniently disposed of on ground or

in pits covered with layers of earth. However, since 1960s, not only has the quantity of solid waste increased but its quality has also changed globally as a result of rapid urbanization, increasing industrialization and rising incomes (World Bank, 2012). Though rural wastes continue to be mainly agricultural wastes, those from urban areas and the industrial units contain diverse types of materials which include toxic and hazardous materials. The state of solid waste management is therefore a critical challenge facing all of the world's cities. The solid waste includes glass, paper, plastic, metal and other organic materials.

The high population and its associated increase in urbanization and economic activities in the city of Accra, has made the impact of the municipal solid waste very noticeable. The urban areas of Accra produce about 760,000 tons of municipal solid waste (MSW) per year or approximately 2000 metric tons per day (Government of Ghana, 2002). According to the Government of Ghana, EPA report, by 2025, this figure is expected to double. Solid waste disposal is becoming problematic. This situation therefore leads to worsening solid waste management problems in urban settlements in particular. Municipal and Metropolitan authorities as well as institutions and households seem unable to organize adequate collection and safe disposal of solid waste. Hence, wastes are left uncollected and posing threats to public health and the environment (Oteng-Ababio, 2010). A walk within town reveals visible solid waste problems such as garbage accumulation, littering and open burning.

In order to solve the solid waste problems, the AMA has put in place two main forms of institutional arrangement for the collection of solid waste within the Metropolis. These are the house - to - house system which operate in high income areas and the communal

container collection system in low - urban income areas for the collection of solid waste. Despite the strategies put in place for the collection of waste in the Metropolis, there are still challenges which result in the inability of AMA to effectively collect the waste generated. Solid waste continues to pile up uncollected. According to the Waste Management Department (WMD) of AMA, between 65 and 75 percent of waste is collected every day. Also, as part of government efforts to overcome the challenges faced in solid waste management, Public-Private-Partnership (PPP) was introduced to involve the private sector in the collection and disposal of waste. The private sector involvement has seen improvement in solid waste collection but has not solved the problems of bad waste management practices such as indiscriminate disposal of waste (Government of Ghana, 2002).

Literature appears to focus on residential waste management with little attention on institutional waste management. For instance, Songsore and McGranahan's (1996) worked on Women and Household Environmental Care in the Greater Accra Metropolitan Area and Oteng-Ababio (2010) worked on Solid Waste Management in Ghana -Beneficiaries Willingness to Pay for Improved Services. The first two reports of the Feasibility study on Waste Stock Exchange Management System in Ghana carried out by MAMSCO Environmental Management Consortium as well as the Cooperative Housing Foundation (CHF) International main report (CHF International, 2010) on value chain analysis of solid waste management for youth engagement in service delivery program carried out by Waste Care Associates have identified eleven non-hazardous industrial wastes in the coastal belt of Ghana and Accra respectively and estimated their quantities. Furthermore, Millennium Cities Initiative report on Findings of the Waste Composition Study for the Aryee Diki electoral area of Accra New Town, Accra Prepared by The Millennium Cities

Initiative (MCI), a project of the Earth Institute, Columbia University and the University of Ghana, investigated job markets for youth engaged in management of solid waste streams. The aforementioned literature appears to focus on waste quantities with little attention on the value of such waste resources. This therefore creates a gap in knowledge relating to the absence of information on economic value of waste generated which makes it difficult for authorities to adopt sustainable methods of waste management practices such as recycling.

Meanwhile institutions such as University of Ghana (UG) and Central University College (CUC) by their activities, tend to generate 'specialized' waste apart from the traditionally well documented waste. They are also single decision-making entities that make it easier to identify and organize groups of individuals, separation of waste and recycling opportunities to a greater extent but these are currently not done. Thus, institutions can implement resource recovery, reuse and recycling with relative ease resulting in reduced pressure on solid waste disposal sites (Mbuligwe, 2002). Furthermore, the inadequate information on quantification and characterization of waste is a challenge hindering policy making on waste management in Ghana (Oteng-Ababio, 2010). Information on the characteristics of waste is an important part for the selection of the most appropriate system for sustainable waste management systems but data on waste characterization is lacking.

While institutions in the developed countries have put in place waste recovery system which enable them to gain economically from adding value to waste resources, institutions in most developing countries continue to incur cost in the collection and disposal of waste. For instance, in 2002, Washington State University (WSU) was able to divert 98% of the

waste generated and in 2005, 99.9% of waste generated was diverted from landfills through its recycling programs (WSU Recycling, 2005). Hence, institutions in developing countries not only lose the benefits that come from adding value to these waste resources, they pollute the environment and incur cost in the areas of collection and disposal. This backs Johannessen and Boyer (1999) observation that, SWM practices that aim at maximizing the yield of valuable products from waste, as well as minimizing the environmental effects have had little or no consideration in Africa. These observations are not different in Ghana. At the national, municipal or institutional levels, steps are not taken to separate waste from source for value addition.

However, there are various technologies available for enhancing sustainable SWM in developed countries. Initiatives from one country can be exported to another. Situational analysis is therefore relevant because any intervention cannot be adhered to in empirical vacuum. This study focus on analysis of institutional SWM practices and examines its waste composition and quantities, using University of Ghana and Central University College as case studies. The study is to gauge the amount of institutional solid waste that can be salvaged through reuse or recycle.

1.2 Objective(s)

The overall goal of the study is to examine institutional solid waste generation and management practices and assessing the possibility of scaling up such practices in ensuring sustainable and effective solid waste management practices of the local as well as national levels.

1.2.1 The specific objectives

Following this broad objective, the specific objectives for the study include the following:

- i. To determine the quantity and composition of solid waste generated in two academic institutions
- ii. To identify current solid waste management practices in public and private institutions
- iii. To highlight the barriers to effective waste management in institutions
- iv. To identify possible solution to overcome barriers to effective waste management

1.3 Research Questions

Research questions to assist in determining the waste management practices are;

- i. What is the content of waste generated in the institutions?
- ii. What is the volume or quantity of waste generated?
- iii. What are the management practices?
- iv. What is the value of the waste generated?

1.4 Justification

Data is a fundamental parameter to consider when deciding on any solid waste management strategy to be adopted. Collection of essential data is therefore a prerequisite to designing programs and strategies appropriate to meet the fundamental objectives of waste management. The nature of waste also dictates up to a certain level, the strategy to be adopted in managing waste. How waste is best recovered, treated or disposed of depends on the nature of the materials in the waste (White et al., 1995). This study will therefore contribute information to both the theory and practice of solid waste management.

Furthermore, effective waste management largely depends on the acceptance and participation from the people within the community. Researchers such as Agbola (1993), Akuoko-Asibey and McPherson (1994) have pointed out that behaviour and perception are very essential to environmental sustainability. Zoomlion Ghana Limited during a presentation at the UN conference on building partnerships for moving towards zero waste in 2011, emphasized on public attitude as one of the barriers to sustainable waste management in Ghana. The presentation further revealed that change in attitude/lifestyle is important in reduction of waste generation.

Some studies suggest that university recycling programs can help improve environmental awareness, attitudes, and behavior within its community. Students who learn about, or are exposed to, environmentally responsible waste practices at their universities can have a significant impact on their community after their college years. Little or no research seems to have been done on specific contents of university solid waste streams and the attitudes and behaviors that drive waste disposal practices. Most importantly, institutions are seen as models. A successful implementation of sustainable waste management option such as recycling in one institution can be adopted in other institutions and at the local government levels.

1.5 Organization of Study

This thesis is organized into eight chapters, chapter one discusses the general overview of the entire thesis and presents the context of the research. Chapter two focuses on the literature review and conceptual framework used in the study. Chapter three concentrates on the background information of UG and CUC and the research methods and materials. Chapter four presents analysis of solid waste composition in the study locations. Chapter

five discusses the waste management practices and institutional arrangement of UG and CUC. Chapter six examines the knowledge, attitudes and perceptions of students towards the current institutional arrangement of solid waste management. Chapter seven discusses the cost of managing waste in the two institutions under study as well as the potential benefits that could be derived from waste recycling. Chapter eight which is the final chapter provides recommendations, limitations and suggestions for further study.

1.6 Conclusion

As urbanization continues to take place, the management of solid waste is becoming a major public health and environmental concern in urban areas of many developing countries. There is limited land space for waste disposal and communities are fighting against the establishment of dumpsites in their communities. This research seeks to identify ways in which value can be added to waste resources thereby reducing the quantities of waste being sent to the landfills. This chapter provided an introduction to the entire thesis. It has discussed the research problem, objectives and justification of the research. The next chapter provides a review of relevant literature on solid waste management and conceptual framework used for the study.

CHAPTER TWO

LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK

2.0 Introduction

This chapter presents a review of the literature on solid waste generation and management. Discussions include the basic concepts and issues relating to waste management and the conceptual framework used in the study.

2.1 Literature Review

This section reviews some of the literature, concepts and definitions on solid waste management in general. This will help one to understand what practices are being carried out, which solid waste management practice is sustainable and which one is not.

2.1.1 Concept of Waste

The definition of waste can be very subjective. This is because what is considered as waste to one person may represent a valuable resource to another. Gilpin (1996) defines the term waste to embrace “all unwanted and economically unusable by-products or residuals at any given place and time, and any other matter that may be discarded accidentally or otherwise into the environment”. Waste has also been referred to as the “unwanted materials arising entirely from human activities which are discarded into the environment” (Palmer, 1998). This understanding of what waste is led to the disposal of all materials considered unwanted. This therefore warranted for another definition of waste which emphasized the resource value of such by-products.

Davies (2008) describes wastes as: “...unwanted or unusable materials ... that emanate from numerous sources from industry and agriculture as well as businesses and

households ... and can be liquid, solid or gaseous in nature, and hazardous or non-hazardous depending on its location and concentration". He went further to say that "what some people consider to be waste materials or substances are considered a source of value by others" This relative attribute of waste can be compared with the concept of 'resource' which has also been defined as material that has use-value (Jones and Hollier, 1997) . Jessen (2002) underscores this by asserting that "our waste stream is actually full of resources going in the wrong direction".

Williams (2005) suggested that waste must have a strict legal definition to comply with the law. According to the Basel Convention, wastes are substances or objects which are disposed of or are intended to be disposed of or are required to be disposed of by the provision of the law (UNCED, 1992). Zimmermann (1951) stated that resources are not, they become and that resources are not static but expand and contract in response to human wants and actions. Drawing from the views expressed above, the definition of waste to be used in this study is any substance (solid) discarded appropriately to be used by another, which causes significant improvement in the environment. Unlike the aforementioned definitions, this definition supports the concept of separation of waste at source as an appropriate method for effective management of waste. Separation of waste could be done based on various waste classifications.

A number of criteria are usually employed to classify wastes into types. Such classification of waste provides the basis for the development of appropriate management practices. Waste can be classified by physical state (solid, liquid, gaseous). Other ways in which waste is classified is by its primary use (packaging waste, food waste, etc); by material (glass, paper, etc); by physical properties (combustible, compostable, recyclable);

by origin (household, commercial, agricultural, industrial, etc.) or by safety level (hazardous, non-hazardous) (White *et al.*, 1995). Waste audit exercise carried out in this study provided insight to the type of waste both institutions of study generate. Realizing the amount of waste generated in the country and how it is managed has profound implications for the quality of the environment and for the prospects of future generations, it is important to minimize consumption and conduct waste management efficiently to curtail the environmental impacts of waste disposal and protect ecosystem services for both current and future generations (Millennium Assessment Report, 2005). Goals and policies are therefore developed by governments to ensure successful attainment of Municipal Solid Waste Management (MSWM) objectives.

The goals of MSWM include the protection of the health of urban population particularly that of low-income groups who suffer most from poor waste management (Schubeler *et al.*, 1996). It also aimed at promoting environmental conditions by controlling pollution and ensuring sustainability of ecosystems in urban region. Furthermore, it supports urban economic development by providing demanded waste management services and ensuring the efficient use and conservation of valuable materials and resources. Finally, it aims at generating employment and incomes in the sector. Governments have over the years put in place adequate national policies, regulatory and institutional frameworks in order to assist in addressing the problem of waste management (Anku, 2000).

An Environmental Sanitation Policy was formulated in 1999 and revised in 2010 which guides waste management practices. The revised policy promotes reduction, reuse, recycling and recovery of all types of waste stream as a way of minimizing the volume

and cost of waste that ends up at the landfills. Various relevant legislations for the control of waste have also been enacted. These include the following:

- i. Environmental Assessment Regulations, 1999 (LI 1652);
- ii. Criminal Code, 1960 (Act 29);
- iii. Water Resources Commission Act, 1996 (Act 522)
- iv. Republic of Ghana (1996). National Building Regulations (LI 1630)

Furthermore, the Ministry of Environment, Science and Technology, the EPA, Ministry of Local Government and Rural Development and the Ministry of Health have also prepared the following guidelines and standards for waste management:

- i. National Environmental Quality Guidelines (1998)
- ii. Ghana Landfill Guidelines (2002)
- iii. Manual for the preparation of district waste management plans in Ghana (2002)
- v. Republic of Ghana (2002).Guidelines for the management of healthcare and veterinary waste in Ghana (2002)
- vi. Handbook for the preparation of District level Environmental Sanitation Strategies and Action Plans (DESSAPs).

Environmental Sanitation Policy was formulated in 1999 and revised in 2010 which guides waste management practices at every level (from district to national) to address the waste problem, yet too much waste is produced and not nearly enough is properly disposed of. Problems with solid waste regulation include a lack of enforcement of environmental guidelines/bye-laws. Also there are many governmental agencies (e.g. Ministry of Local Government and Rural Development, Ministry Of Environment, Science And Technology, Environmental Protection Agency, Municipal And Metropolitan

Assemblies) involve in the management of waste; hence resulting in neglect of duty or lack of commitment. This study therefore agrees with Oteng-Ababio (2010) who attributed the failure of the environmental /sanitation policies to meet their objectives to lack of demonstrable political will and commitment to effective management of these policies. An integrated approach to the enforcement of environmental regulations is needed for the way forward in sustainable waste management. Given the huge complexity of issues and problems in various solid waste management systems across developing nations, it is apparent that the top-down solutions and management strategy will no longer be effective. Rather, a much broader and more integrated set of solutions will be needed to ensure long term sustainability of the waste management system. In the developed countries the most compatible environmentally sustainable development approach to waste is the “Integrated Waste Management” (Cole and Sinclair, 2002; Medina, 2002; Zerboc 2003). An integrated approach to waste management consisting of a “hierarchical and coordinated set of actions” (Medina, 2002) seeks to reduce pollution, maximize recovery of reusable and recyclable materials, and protects human health and the environment so far as sustainable development is concerned.

2.1.2 Sustainable Development

Sustainable development has been described by World Commission on Environment and Development (WCED) (1987) as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs”. The environmental, social and economic systems that form the community must provide a healthy, productive and meaningful life for all forms of life both in the present as well as in the future (UNESA, 2002). Sustainable development has thus made us aware of the need to prevent environmental degradation and live sustainably. Environmental

degradation leads to resource depletion, declining standards of living, health problems, conflicts and many more (UNESA, 2002).

Daskalopoulos *et al.*, 1998; Medina, 2002; and Zerboc, 2003 are of the view that “integrated waste management aims to be socially desirable, economically viable and environmentally sound”. In case of solid waste management framework in a developing country, it is to be noted that solutions which work for some countries or areas may not be appropriate or applicable for others. Specific issues, problems, environmental conditions and existing socio-economic framework will determine the appropriateness of various strategies and technologies in solving the problem of solid waste. The main emphasis is on the four R’s (reduce, reuse, repair and recycle), thus, creation of less waste and increased material recovery. This is further explained in the waste hierarchy.

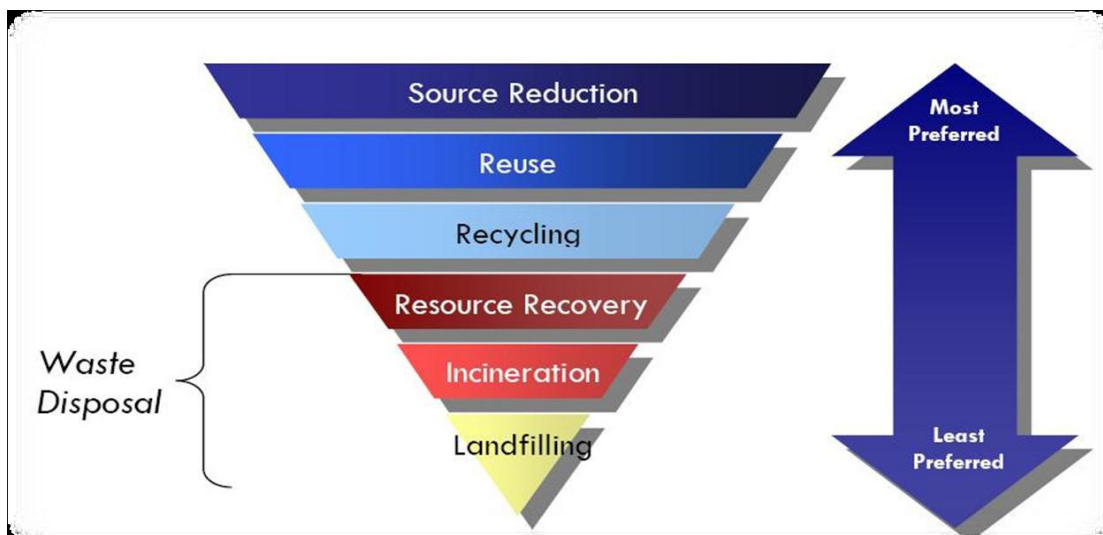
2.1.3 The Concept of Waste Hierarchy

Studies by Girling (2005) and Furedy (1992) have revealed that one method of ensuring sustainable solid waste management is to follow the waste hierarchy. The concept of a waste hierarchy was first introduced into a European waste management policy in 1975, which showed that waste should be handled differently based on its characteristics (Girling, 2005). It is therefore expected that developing countries would draw upon this positive experience of the developed world. Waste recovery provides a solution to the multi-billion dollar waste disposal problem by reducing the waste and possibly, greenhouse gas emissions generated by the waste sector based on the concept of the “3Rs” (reduce, reuse and recycle). The concept of the “3Rs” or the hierarchy classifies waste management strategies according to their desirability in terms of waste minimization. The waste hierarchy remains the cornerstone of most waste minimization strategies with source

reduction being the most preferred option and landfilling the least. Broadly, the objective of the concept is to as much as possible extract the maximum practical benefits from products as to generate the minimum amount of waste meant for final disposal. Following the waste hierarchy will enable institutions and local authorities identify ways to reduce waste and offer the most wide reaching benefits in terms of reuse, recycling and cost savings.

A waste hierarchy is widely used as a simple communication tool that consists of the following waste management approaches, in order of importance:

Figure 2. 1 Waste Hierarchy



Source: <http://earth911.com/news/2009/03/09/waste-hierarchy-whos-on-top-in-the-game-of-trash>

By preventing (reducing) the generation of waste itself, we can minimize other problems related to waste disposal. Waste generation according to Tchobanaglou *et al.* (1993), embrace activities in which materials are identified as no longer of value and are either thrown away or intended to be discarded. Boigner *et al.*, (2007) however came out to say that richer societies have higher rates of waste generation per capita than poor societies. Hence the rich generate more waste than the poor. Schubeler *et al.* (1996) on the other

hand concludes that waste generation is a function of people's attitudes towards waste which include patterns of material use and waste handling, their interest in waste prevention and reduction and even the extent to which they refrain from indiscriminate littering and dumping. Consuming fewer products and getting rid of less waste is therefore considered as source reduction (Sally, 2004). This study has confirmed the fact that wastes are unavoided by-product of activities carried out by the two institutions of study. However, these wastes can be minimized by consciously adopting appropriate techniques. For instance, printers can be set to print on both sides of the paper. This can help to reduce the number of sheets to be used, hence reduce waste. When waste reduction becomes difficult to practice, reuse/repair/recycle is another method to adopt.

Reusing relates to the recovery of items to be used again. Reusing ensures reduction in raw material consumption saves energy and water, reduces pollution and prevents the generation of waste (Kulkarni, 2008). Reuse is also an option for source reduction. The main application of reuse is to extend the life of the product or material. Compared to recycling, reuse is preferred most as it does not undergo any upgrading and therefore no material and energy are used and at the same time reduces the cost and the need for disposal (Kulkarni, 2008). A reuse program not only saves money, it also can be a source of revenue for the institutions/households that implement it (Jessen, 2002). Items such as computers, air conditions, tables and chairs are repaired for reuse in the two study locations. The two institutions therefore save money since cost of obtaining new items is higher. This also helps the institutions to reduce the cost and the need for disposal. Where used items or materials need to be processed into useful products, recycling is encouraged.

Recycling is an activity of collecting, sorting and processing of used or discarded materials into useful products to its original form or for other purposes. It is considered as one of the effective solutions for saving landfill from producing greenhouse gas (Hansen and Sato, 2001). The foremost aim of recycling treatment method is converting waste into valuable materials. Materials like paper, plastic, metals and glasses are some of the recyclable materials used for recycling and manufacturing products. The existence of waste pickers, scavengers etc., recover other valuable materials from entering the waste stream. Especially in developing countries, itinerant buyers play a vital role in recovering materials for recycling; they buy every material that has some monetary value—newspapers, plastic bottles, etc (Mesharch *et al.*, 2013). It is however, evident that some improvement in these traditional systems can be brought about. A formalized waste recycling supported by local municipality can go a long way in reducing the quantity of waste that ends up in the landfills. Recycling waste can be a viable economic option. The researcher therefore agrees with Mesharch, *et al.* (2013) who are of the view that the informal waste collectors play a vital role in the collection of solid waste but their participation is not institutionalized to enhance partnership between the formal and informal waste collectors.

Composting (resource recovery) is a method adopted to remove large amount of degradable waste materials from the waste stream. Studies conducted by Cointreau (2000), found that 78-81% of compostable materials in the household waste was generated in major cities of Indonesia and Sri Lanka (Bandung and Colombo respectively). In a study, Zurbrugg (2003) found that major cities in developing countries have 68-82% compostable waste content, however, it is ironic that composting is not widely practised in developing countries (Zerboc, 2003).

The advantages of composting are numerous: it reduces the amount of waste significantly. It can be used as fertilizer and natural manure for agricultural uses and reduces the damage to environment (Ofosu-Budu *et al.*, 2010). In developing countries, composting has the greatest potential for success, as most of the urban centers are surrounded by small scale agriculture (Sally, 2004, Drescher and Zurbrugg , 2006). The two institutions of study have grown flowers, hedges, trees, grasses for beautification purposes. UG in particular has farms where crops are grown for research and learning purposes. However, there are no composting initiatives being carried out in these institutions even though this study showed that the institutions generate a significant amount of food/compostable waste. The Teshie compost project was established in Ghana to produce organic manure but collapsed as a result of expansion of settlement and malfunctioning of machines. However, the New Town compost project and the James Town HCF are still working to help produce compost to support urban agriculture (Annorbah-Sarpei, 1998). This could be attributed to the fact that there has been financial support coming from government and other donors to support the compost projects. Additionally, compost produced is being patronized by urban farmers.

Incineration is the process of burning of wastes under controlled conditions, usually carried out in an enclosed structure. Although incineration has high rate of waste reduction (80-95%), there are many issues that make incineration not so viable an option in developing countries (World Bank, 1999). Solid waste incineration plants tend to be among the most expensive solid waste management options, being capital-intensive and require high maintenance costs they may be beyond the reach of many of the lesser developing countries (World Bank, 1999). This may not be practical or feasible for developing countries.

Land filling is the most commonly used method for waste disposal in most developing countries (Tchobanaglou *et al.*, 1993). Landfills are necessary for safely disposing wastes that cannot be prevented, reused, recycled or composted. However, disposing of all municipal wastes collected at landfills/or uncontrolled dumpsites is not desirable from a social, economic, and environmental point of view (Oteng-Ababio 2010). The appalling conditions around waste disposal facilities in Ghana's major cities have caused some host communities to protest against further dumping of waste in their communities as was the case of Oblogo where the people of *Oblogo*, led by their chief, demonstrated against further dumping of waste in their community (*Ghanaian Times*, February 1, 2007). As a result of the poor maintenance of waste disposal facilities, many communities are now refusing to accommodate new waste disposal projects. This could be facilitated by the frequent media reports which draw people's attention to the debilitating effects that improperly managed waste dumps can have on humans and the environment (Oteng-Ababio, 2010). Furthermore, the unwillingness of landowners to release land for waste disposal can also be attributed to the track record of government's failure to pay compensations to land owners as well as poor management of existing landfills (*Crusading Guide*, Wednesday, August 22, 2007). This method is the last option on the waste hierarchy. However, most waste from the institutions of study ends up in landfills. This is because waste materials are not segregated for value addition. This study therefore demonstrated that, when source segregation of waste is carried out in these institutions, less waste material are likely to end up in landfills. Solid waste management in urban areas is a challenge especially in developing countries.

2.1.4: Urban Solid Waste Problems in Developing Countries

In Asia, Africa and Latin America, cities are growing rapidly, fuelled by large-scale rural-urban migration and natural increases within the cities (Songsore, 2004). Current projections show that most of the world's future population growth will take place in developing countries with more and more people in the urban areas (UN-Habitat, 2010)

Solid waste disposal is becoming problematic with the increased numbers of people in urbanized areas and with the increase in quantity and complexity of waste generated compared to the decrease in available land for waste disposal. This therefore leads to the worsening solid waste situation found in urban settlements. Municipal authorities in Ghana seem unable to organize adequate collection and safe disposal of solid waste. This therefore results in posing threats to public health and the environment. A walk within town reveals visible solid waste situation such as open burning, garbage accumulation and littering. Land filling is the most commonly used method for waste disposal in developing countries (Tchobanaglou *et al.*, 1993). Landfilling involves placing wastes in large, specially designed cavity then covering them with soil each day to prevent attraction of animals and insects (Kobus, 2003). However, due to inadequate resources for the establishment of such specialized cavities, most developing countries dump their municipal solid waste on land in an uncontrolled manner (Da Zhu *et al.*, 2008). This disposal situation deteriorates as settlements extend closer to the dump sites.

In most cities in the developing world, the waste situation serves as a hindrance against the achievement of the major objective of solid waste management which is to protect human health and the environment from the hazards posed by waste (Hardoy *et al.*, 2001).

Municipal authorities of developing countries are unable to handle increasing quantities of waste which results in uncollected waste (Zahur, 2007). Municipalities are faced with financial and planning challenges to enable them cope with the increasing waste generated by the increasing population. This therefore affects waste collection and disposal services (Da Zhu *et al.*, 2008). MSWM involves huge expenditures in the collection and safe disposal of waste. In Ghana, 50-75% of municipal budgets are spent to tackle the persistently increasing waste generation while the revenues received as collection and disposal fees cannot cater for the cost incurred in managing waste (Danso *et al.*, 2006). Improvement in infrastructure and technology to overcome barriers to the safe disposal of urban waste requires new and improved forms of management practices.

Solid waste collection and disposal is the sole responsibility of the AMA in the Accra metropolis. The waste management department of AMA therefore sees to the collection, transport, treatment and disposal of municipal solid waste. The Accra metropolis has been demarcated into waste collection districts where a company is contracted by AMA to collect waste in one or two districts. The main types of vehicles currently in use by AMA are compaction and skip trucks. There are no waste transfer stations hence wastes are taken by road directly to the disposal sites. According to WMD sources, there are two methods of solid waste collection in the city. One is the franchise method where house-to-house collection is done in high income/controlled areas. The households are however charged based on the frequency of the waste collection. These areas are well-planned residential areas with access roads described as first and second class. The second method of waste collection is the contract method where waste contractors are paid by the AMA to perform both block and communal container collection. Block collection occurs in middle-income residential areas and the central communal container collection occurs in low

income, high population density and deprived residential areas where houses are not well planned with poor or even no access roads (third class roads). Waste generators here do not pay user charges as in the case of the well-planned residential households do.

Despite the strategies put in place for the collection of waste in Accra, there are still challenges which result in the inability of AMA to collect some waste. According to the WMD of AMA, between 65 and 75 percent of waste is collected every day. Inadequate logistics, bad nature of roads and inadequate funding are identified as some of the challenges hindering the efficient collection of waste in the Accra metropolis. According to the Government of Ghana (2002), the Accra Metropolitan Assembly spends about two billion Ghana cedis per month on waste collection alone and about 12 billion Ghana cedis per year on urban solid waste management. This amount does not however cater for about 30 per cent of solid waste generated in the metropolis (Government of Ghana, 2002).

Data is generally lacking in the waste sector of developing countries. Available studies on the topic suggest that solid waste management is generally characterized by inefficient collection methods, insufficient coverage of the collection systems and improper disposal of municipal waste (Hardoy *et al.*, 2001). Major urban settlements are, therefore, characterized by waste accumulations and poor environmental sanitation (Hardoy *et al.*, 2001).

Ten common factors that serve as hindrance to sound solid waste management efforts in developing countries are identified by Linden *et al.* (1997). These are: Inappropriate technologies/processes, enforcement inefficiencies/non-existence; illegal dumping, lack of financing, lack of training/human resource, lack of political support, lack of

legislation/policy overlapping governmental responsibilities, rapid increase in waste generation/limited data, lack of awareness among public, and limited land areas; land tenure issues.

2.2 Conceptual Framework

Waste management is nowadays far more complex than it was some thousand years ago. The complexity arises not only because of the huge quantities of residuals produced by the modern society, but also because of differences in the composition of the waste (UNESA, 2002). In recent years, increase in population, changed consumption patterns and economic growth has augmented the generation of waste everywhere. This is especially visible in urban areas with high population density. There are many different solutions to approach the solid waste problems. These include selective collection, composting, proper management, incineration and landfilling. An integrated approach, where various complementary practices are used in achieving safe and effective handling of waste is needed.

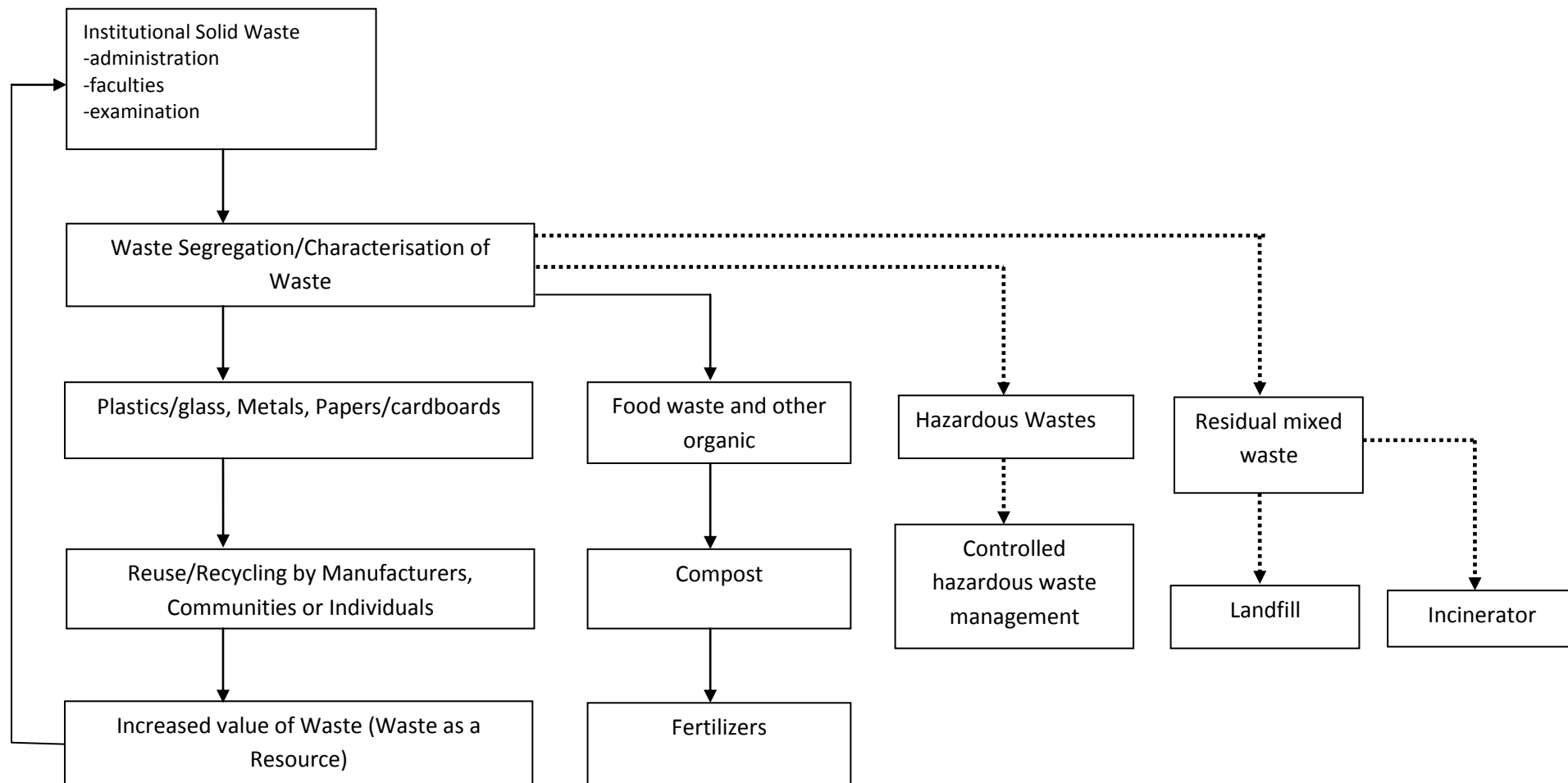
In general, waste from institutions contains not only valuable and reusable materials, such as metals, glass, paper, plastic and food waste, but also a significant amount of hazardous waste such as mercury from batteries, cadmium from fluorescent tubes, toxic chemicals from solvents and disinfectants, etc. An efficient waste management program will bring about various benefits to the institutions such as increased health standards, pleasant and clean environment, among others. Based on the Agenda 21 (UNCED, 1992) waste management has to deal with the following issues:

- i. Minimisation of waste in quantity and of contaminant concentration.
- ii. Increased sound waste reuse and recycle.

iii. Ensure environmentally friendly treatment and disposal of no recoverable wastes.

The composition of the waste is therefore important especially to define ways of safe disposal, potential for recycling and appropriate waste collection method. If the community is involved in the process of separation of waste, there is a chance of achieving waste minimization goals with reduced cost.

Based on the problem statement and relevant literatures reviewed, the pathway to divert solid waste from being landfilled is adopted from Oteng-Ababio, (2014). It shows how each component of institutional solid waste stream can be managed effectively in order to add value to the waste resources.

Figure 2. 2 Pathway to Manage Waste as a Resource (Integrated SWM)

Source: Adopted from Oteng-Ababio, 2014

The literature reviewed has revealed that there is changed in consumption patterns. Economic growth has augmented the generation of waste everywhere. This is visible in urban areas with high population density. An efficient waste management program will therefore bring about various benefits to the community such as increased health standards, promote pleasant and clean environment, among others. Based on the Agenda 21 (UNCED, 1992), it is possible to say that waste management programs have to deal with the following issues:

- i. Minimisation of waste in quantity and of contaminant concentration.
- ii. Increased sound waste reuse and recycle.

An Environmental Sanitation Policy was formulated in 1999 and revised in 2010 which guides waste management practices. The revised policy promotes reduction, reuse, recycling and recovery of all types of waste stream as a way of minimizing the volume and cost of waste that ends up at the landfills. Institutions which act as autonomous bodies have the key role in adopting the policy to suit their environment in order to monitor the generation of solid waste and identifying suitable methods for proper management and safe disposal. Concerted efforts are required to institute and improve environmental monitoring and control to keep valuable wastes materials out of the municipal system, especially landfills, sewers and drains by following the pathway to divert solid waste from landfills as indicated in Figure 2.2.

Because separation at source has not been implemented as part of solid waste management practices in institutions yet, valuable waste materials are being sent to the landfills. Addressing the problems of reducing cost of managing waste and adding value to waste resources, source separation of waste is encouraged. Source separation is being done

throughout the developed world and successes of the implementation of source separation could be replicated in institutions within developing countries. Instituting separation at source within institutions is going to require a great deal of effort, time and planning. Thus, additional infrastructure, changes to systems and additional expenses will be accrued to get the system in place. Partnership with the private recycling sector might have to be a consideration. Multiple storage containers or bins are required to be used for the disposal of different waste types.

Recyclables such as paper, glass, metal and plastics would be sold to recycling companies/individuals for reuse or recycle into usable materials. Separation of waste for reuse purposes, materials or items can either be used for their original purpose, or for a different one. For recycling, materials or items are processed either back to the original product or a different one. These usable items could be consumed by the institutions or sold to the general public. Reuse and recycling are said to be more sustainable (Lardinois and Furedy, 1999) and are among the most preferred methods of managing waste according to the waste hierarchy indicated in Figure 2.1. Reuse and recycle not only help to reduce the quantities of waste that ends up in landfills, they also serve as viable economic option (Mesharch *et al.*, 2013).

Additionally, substantial quantities of organic/food wastes could be diverted from landfills if source separation is practised. Organic/food waste can be processed into compost/fertilizer and utilized on institutional farms or sold to the public. This is because compostable materials constitute a significant portion of municipal solid waste in most cities of developing countries (UNCED, 1992) and as such composting assists in removing

a large amount of degradable waste from being sent to landfills and prevents the generation of methane emissions.

Furthermore, source separation of waste will enable institutions keep hazardous waste out of the municipal waste stream and monitor the generation of hazardous waste as well as identifying suitable sites for proper management and safe disposal. When waste minimisation and recycling are actively practised, there is some quantity of mixed or residual waste remaining for disposal. This mixed waste can be incinerated to reduce the quantity and then sent to the landfill. Residual waste which is the smallest portion after waste separation can be sent to the landfills as it cannot be prevented, reused, recycled or composted. The consequence for mixed waste is landfill which is the least preferred method for managing waste according to the waste hierarchy indicated in Figure 2.1.

2.3 Conclusion

Economic impacts of waste collection and disposal may include such factors as the reduction of illness and health care costs of waste workers and enhancement of environmental quality. Economic evaluations may be employed to demonstrate the external costs of waste pollution and to build support for improved waste management. In most cases, however, municipal authorities do not have the capacity to conduct economic evaluation.

In spite of efforts by municipal authorities and institutions to improve waste management, most countries especially in the developing world still resort to strategies at the bottom of the waste hierarchy. This is attributed to the fact that waste is mixed from source and there are no available technologies adopted by the authorities to sort these wastes, hence all

waste is therefore sent to the landfill/dumpsite. Separation at source is needed so that materials do not mix within the waste streams. Separation of waste will also assist in identifying the appropriate method to adopt for managing each component within the waste stream more efficiently. Solid waste separation at source in institutions would therefore allow for great volumes of waste to be diverted away from landfill. The next chapter discusses the study area and the research methods and materials used in this study.

CHAPTER THREE

STUDY AREA AND RESEARCH METHODOLOGY

3.0 Introduction

The study sets out to analyse solid waste management practices in two institutions. This was premised on the basis that institutions are “controlled” entities whose waste types, quantities and properties can be easily quantified and analysed to know the basis for assessing the prospects for adoption of effective waste management practices. The two institutions are the University of Ghana (public) and Central University College (private). These two institutions were chosen because as compared to other institutions, they are the largest public and private institutions in Ghana at the moment. Given that it is within an institutional context, issues and findings can be compared to or replicated in similar environments. This chapter presents relevant information about the two study areas and the methodology adopted for the research.

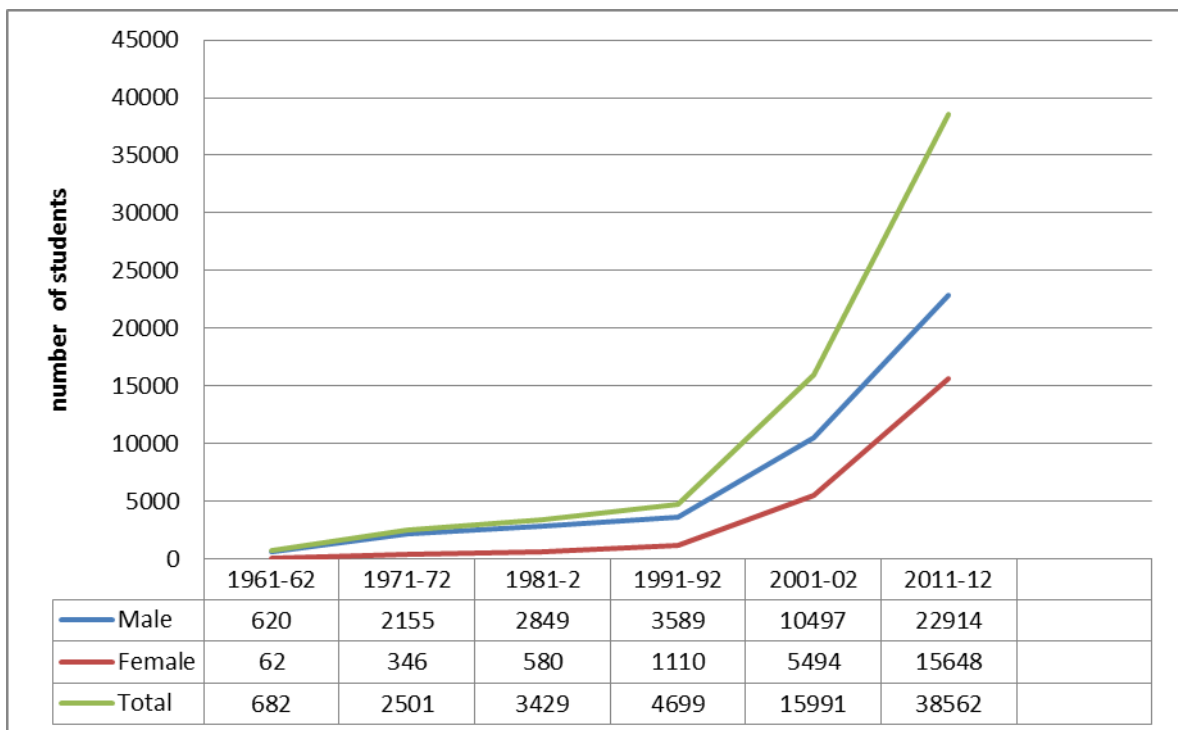
3.1 An Overview of the Research Locations

The UG and CUC are located in the city of Accra which is located on longitude 0 10' West and latitude 5 36' North on the coastal lines of the Gulf of Guinea. The climate is tropical with alternating dry and wet seasons. The extremes of the dry season are marked during November and March, and during the wet season the highest range of rainfall are in June and September. The annual rainfall is less than 1000mm, and humidity is about 80 percent during the wet season, dropping to 70 percent in the dry season (Ghana Meteorological Agency, 2010).

3.1.1. University of Ghana

UG is the premier and largest public university in the country, founded by an ordinance in 1948 for the purpose of providing for and promoting university education, learning and research. In 1960/61, the UG was set up by an Act of Parliament to enable it have power to award its own degrees which was not done previously. Its student population has grown from 682 in 1961 to 38,562 in 2012 (University of Ghana Basic Statistics, 2012). Figure 3.1 shows trends in students' enrolment over the years.

Figure 3.1 Trends in students' enrolment by gender at ten-year intervals: 1961-2012



Source: University of Ghana Basic Statistics, 2012

Figure 3.1 reveals that student population is ever increasing. The school started in 1961 with 620 male students and 62 female students representing 91% and 9% respectively. The disparity between male and female leaves much to be desired. However, the gender gap in student' population is being bridged as more females are being enrolled over the years. Currently there are 22,914 male students and 15,648 female students representing 59.4%

and 40.6% respectively. This could be as a result of efforts made by government, non-governmental organizations as well as corporate bodies in promoting girl child education in the country. It is important to note that the student population includes students who offer distance education programs. The teaching and learning for the distance education program begins when the regular students are on vacation. This therefore indicates that, teaching and learning in UG is continuous and as such, waste generation is continuous.

The number of employees has also increased from 4 in 1961 to 6203 in 2012 (University of Ghana Basic Statistics, 2012). Table 3.1 shows composition of staff as at January, 2012.

Table 3.1 Faculties and population of Staff as at January 2012

Faculties	Gender	Senior members	Senior staff	Junior staff	Total
Business school	Male	61	29	68	150
	Female	12	25	60	45
College of agriculture and consumer sciences	Male	77	84	348	507
	Female	28	26	31	85
Faculty of arts	Male	121	78	75	274
	Female	65	58	29	152
Engineering science	Male	39	13	6	58
	Female	4	10	2	16
Law	Male	19	6	7	32
	Female	3	3	2	8
Faculty of science	Male	141	94	109	344
	Female	30	43	15	88
Faculty of social studies	Male	172	136	149	457
	Female	52	82	39	173
Central Administration	Male	131	259	1184	1574
	Female	69	281	269	619
Total	Male	984	999	2536	4519
	Female	341	778	565	1684

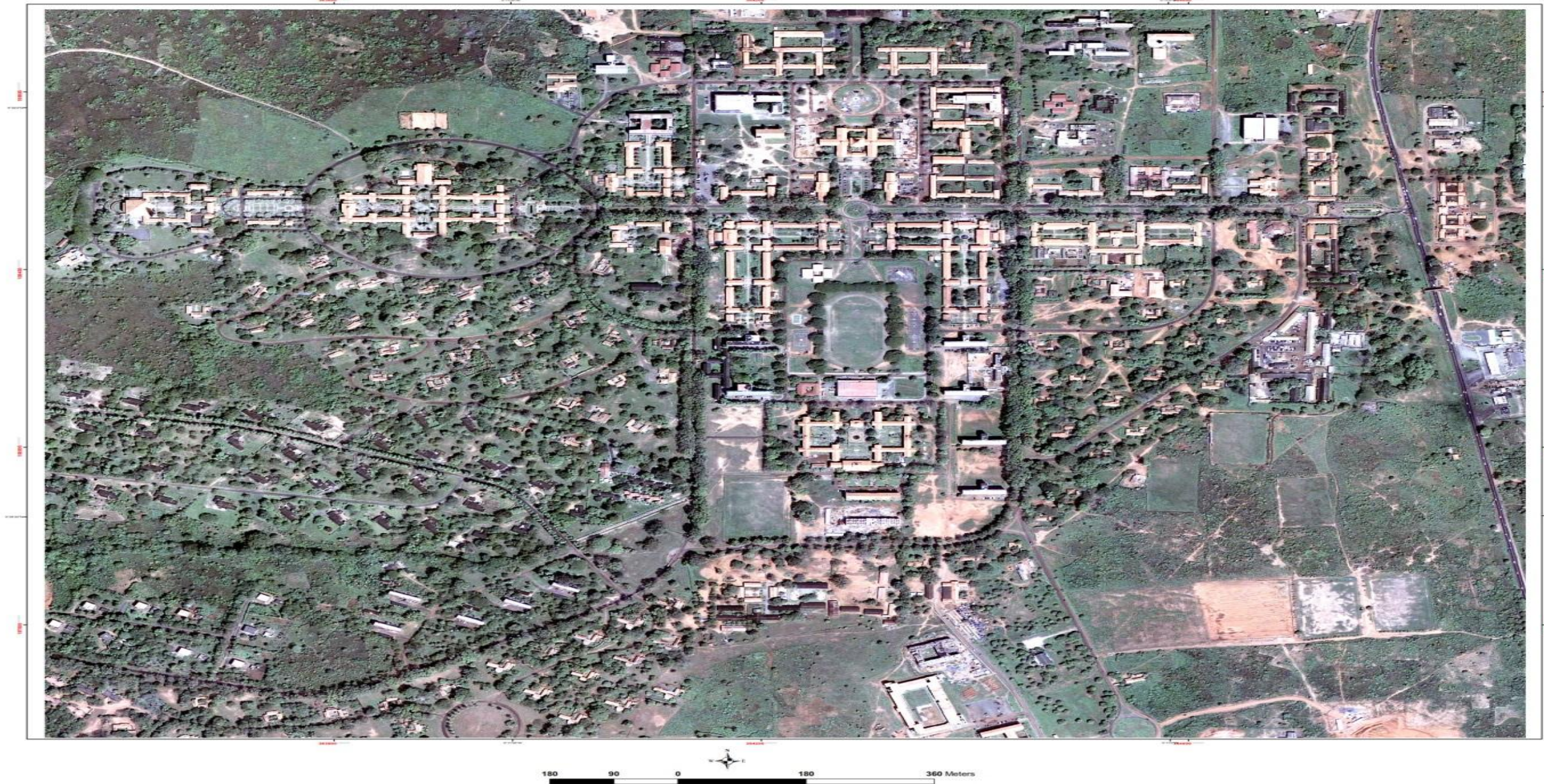
Source: University of Ghana Basic Statistics, 2012

With the total number of 6203 employees (see Table 3.1), there are 4,519 male employees and 1,684 female employees representing 73% and 27% respectively. This therefore indicates that there is a wide disparity; hence the male-female gap needs to be bridged. In addition to the various academic faculties (see Table 3.1) in UG, there are restaurants/food joints, provision shops, laboratories, clinic and a hospital. UG is modeled as a community.

It provides residential accommodation for under-graduate and post-graduate students as well as flats and guest rooms and bungalows for senior members and guests. There are several halls of residence (available to all students). Some of the present halls and hostels include [Akufo Hall](#), [Commonwealth Hall](#), [Volta Hall](#), [Mensah Sarbah Hall](#), [Valco Trust Hostel](#), [International Students' Hostel](#), SSNIT Hostels [Ghana Hostels Limited), Legon Hall, [Jubilee Hostel](#) and others.

Figure 3.2 Satellite Map of University of Ghana Main Campus

**MAIN CAMPUS, UNIVERSITY OF GHANA, LEGON
AS CAPTURED BY QUICKBIRD SATELITTE (2004)**



Source: Quickbird Satellite, 2004

3.1.2. Central University College

The Central University College is one of the premier private universities in the country and it was founded by the International Central Gospel Church (ICGC) in Accra. It started off as a pastoral training institute in 1988, metamorphosing into a Central Bible College by June 1991. It later became the Central Christian College in 1993 and eventually the Central University College in 1997. Among the stated aims of the University is to provide an integrated and biblically-based tertiary education with particular reference to the needs of the African continent (Website. Central University College). Central University College is currently the biggest private university in Ghana and has student population of 8,400 and over 571 workers.

CUC has four campuses at different locations (Miotso, Tema, Dansoman and Mataheko) and they offer various programs. The Miotso campus at Prampram is about 58.2 km away from the central business unit of Accra. This campus accommodates the School of Business Management and Administration and the School of Applied Sciences. Also the administration section of the University College is located here. The Mataheko Campus is located in Kaneshie and offers Business Management and Administration as well as Arts and Social Sciences. The Dansoman Campus houses the School of Theology and finally, the Christ Temple & National Insurance Commission (Graduate School Campus) which run the Master of Business Administration program with a duration of eighteen calendar months.

CUC has five faculties/schools. the School of Theology and Missions which is the oldest of the schools, was started in 1988 as a pastoral training institute thus predating the university. It is made up of the Department of Biblical and Theological Studies, the

Department of Historical Theology and the Department of Practical Theology. There is also the Central Business School which was established in 1997 and consists of the Department of Accounting, the Department of Finance, the Department of Agribusiness Management, the Department of Management and Public Administration, the Department of Human Resource Management and the Department of Marketing. Faculty of Applied Sciences is available and it is located on the Miotso campus. Furthermore, the Faculty of Arts and Social Sciences, which is the newest of the faculties was established in October 2006 and is made up of Department of Communication Studies and Department of Environment and Development Studies. CUC also has Graduate School of Business which offers Master of Business Administration. In addition, CUC has fewer restaurants, provision shops and laboratories as compared to UG.

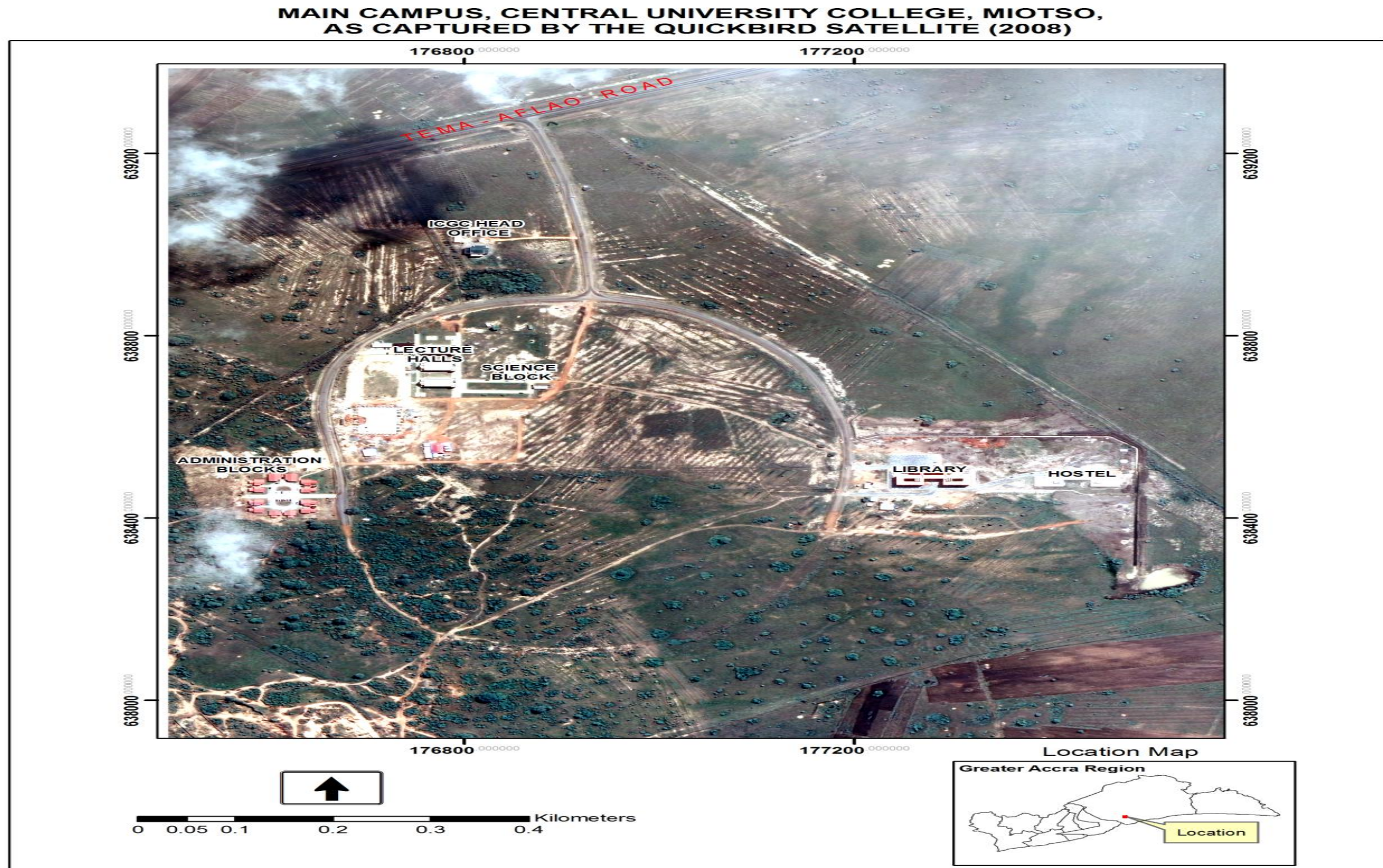
The Central University College is also committed to maintaining a safe and comfortable housing environment that values friendship and academic success when it comes to accommodation. Some of the hostels available to students include Joy Otabil, Billy Graham, Kathryn Kulhman, Justice, Freedom, Integrity, Faith and Chancellor.

Figure 3.3 Satellite Map of Central University College, Mataheko Campus



Source: Quickbird Satellite, 2005

Figure 3.4 Satellite Map of Central University College, Miotso Campus



Source: Quickbird Satellite, 2008

3.1.3. Waste Management Units

Both institutions of study are controlled areas with well-planned residential, academic and recreational areas as well as access roads. They have their waste management units. The Department of Environmental Health Services in UG has long been in existence under the Directorate of Physical Development and Municipal Services. It is responsible for sanitation and waste management, pest control, health education, food hygiene, among others. It is also responsible for cleaning and waste collection in academic and administrative units of the University while outsourcing cleaning and waste collection services from private agencies to handle the residential units of the University. On the other hand, Estate Department of Central University College is responsible for supervising environmental, sanitation and waste management issues among others. This department has been in existence since the genesis of the institution in 1991. Cleaning services as well as waste collection services are outsourced from private agencies in all CUC campuses.

The overall aim of the Department of Environmental Health as well as the Estate Department is to improve the health and well-being of the students and workers in the institution. This is because the environment in which people live and work has a key influence on their health. According to the estates managers in UG and CUC, Waste generated by the two Universities includes:

- i. General office waste such as newspapers, magazines, boxes, paper etc.
- ii. Waste from gardens and open space
- iii. Commercial sources of waste and
- iv. Residential sources of waste

3.2 Research Materials and Methods

The study used both primary and secondary data. Primary data sources include questionnaire administration, waste audit and field observation and in-depth interviews with sanitation workers. Secondary data sources include review of journals, reports, articles, books and internet resources that contain information on solid waste management.

3.2.1 Waste Audit

Available data is a fundamental parameter for deciding on any effective solid waste management strategy. It is important to assess the composition of the waste and the activities that contribute to the amount and types of waste generated in order to develop an efficient waste management system for solid waste (Koufodimos and Samaras, 2002).

To help obtain such data, analysis of composition of waste in the two selected institutions was carried out. This study was designed to characterize the waste stream, to determine its composition by weight and to utilize this knowledge in assessing the waste management practices and further recommend suitable waste management strategies to be adopted for waste diversion programs. Previous studies have demonstrated a correlation between waste generation trends and socio-economic characteristics (Oteng-Ababio, 2010). This study targeted waste stream characteristics within institutions in order to better inform the MSWM needs of the nation.

3.2.1.1 Selection of Units for Waste Audit

Four member audit team (which can be easily managed and monitored) in University of Ghana was selected by recruiting four janitorial workers from UG to assist in collecting waste samples from thirty offices in each of these three units namely the Registry, Faculty

of Social Science and The Faculty of Science. These three entities employ different methods in their day to day activities in the University. This would further inform decision makers on which unit to target for waste diversion / recycling initiatives and how best these wastes can be properly managed. On the other hand, a three member audit team was set up in Central University College by recruiting three janitorial workers to collect waste samples from 25 offices in the Mataheko campus. This is so because, accessibility to offices was a challenge and also, unavailability of space to conduct the exercise in the other campuses limited the exercise to be carried out in only the Mataheko campus [waste streams from the residential units of the two universities were not sampled because it was observed that the waste characteristics were similar to that of household waste which were studied by Fobil *et al.* 2005 and Earth Institute, (2010)]. The teams including the researcher developed waste checklist through site observation. Two days trial waste audit was conducted at the Departments of Information Studies and Botany of UG. It involved identifying the likely individual waste streams that would be encountered during the audit as well as ensuring that requisite materials needed for the audit were handy.

3.2.1.2 Waste Collection

Each of the offices was provided with bin bags for daily waste produced to be stored. These bin bags were then picked up in the morning (twice a week) for three weeks and emptied into bigger bin bags and labeled as indicated in Plate 3.1.

Plate 3.1 Waste from offices stored in black plastic bags



Source: Fieldwork, 2013

Refuse from each office was collected twice a week, on Mondays and Thursdays. This enabled the researcher to obtain a representative weeks' worth of waste generated. The bags from each unit were given special identification numbers and then transported to a designated site within the Universities (for convenience and limited transportation) for sorting and segregation.

3.4.1.3 Waste Stream Analysis

A large clean plastic sheet was spread on the floor at the sorting site, and the contents of the bag(s) of waste taken from each office were manually separated by members of the audit team (who wore protective equipment such as nose masks and hand gloves) to determine the proportion of the various waste components in the waste stream. Each category of waste for each unit was put in a plain bin bag as shown in Plates 3.2 and 3.3, labeled and weighed on a manual spring scale as demonstrated in Plate 3.4 and recorded on a spreadsheet. However when waste sample was not large enough on the first day of collection (as was the case in CUC), this was stored and added to waste collected on the second collection day of the week and weighed at the end of the week for three weeks. Sorting was done for six hours a week (three hours a day) in UG and sorting in CUC was done for four hours a week (2 hours a day). This is because there was less quantity of waste sorted in CUC. The type of materials present in the waste stream of each institution was the same, except that they differed in weights and proportions. The component materials in the waste stream were classified as follows:

- i. Paper (which comprised of cardboards, A4 sheets, calendars, newspapers, etc.)
- ii. Food waste (which consisted of fruits, sandwiches, sweets, left over from lunch packs, etc.)
- iii. Plastics (comprised of beverage bottles, water bottles, etc.)
- iv. Other waste (which included glass, metal, etc.)

Plate 3.2: Plastic waste



Source: Fieldwork, 2013

Plate 3.3: Paper waste



Source: Fieldwork, 2013

Plate 3.4 Weighing categories of waste



Source: Fieldwork, 2013

Solid wastes were sampled from academic and administrative buildings. This is because data on wastes generated in these places are usually assumed to be mainly paper. This study therefore was carried out to ascertain the types of waste generated in the academic and administrative units by using scientific methods (waste audit). Waste audit was carried out to classify the composition of the solid waste in public and private universities. The components found in each location were analysed to find opportunities of solid wastes diversion such as recyclable and non-recyclable wastes. Then, the composition and weight of solid wastes, both before and after separating solid wastes was used to compare between the two options (recycling versus landfilling). The analysis was done as follows:

- i. The percentage composition of solid wastes generated in the study sites.

- ii. The total weight of the solid wastes produced from the study sites.
- iii. The value of the recyclables

The audit teams participated fully in the process during the audit period. This could be attributed to the fact that, they were well paid. Also, protective clothes such as gloves and nose masks were provided and this made them to feel safe during the sorting exercise.

Despite the overall success of the three-week waste audit, there are notable limitations that must be regarded. There were neither tents nor trees at the sorting sites. Members of the audit team were therefore exposed to the scorching sun during the first week of the sorting period which started at 11am and ended at 2pm. After the first week, sorting was carried out between 8 and 11 o'clock in the morning. Also, in order to conserve limited time and financial resources, wastes sampling and labeling were completed by janitorial staff as part of their regular waste collection responsibilities. They were trained on how to sample waste and label it. However, the researcher did not have complete control over the waste sampling process. As a result, certain waste components were excluded from the study (i.e. packing cases, broken chairs, etc.). Limited resources also restricted the assessment of waste at residential, healthcare and recreational buildings which when combined would represent a significant and distinct portion of the universities' waste. This notwithstanding, the audit results gave us a fair idea of the waste stream found in institutions and the potential volume discarded.

3.1.2 Questionnaire Administration

In collecting data on the attitudes, knowledge and perception of students towards solid waste management practices in their various institutions, questionnaires were administered. The questionnaire was in two parts. The first part captured demographic

data of respondents and the second part captured information on students' knowledge, attitude and opinion. Closed- ended questions were used where respondents were given options to choose from. This enabled answers to be meaningfully compared and analyzed easily. There were few open ended questions which required respondents to express their opinions without limitations. This helped in providing further explanation to issues raised in the questionnaire. The questionnaires were answered by students to establish possible link between knowledge and behaviours relating to how waste is managed and to identify possible barriers and solutions to managing waste more sustainably. A total of 150 students each in the study locations were sampled as a result of limited resources. Students were randomly selected. This was done in order to give each student an equal chance of being sampled.

3.1.2.1. Pre-testing of Questionnaire

Five questionnaires were sent to 5 students in University of Professional Studies. These students were randomly selected. Closed ended questions were used where respondents ticked their preferred option. Responses from the pre-testing exercise were compared and analyzed. All questions were answered by respondents. However, it was a challenge to understand or appreciate some of the options chosen by the respondents. This demanded the questions to be reviewed. Open ended questions were also asked to allow respondents freely express their opinions.

The data from questionnaires were coded and fed into Statistical Package for Social Science (SPSS) to produce figures and tables for easy visualization and interpretation. This is because data presented in the form of graphs gives a pictorial view and understanding of the issues under consideration. Simple percentages were used to compare the data obtained from the two institutions.

3.1.3. *Interview*

Interviews were also carried out to obtain data from a number of stakeholders in the study locations. Interviewing is a useful path of collecting qualitative data because it allows respondents to report on themselves, their views, their beliefs, practices, interactions and concerns (Freebody, 2003). Heads of waste management units in each study location whose roles include managing waste generated by the institutions was considered for the interview. Questions asked included:

- i. How is waste stored?
- ii. How is waste collected?
- iii. What is the rate and time of collection?
- iv. Which personnel are in charge of waste collection?
- v. What are the disposal practices?

This helped in understanding the institutional arrangement put in place for the management of solid waste. Five administrative workers each in both locations were randomly selected and interviewed in their offices to help the researcher gain detailed information on the activities carried out and the materials used in offices. Questions asked included:

- i. What are the main activities carried out in the offices?
- ii. What materials are used in the offices?
- iii. How is waste disposed off in the offices?

This helped in knowing the materials likely to be found in the waste stream before carrying out the waste audit exercise. The Managing Director of Super Paper Company Limited (SPCL) was also interviewed to understand the prospect of paper recycling. Questions asked include:

- i. How are raw materials obtained for the recycling activity?

- ii. How much is the company willing to pay for waste paper?

The interview was scheduled at a time appropriate for the interviewee and in the interviewee's office. Confidentiality was highly considered.

The qualitative data from interviews conducted with respondents was analysed by making summaries of the views of the respondents and supporting these with relevant quotations that captured these views, supported with data from documentary sources and from my own field observations of the waste situations in the two institutions of study, UG and CUC.

3.2. Conclusion

This chapter discussed the study area and the research methods and materials used in the study. It provided background on University of Ghana and Central University College, the two study locations of this research. The next chapter discusses the institutional waste management practices.

CHAPTER FOUR

SOLID WASTE MANAGEMENT PRACTICES

4.0 Introduction

This chapter discusses the solid waste management practices and their implications on environment, health and cost. Persons interviewed included the officers' in-charge of managing wastes in the institutions of study.

4.1 Institutional Arrangement in SWM

The two institutions of study have put in place various measures to handle waste. These measures are discussed in subsequent paragraphs to describe the institutional arrangement of solid waste management in both institutions of study.

4.1.1 Storage, Collection rate and time of collection

Waste storage methods as well as frequency of collection of waste can be used as a measure of good waste management practices. It is an indicator of awareness by all concerned on the need for a clean environment. To evaluate this aspect of Solid Waste Management (SWM), the officers in charge of cleanliness, waste collection and disposal at the two institutions of indicated the methods used in storing waste and how often waste was collected from generation points for disposal in a week. The storage of waste prior to collection or disposal is an important aspect of waste handling practices. The field observation and survey conducted show that waste is stored in bins in both institutions before disposal. An interview with the head of waste management unit in CUC revealed that, commitment from management in providing the necessary bins for the storage and collection of wastes is paramount in preventing littering and unauthorized dumping of waste. Street bins were seen covered and evenly distributed (intervals of 50 meters) in

CUC. Collection of waste from the points it was generated is carried out by a contracted private company. These bins whether full or not, are emptied in the morning by a private waste collection company twice a week. The collection is done twice a week due to the low waste generation rate. With this regularity in collection, there are no sights of potential unauthorized dumpsites.

On the other hand in UG, while some bins were covered, others were overflowing with waste and not covered. Collection of waste from the points it was generated is done by workers employed by the institution. According to the head of the Waste Management Unit in UG, there were limited bins available and as such street bins were placed at few areas within the institution. The officer however placed emphasis on attitudes of students and workers as a critical factor influencing waste disposal. The officer further explained that individuals drop waste indiscriminately and this results in littering. This is attributed to the fact that the few available street bins are not positioned at the appropriate or vantage points such as the various bus stops where they can easily be accessed. Most of the street bins are not being utilized. By implication, the use of street bin as an institutional arrangement for waste collection calls for effective planning. The location of street bins needs to be carefully planned in order to satisfy the needs of the people. These bins are picked up by waste workers from the Waste Management Department of the institution once every morning from Monday to Saturday and the content emptied. However, due to irregularities in collection, the bins are seen overflowing as shown in plate 4.2 and further waste generated are being dumped at unauthorized places within the University as indicated in plate 4.3. Exposed rubbish from overflowing bins and unauthorized dumpsites are easily blown away by wind causing littering as shown in plate 4.1.

Plate 4.1 Rubbish blown into the gutter by wind



Source: Fieldwork, 2013

Plate 4.2 Overflowing street bin in U G



Source: Fieldwork, 2013

4.1.2 Logistic, Transportation and Disposal Methods

The Environmental Health Service Department in UG collects and disposes of waste to the landfill site/dumpsite. The Unit has two very old trucks (18 years old) and one fairly new compacter truck (5 years old). Out of the three waste trucks, only the compacter truck is currently mobile. This single waste truck is unable to collect all the waste generated in a day. This has resulted in the collection of only 35% of the total waste generated on campus, while the rest deposited on unauthorized refuse dumps represents 40% (Gbogbo and Awotwe-Pratt, 2008). There is no significant change in the situation since 2008. According to the officer in charge of waste management, the uncollected waste is either burnt on site or accumulated and collected on a later date. On the other hand in CUC, all waste generated is collected and transported to dumpsite on a regular basis by a contracted waste company. Management of CUC has made available bins for the storage of waste prior to collection.

4.1.3 Units in Charge of Managing Waste

Currently, all waste generated by the University of Ghana is landfilled although almost all components of the waste found in the waste stream have the potential to be either recycled or reused. The department of Environmental Health Services handles the collection and disposal of waste from the various departmental and administrative units of the University while Zoomlion Ghana Limited and other private cleaning agencies are contracted to handle the collection and disposal of waste from the residential areas. The Environmental Health Services Department of the University has not been successful in delivering its waste management services to expectation due to increasing population, inadequate personnel and logistics. The poor delivery of waste handling services by the unit led to the involvement of the private sector (Zoomlion and other cleaning agencies) to handle the

collection of waste generated in residential areas of the University. However the institution is still faced by the problem of indiscriminate disposal and burning of waste as indicated in plate 4.3. The Academic Affairs Directorate of UG from 2011 has put a system in place to recycle only used examination papers. According to the Director of Academic Affairs (UG), the scheme has been successful due to regular and timely collection of waste paper as well as large storage space for the waste paper.

The study found out that there is no integration among the unit and the private waste and cleaning service providers in solving solid waste management problems. This has resulted in the neglect in some areas of the institution in so far as waste collection in concerned. That is to say that, there is no central body that supervises the services rendered by Zoomlion Ghana Limited and the other private cleaning agencies. Also there are no clear-cut territorial coverage assigned to each waste management unit and as a result, there is the situation of some areas being neglected while overlapping of responsibilities occurs in other areas. This therefore agrees with Ogawa (2002) observation that, it is characteristic of developing countries to have several agencies involved in the delivery of solid waste and other municipal services. Ogawa further observed that there are often no clear roles or functions of the various agencies involved in environmental management. At the same time, there is no single unit designated to coordinate the activities of the various waste management units resulting in gaps in service delivery such as uncollected waste at neglected areas. This study also agrees with studies done by Armah, 1993; Attahi, 1999; and Ogawa, 2002; that, the inadequate coordination among the relevant sector units often results in different units duplicating functions and gaps in service delivery.

In the case of CUC, the Estate Department is responsible for handling environmental sanitation and waste management issues among others. This department has been in existence since the genesis of the institution in 1991. There is a scheme in place to divert examination papers from being landfilled. All CUC campuses have recycling schemes in place mainly for examination papers. Examination answer booklets and some office paper are given out to Super Paper Company Limited (paper recycling company) to recycle into tissue paper. According to the Manager in charge of Estate Department, the scheme has been a success and the success is attributed to the commitment made by management of the University to partner with a paper recycling company, SPCL, for recycling examination papers and paper waste from the central administration into tissue paper. The scheme is however challenged with irregularities in collection and lack of storage space. According to the Managing Director of SPCL, the paper recycling company has not been regular in collecting the waste paper because the quantity produced by CUC is not large enough (thus less than a ton weekly). The Managing Director further said it would be beneficial to both partners if the institution accumulates the waste paper generated for a period to obtain up to a ton or more. This suggestion is however a challenge to CUC since it does not have enough space for the storage of large quantities of paper waste. Zoomlion Ghana limited is contracted to collect and dispose of solid waste generated by the institution. Cleaning services are also outsourced.

Plate 4.3 Indiscriminate disposal practice in University of Ghana



Source: Fieldwork, 2013

4.1.4 Scavenging in Institutions

While developed countries have realized the value of waste resources and have put in place efficient ways for recovery and recycling of valuable materials from waste, most developing countries have not (Kocasoy, 2001). Sorting for recyclable or recovery for valuable materials was seen being carried out by scavengers in UG while in CUC scavengers were not sighted. The scavenging activities in UG contribute to littering within the University compound.

The study revealed that in UG scavengers are often seen on dumpsites and around refuse containers/bins where they search through garbage in unhygienic manner, for recyclable materials. Some sanitation workers from UG as well as some individuals from nearby communities are seen searching through various bins and containers for recyclable

materials. Interaction with some scavengers who are also employees from the Waste Department of the University revealed that, even though scavenging is not part of their job description, they engage in it in order to gain additional income to support their meager salaries. The interaction further revealed that these employees from UG received an average of GH¢350 per month as wages. According to the officer in charge of waste management in CUC, employees from the contracted waste company received an average of GH¢500 as wages per month but these employees do not engage in scavenging activities. Also, individuals from nearby communities do not have access to the waste bins/containers in CUC as a result of security checks put in place by management. However in UG, individuals from neighboring communities easily access the waste bins and containers without being questioned. Interaction with some of these individuals indicates that, they do not have any source of livelihood besides scavenging.

Items and materials scavenged include plastic bottles, sachets and glass bottles. These items are sold for additional income. Contents in bottles are poured out and wiped “clean” with a rag. These items are later packed (see Plate 5.4) for sale to local drink sellers, detergent sellers and cooking oil sellers in Madina and Nima. However, as discussed in Chapter Five, all types of waste including potential hazardous waste from the Faculty of Science are kept in the same bins/containers from which the aforementioned recyclables items are scavenged. Hence the probability of contamination is high and can cause health problem when items used are not properly cleaned. This study therefore showed that, contamination of recyclable and reuse materials (caused by the disposal practices where all sort of waste are kept in the same containers/bins) can be minimized if students and faculty members are provided with multiple bins for separate disposal of different waste types. That is to say, hazardous waste from the institutions can be properly managed from

causing contamination when separated from other types of waste generated. Other recyclables such as plastics, food waste and paper when separated from other wastes can also attract value addition.

Plate 4.4 Plastic and glass bottles retrieved from waste bins



Source: Fieldwork, 2013

Interaction with some of the scavengers revealed that, they do not support the idea of source separation of waste. Their concern is that source separation would deny them access to garbage hence depriving them from getting any additional earning. The study however revealed that, some of the scavengers were afraid of losing their only source of livelihood if source separation of waste is practised. Other scavengers, due to selfish interest, do not support the idea of source separation of waste.

4.2 Implications of Solid Waste Management Practices

The current solid waste management practices in both institutions have implications on the environment, health and cost. These are discussed in subsequent paragraphs.

4.2.1 Impacts of Solid Waste Management Practice on the Environment

Street bins are made available on UG main campus but most of them seem not to be utilized. This could be attributed to the fact that, the street bins are not strategically sited for easy access. As a result of limited bins placed at vantage places in the University of Ghana main campus, there are instances where waste overflows and stays uncollected for weeks. The waste containers available are also seen not covered and the waste, which contains high amount of plastic bags are blown about by the wind causing littering (see plate 4.5). According to students whose hostels are near waste containers, the sight and smell of uncollected wastes constitute a major discomfort to them. According to Campbell (2009), vultures and related species are often found in areas characterized by open food markets, large garbage disposal areas and in some cases poor sanitation. The amount of waste collected and disposed of daily by the sanitation unit on the university campus represents only 35% of the total waste generated on campus, while the quantity deposited on unauthorized refuse dumps represents 40% (Gbogbo and Awotwe-Pratt, 2008). Thus, a large quantity of waste is available for the vultures to feed on. The presence of vultures therefore indicates that waste is not properly managed in UG.

Plate 4.5 Uncovered container and uncollected waste

Source: Fieldwork, 2013

The mixed waste (paper, food waste, faecal matter, etc) is often disposed off at dumpsites and containers are located closely to residential and commercial areas where food is prepared or sold. This is unhygienic because flies move from the dumpsites/containers and settle on food and water that is sold to thousands of students, workers and visitors, hence affects public health. This was made clear when the Vice-Chancellor of the University of Ghana, at the second durbar, dubbed ‘Vice-Chancellor’s Interaction with Students’, held as part of measures to educate the students on new policies and programs being undertaken by the University, disclosed that foods prepared on campus contain “faecal matter”, and there is therefore the need to put effective measures in place to protect the lives of students (The Finder, March 20, 2013). Also, it was revealed at the durbar that similar researches by the Noguchi Memorial Institute of Medical Research (NMIMR) as

well as some graduate students showed that the water often used to prepare food for sale on campus contained faecal matter which poses serious health hazards.

At the Central University main campus there is however no littering due to the fact that management has put street bins at vantage points (50 meters interval) for easy access. Storage bins are well covered and the timely collection of the waste generated resulted in no sight of overflowing waste, uncollected waste or unauthorized dumpsite. Also, there are no sights of vultures on the university campus. This has made the campus tidy and hygienic. This therefore confirms that waste is properly disposed off and that, location and convenience are important for safe disposal of waste as indicated by Ludwig *et al.* (1998) and Oteng-Ababio (2010). By implication, the use of street bin as an institutional arrangement for waste collection calls for effective planning. The location of street bins needs to be carefully planned in order to satisfy the needs of the people.

4.2.2 Health Impacts of Solid Waste Management Practices

A review of health data collected in 1994 for solid waste disposal in Ghana indicated that solid waste workers experience higher incidence of sick days, work related accidents and mortality (Menel, 1994). Observation of waste handling at UG revealed that most sanitation workers (who fall between the ages of 35 and 58) work with bare hands, their own clothes and sandals. The workers are therefore potentially exposed to health hazards that limit the effective management of waste. According to the waste workers in UG, they have been provided with a single pair of hand gloves and one over-all safety clothes within the last three years. They indicated that requests for more safety clothes have been made but management has not responded to their request. Contreau-Levine (2000) has

emphasized that inadequate safety gear, low wages, advanced age and weak workers in the solid waste management activities put the workers to health hazard situations.

Meanwhile, the officer in charge of waste management and sanitation in UG reiterated that these safety gears are limited but many a time, some of the workers refuse to put their safety gears on. It was also revealed that there were plans to acquire logistics for the workers however, the acquisition and delivery had delayed due to inadequate funds. Also, it was observed that not only were there no enforcement on workers to put on protective attire, the department does not have routine health check-ups for the workers as well. Interaction with some workers (who work without any protective attire) revealed that, they felt uncomfortable putting on safety boots and gloves. On the other hand at CUC, sanitation workers (who fell between the ages of 28 and 45) went about their activities with their protective attire on. This is due to the fact that, the private sector sanitation management provided its workers with the needed safety logistics and also enforced their usage. Hence compliance and enforcement of health and safety measures were high in CUC but relegated to the background in UG.

4.2.3 Impacts on Cost

The provision of waste management services in any large city/institution is an expensive undertaking that makes huge demands on finances (Armah, 1993; Onibokun and Kumuyi, 1999). Apart from making investments in capital equipment, money is also required for the day to day operations such as procurement of fuel, spare parts, salaries and working gears. It is however important to note that UG (according to the officer in charge of waste management) did not have any recycling scheme put in place as part of their infrastructural design even though it had the needed population to support such initiative

until 2011. This may be attributed to the fact that, the University was established at a time (1948) when environmental issues appeared to be relegated to the background especially in Africa. The institution spends GH¢193,440 (which is equivalent to \$ 96,720 with the exchange rate of GH¢2) in the collection and disposal of waste annually (see Table 5.7).

On the other hand, CUC constructed a sewage recycling plant which in view of the school's population is too small to meet the capacity of the plant resulting in the scheme being underutilized. This is due to the fact the institution was established quite recently (1988) and therefore considered environmental technologies present at the time. The study revealed that the annual cost incurred in managing waste in CUC is GH¢142,775 (which is equivalent to \$71,388 with the exchange rate of GH¢2 to a dollar) (see Table 5.7). The cost however excludes disposal, insurance, licensing and maintenance charges as well as environmental externalities caused by current management practices in the two institutions of study.

4.3 Conclusion

The one-to-one interview with administrative officers in both UG and CUC indicates that few individuals among the institutions' populace reuse some of the waste materials such as paper etc. However, the research looked at the picture of what happens to waste generated by the institutions and the criteria used were not based on individual assessment. Both institutions on the other hand recycles examination paper, however, if the principle of separation of waste is adopted, more waste resources would be identified. Furthermore, the placement of bins at vantage points for easy access is an important consideration to be made to ensure effective waste collection and disposal practices. The next chapter analyses the institutional waste streams.

CHAPTER FIVE

ANALYSIS OF INSTITUTIONAL WASTE STREAM

5.0 Introduction

This chapter discusses the outcome of the waste audit carried out in the research locations. Instituting best available techniques to managing waste effectively requires an audit of the types and amount of waste produced (Waste Watch, 2003). The audit results provided information from which the effectiveness of recommended techniques, and future analysis, could be gauged. It also provided an opportunity to know how waste stream could be diverted from landfill.

5.1 Waste Audit Outcomes

The composition of waste between various departments is compared and the opportunity for diverting some waste streams from landfill is indicated. Waste samples were taken from the Registry, Faculty of Social Science and the Faculty of Science (UG). The total composition and waste weighed at the end of the three weeks audit period for UG is illustrated in Table 5.1 and Table 5.2.

Table 5.1 Waste stream composition of UG

Source/Material	Paper (kg)	Plastics (kg)	Food (kg)	Other (kg)
Registry	90.75	26.75	20	15.5
Social Science	62.5	27	30	19
Science	38.95	32.25	24	41
Total	192.2	86	74	75.5

Source: Fieldwork, 2013

Table 5.2 Percentage waste composition in UG

Source/Material	Paper (%)	Plastics (%)	Food (%)	Other (%)
Registry	47	31	27	21
Social Science	33	31	41	25
Science	20	38	32	54
Total	100	100	100	100

Source: Fieldwork, 2013

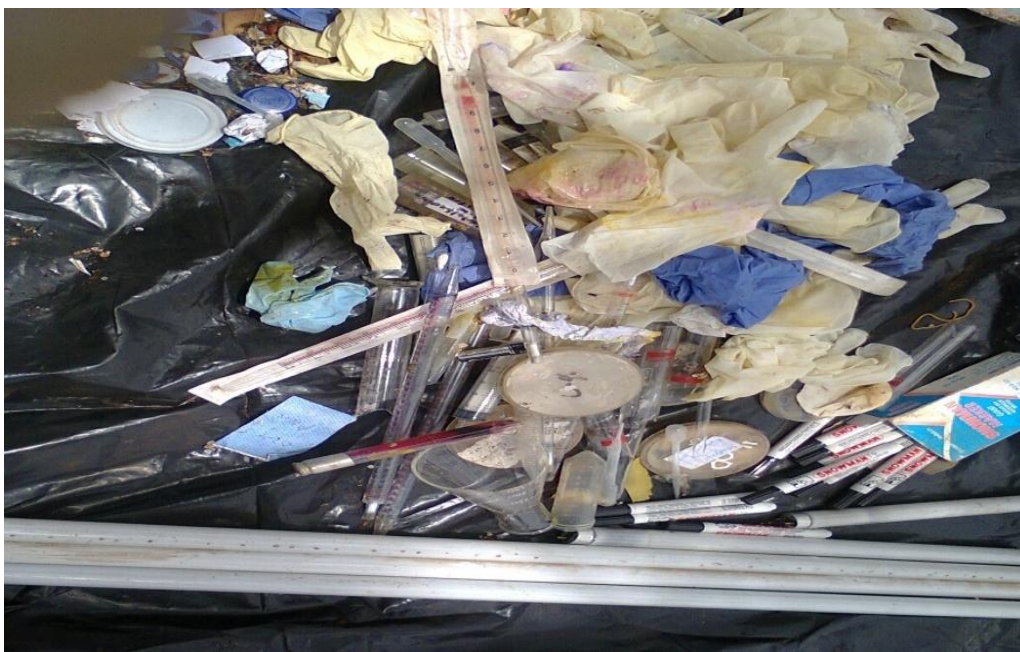
As shown in Table 5.7, paper, plastics and food wastes were the major waste streams. Paper wastes comprised of cardboards, A4 paper, magazines, envelopes, calendars and newspapers. Plastic wastes identified consisted of plastic bottles, plastic bags, hand gloves and water sachets. The food wastes identified included left over from breakfast and lunch packs. Finally, the ‘other’ wastes category comprised of glass bottles, bulbs, glass test tubes, broken cylinders, cotton and syringes.

It can be deduced from Table 5.1 and Table 5.2 that, not only did Registry generate more paper wastes than the Faculty of Social Science and The Faculty of Science; it also generated more paper waste than the other types of waste identified during the three weeks audit period in UG. Thus, the Registry recorded 90.75kg (Table 5.1) representing 47% (Table 5.2) of total paper waste sampled while the Faculties of Social Science and Science recorded 33% and 20% respectively. This is attributed to the fact that, the Registry serves as the center of all administrative services of the University and the amount of paper waste recorded from reports, print outs, junk mail, etc. The study further observed from the audit

that, there was little shredding done by hand. Other papers were also crumpled. This however raises concern on security of vital/confidential information which when exposed to wrong hands may cost the University dearly. The Registry would be a suitable place for recycling paper waste.

The Faculty of Science recorded the highest amounts in plastics (which is 32.25kg, representing 38%) and ‘other’ wastes category (which is 41kg, representing 54%). This is as a result of various experimental activities carried out in their laboratories. A substantial amount of toxic waste substances such as test tubes containing chemicals as shown in Plate 5.1 were found in the waste taken from the Faculty of Science. The Faculty of Social Science recorded a higher amount of food waste than the Science Faculty and Registry (Tables 5.1 and 5.2).

Plate 5.1 “Mixed waste” category from the Faculty of Sciences which contain hazardous substances



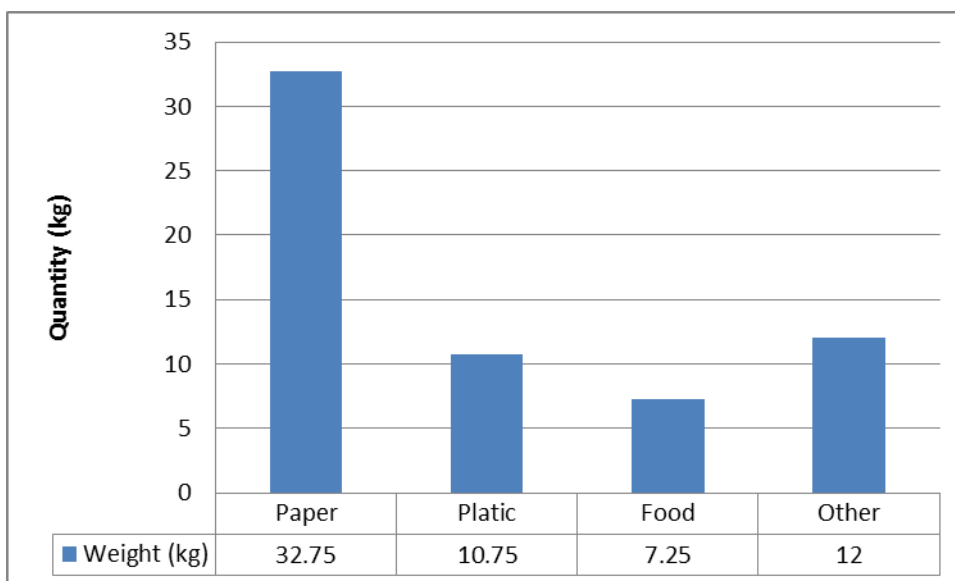
Source: Fieldwork, 2013

Majority of paper waste, food waste and recyclable plastic were generated throughout the academic and administrative units. It is concluded after the three weeks waste audit that,

average waste generation rate per person was 0.32kg (see appendix 2ii) which is below the national average of 0.5kg (AMA, 2010)

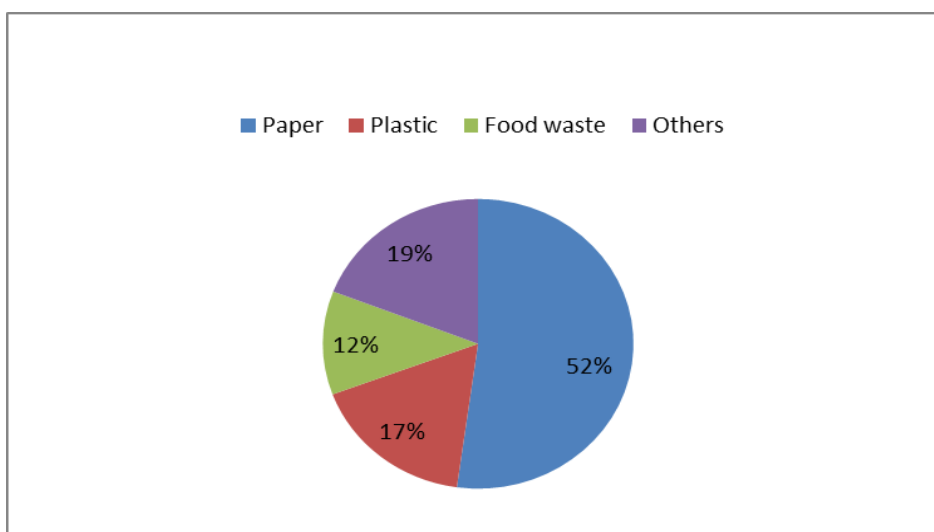
On the other hand, samples of wastes were taken from 25 offices within the Mataheko Campus of the Central University College. The total composition and waste weighed at the end of the three-week audit period for CUC is illustrated in Figure 5.1

Figure 5.1 Waste Composition of CUC



Source: Fieldwork, 2013

Figure 5.2 Waste composition in percentages (CUC)



Source: Fieldwork, 2013

As illustrated in Figures 5.1 and 5.2, paper, plastics and food waste were the major wastes found in the waste stream during the three-week audit carried out in CUC. Like UG, majority of waste generated was paper waste. Paper waste was 32.75kg representing 52% of total waste sampled for the three weeks in CUC (see Figures 5.1 and 5.2). These were from reports, print outs, junk mail, etc. but unlike UG, most of the paper waste generated from CUC was shredded by machines. This made it difficult for the content of documents to be exposed. Plastic waste which weighed 10.75kg representing 17% of total wastes sampled in CUC were mainly water bottles, sachets, plastic bags and plastic cups. The 'Other' waste streams category (which recorded 12kg representing 19% of total waste sampled in CUC) consisted of cartridges, glass bottles and bulbs. Food waste was the least recorded and 7.25kg representing 12% of the total waste sampled (Figures 5.1 and 5.2). The food waste was mainly from left over from breakfast and lunch packs.

The waste materials within the two institutions of study fall into four broad categories;

- i. Recyclables-paper, glass and plastics
- ii. Organic material such as food waste
- iii. Hazardous materials-chemical waste from laboratories
- iv. Miscellaneous materials such as used pampers

The variety of materials that workers use and throw away reflects the varied activities that take place in their offices. Typical office activities identified during site observation in both UG and CUC include paper based activities such as typing documents, sending and receiving information, scanning documents electronically and hard copies and printing documents, minutes, agenda, reports, work order forms, work rosters, application forms.

According to the Director of Academic Affairs (UG), recycling examination papers so far has been a success due to regular collection of waste paper and available storage space. On the other hand, according to the Estate Manager at CUC, the recycling initiative is challenged by lack of storage space and irregular collection. The study therefore revealed that both public and private institutions show concern about the environment through recycling of examination papers.

5.2 Implications of Waste Audit

The results from the three-week waste audit in UG/CUC demonstrated that there were opportunities to divert paper, plastic and food waste from landfills. The three 'Rs' (reduce, reuse and recycling) which are encouraged as indicated by the Waste Hierarchy (Figure 2:1) to return waste to the production cycle have thus become more important as this results in lower environmental impact and energy consumption, as well as a decrease in both the extraction of virgin raw materials and the amount of waste deposited in landfills (Snow, W., and Dickinson, J. 2001.). With the results of the waste audit, the following inferences can be provided with respect to potential paper and plastic recycling as well as composting.

In studies carried out in Accra by Fobil et al (2001), the percentage of plastic waste generated in "low-class residential" area(s) was estimated at 9%. AMA (2010) also reported 3.5% presence of plastic waste. Results of the samples from the research locations however show significant higher amount of paper (46% and 52% for UG and CC respectively) and plastics (20% and 17% in UG and CUC respectively). These, if properly managed, can attract value addition. A summary of waste composition for the three weeks waste audit in UG/CUC is illustrated in Table 5.3.

Table 5.3 Comparative waste composition in UG/CUC

Source/Material	Paper (%)	Plastics (%)	Food (%)	Other (%)
UG	46	20	17	17
CUC	52	17	12	19

Source: Fieldwork, 2013

Data and field observations demonstrate a need for paper and plastic recycling programs. The majority of respondents in the study expressed willingness to separate paper and plastic waste from their waste for recycling and this is discussed in chapter six.

Another significant output of the waste audit is the high representation of food materials (organic waste) in UG. Although this is not unique to the institutions, the study revealed that such organic materials from the institutions do not contain faecal matter as compared to those from the households. A study by MCI at Ayidiki recorded about 10% of faecal matter contamination at James Town and the amount of faecal matter present was as high as 20%. Thus, in all possibility and probability, organic waste from the institutions can be a potential input for compost manure as food materials made up of 17% and 12% of the sample waste stream in UG and CUC respectively as indicated in (Table 5.3).

Academic learning at CUC is discontinued when the institution goes on recess while at UG it is continuous and materials are readily available. Currently there is a system in place at CUC and UG where waste is collected and disposed of. One of the main technical barriers to recycling is contamination and in order to overcome the problem of contamination, materials need to be segregated and dumped into recommended recycle bins.

The waste streams audited is used to make the annual estimations. The 246 days used for estimating the annual waste generation was calculated by subtracting 52 weekends (104 days) and 15 public holidays from 365 days in an average year in Ghana. From the waste audit carried out, it was realized that the daily waste generation rate per worker is 0.32kg/person and 0.21kg/person for UG and CUC respectively (see appendixes 2 iii and 3 iv). Estimation for the annual waste generated in UG and CUC is illustrated in Table 5.4.

Table 5.4 Annual waste estimation

Institution	Daily rate per worker, kg	Total number of workers	Total daily generation, ton (daily rate × total population of workers ÷ 1000)	Annual estimates in ton (daily generation × 246 days)
UG	0.32	6,203	1.985	488.3
CUC	0.21	527	0.1107	27.2

Source: Fieldwork, 2013

From Table 5.4, it can be realized that in UG, 488.3 tons of waste (which according to the Managing Director of SPCL, when sold at GH¢60 per ton will be worth GH¢29,298) is generated annually from administrative and academic buildings while in CUC, 27.2 tons of solid waste (which when sold at GH¢60 per ton will be worth GH¢1,632) is generated annually from administrative and academic buildings. This waste when well managed can attract value addition leading to possible savings. The study reveals that paper waste is the most dominant type found in both institutions under study. Thus, it gave a fair idea of the potential of recycling in the two institutions of study.

5.3 Managing Institutional Waste as a Resource, Cost-Benefit Analysis

As already discussed in the first section of this chapter, paper constitute about 46% and 52% of the total waste generated in UG and CUC respectively. There are also other sources of paper generation which includes examination units. UG and CUC have central procurement systems which provide stationary (including A4 paper) to all faculties, schools and centers. According to the officers in charge of procurement in UG and CUC, the total annual consumption of A4 paper for 2010 was 20,250 and 2,995 reams respectively. According to the officer in charge of procurement, UG spent GH¢ 139,928 on 20,250 reams of A4 paper in 2010 while CUC spent GH¢ 20,366 on 2,995 reams in 2010. Furthermore, UG consumed 20,000 reams of A4 paper in 2011 at the cost of GH¢168,700 while CUC consumed 5,550 reams of A4 paper at the cost of GH¢38,850. There is also the possibility of faculty members as well as students procuring A4 paper from external sources. Table 5.5 illustrates the annual cost of A4 paper in both institutions of study.

Table 5.5 Annual cost of A4 paper consumption

Central Procurement of A4 Paper	2010		2011		Annual Average	
	Quantity in reams	Cost (GH¢)	Quantity in reams	Cost (GH¢)	Quantity in reams	Cost in (GH¢)
	(i)		(ii)		(i)	
UG	20,250	139,928	20,000	168,700	20,125	154,314
CUC	2,995	20,366	5,550	38,850	4,273	29,608

Source: Fieldwork, 2013

From Table 5.5, it can be deduced that the average annual quantity of A4 paper procured in UG is 20,125 reams while CUC recorded 4,273 reams. The cost of paper increases as the years go by. This therefore means that, the level of consumption for A4 paper is

directly affected by the number of faculties and schools of the institution. As discussed earlier in Chapter Three, UG had more faculties and schools than CUC; hence there are more employees and students in UG than CUC. This has contributed to the higher consumption of paper in UG. The weight of a ream of A4 paper was recorded as 2.8kg in both institutions of study. In short, annual A4 paper consumption in UG is 56 tons and 12 tons in CUC (see appendix 4)

Similarly, as discussed in Chapter Three, UG with a student population of 38,562, uses more examination booklets than CUC with a student population of 8,400. Each examination booklet weighed 0.054 kg in UG and 0.083 kg in CUC. This is because the examination booklet used in CUC is thicker than that used in UG. Therefore, the annual quantity of examination papers used in UG is 25 tons which is the total population of student multiplied by the weight of the booklet, while CUC uses 8 tons which is also the total population of students multiplied by the weight of the booklet (see appendix 5).

There are also other sources of generating paper waste in the two institutions of study and these include centers providing secretarial services, students' project works, students' assignments and traders. These are considered as miscellaneous sources and it was assumed that the paper waste generated by the miscellaneous sources equals to 10% of what is generated by the central procurement in both institution. If the paper waste generated from all the aforementioned sources is well managed and devoid of contamination, it can be sold to paper recycling companies for value addition. In an interview with the Managing Director of Super Paper Company Limited (SPCL), a company which recycles waste paper into toilet rolls, buys its raw materials at GH¢ 60

(\$30) per ton. Table 5.6 presents the most dominant sources of paper waste in the two institutions of study and their estimated economic value.

Table 5.6 Sources of paper waste

Source of paper	Annual estimate of paper waste in tons		Annual estimated economic value (GH¢)	
	UG	CUC	UG	CUC
Annual procurement	56	12	3,360	720
Annual examination papers	25	8	1,500	480
*Miscellaneous Sources	6	1	360	60
Total	87	21	5,220	1260

Source: Fieldwork, 2013

Table 5.6 shows that, if paper waste is well managed, the institutions of study can benefit from the sale of waste paper. Thus, UG can gain GH¢5,220 (\$2,610 at the exchange rate of GH¢2) while CUC can gain GH¢1,260 (\$630 with the exchange rate of GH¢2) from the sale of waste paper. UG and CUC stand to gain GH¢1,500 and GH¢480 respectively from the sale of used examination papers as indicated in Table 5.6.

5.4: Cost of Managing Institutional Solid Waste

The benefits of recycling could be understood as savings in landfill disposal costs. Landfill disposal cost is made up of the financial costs of the landfill and the externalities (environmental costs) as well as the costs of collection and transportation. Table 5.7 shows annual cost incurred in the collection and disposal of waste. This was revealed by the researcher's interaction with the officers' in-charge of waste management in the two institutions under study.

Table 5.7 Total annual cost estimates

Cost of waste collection and disposal services	UG (GH¢)	CUC (GH¢)
Annual Landfill disposal fee	8,640	-----
Annual cost of waste collection and cleaning services outsourced	168,000	142,776
Annual salaries	16,800	-----
Total	193,440	142,776

Source: fieldwork, 2013

It can be deduced from Table 5.7 that, in UG, GH¢8,640 (daily landfill gate fees of GH¢12.13 multiplied by 356 days in a year) is incurred as annual landfill disposal fees, GH¢168,000 is paid to Zoomlion Ghana Limited as outsourced waste collection charges and GH¢16,800 is paid as salaries to four waste collection officers at the waste management department. On the other hand, in CUC, disposal costs as well as salaries are absorbed as part of service fee charged by the contracted waste management companies and that is why no figures were indicated in Table 5.7. Efforts to divert selected waste from landfill through separation of waste over a calendar year will result in reducing annual disposal cost as well as cost of waste collection in both institutions of study.

The financial benefits of recycling include costs we do not have to incur in disposing of recyclable materials in a landfill. When we recycle, tons of materials are diverted from landfills and no longer need collecting, transporting and landfilling. There are savings at each step of the way and these savings are the direct financial benefits to recycling. These are often described as “avoided costs”.

Indeed, the cost indicated in Table 5.7 does not include the cost of machinery, maintenance, insurance, licenses and most importantly environmental externalities that the current practices evoke. The negative externalities associated with landfill disposal methods include environmental effects to the surrounding area. The environmental effects arise from the greenhouse gasses (such as methane) emitted from landfills when waste decomposes, the potential groundwater pollution through toxic seepage, and air pollution from the transportation of waste as well as decreased property values in the areas surrounding landfills and increased traffic (Mbuligwe, 2002).

For paper recycling to be successful in the institutions under study, there is the need to educate students, senior and junior staff on the need to avoid contamination of waste paper for recycling. Needed infrastructure (e.g. waste store house), equipment and materials should be made available by management to make source separation of waste possible. There should also be conscious efforts to involve the informal sectors in order to prevent scavenging and contamination. Additionally, there should be easy market for the recyclable waste paper. Furthermore, recyclables should continuously be made available for prompt pick-ups. These requirements when met would make paper recycling practices successful.

4.5 Conclusion

Value could be added to institutional waste resources especially paper waste if source separation of waste is carefully practiced to generate revenue while saving the environment from pollution. If proper waste management practices are not taken into consideration, collection and disposal costs will increase and subsequently increase the institutions' financial budgets. If necessary actions are taken to recycle, revenue would be

generated from sale of recyclables and at the same time, cost savings can be made by diverting waste from going to the landfills. The study therefore reveals that UG spends GH¢193,440 to throw away GH¢29,298 value of recyclable waste paper annually while CUC spends GH¢142,776 to throw away GH¢1,632 yearly. UG and CUC however gain GH¢1,500 and GH¢480 respectively from the sale of waste examination papers. The next chapter discusses students' knowledge, attitude and practices of solid waste management.

CHAPTER SIX

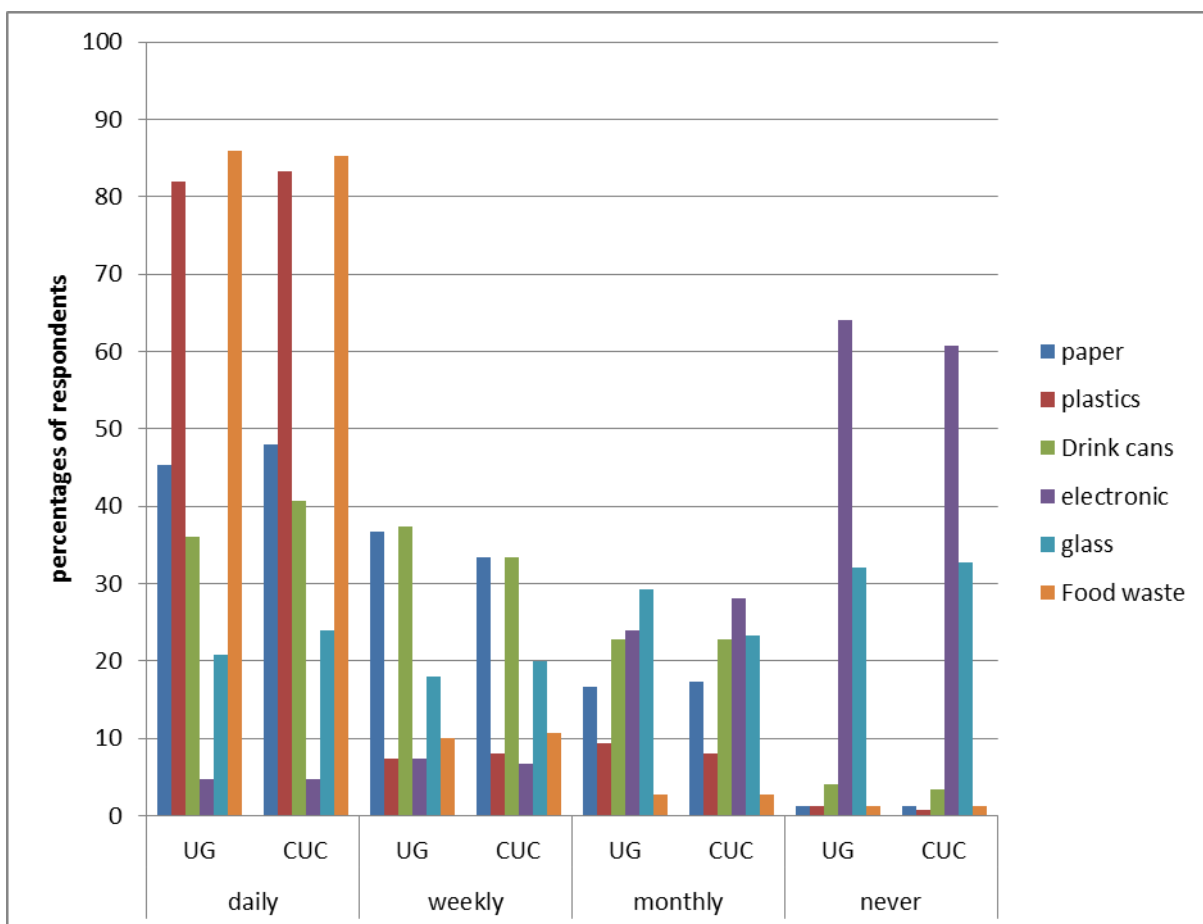
EXPLORING STUDENTS' KNOWLEDGE, ATTITUDES AND PRACTICES OF SOLID WASTE MANAGEMENT

6.1 Introduction

This chapter discusses students' knowledge, attitudes and practices of solid waste management as well as challenges to waste management issues in universities. There are limited studies that have captured waste management problems in Ghanaian educational institutions, particularly the opinion of students. Individual awareness and attitudes towards waste generation and management is critical in the effort to respond to the waste management challenge. This follows the 1992 Conference on Environment and Development where all nations recognized unhealthy disposal of solid waste as a barrier to environmental sustainability (UNCED, 1992).

6.2 Assessing Respondents' Attitudes

In relation to respondents' attitude towards the current institutional solid waste management arrangement, the waste type generated and the method of waste storage are illustrated in Figure 6.1 and shown in Table 6.2 respectively.

Figure 6.1 Waste type and the frequency of disposal

Source: Fieldwork, 2013

The influence of human activities on categories of waste put in bins was confirmed after the analysis of the questionnaires. It can be deduced from Figure 6.1 that, food waste was the key material that was disposed of daily by students in both institutions of study. At UG the sample recorded 86% of total respondent who discarded food waste daily, 10% discarded food waste weekly, 3% discarded food waste monthly and 1% never discarded food waste while at CUC, 85% of respondents discarded food waste daily, 11% discarded food waste weekly, 3% discarded food waste monthly and 1% never discarded food waste. Plastic waste was also found to be the second largest waste type disposed of by students on a daily basis. Thus, at UG 82% of the total respondents threw away plastic waste daily, 7% discarded plastics weekly, 9% discarded plastics monthly and 1% never threw away

plastics while at CUC 83% of total respondents discarded plastics daily, 8% discarded plastics weekly, 8% discarded plastics monthly and 1% never discarded plastic waste. Paper was the third largest material discarded by students daily. At UG, 45% of total respondents discarded paper daily, 37% discarded paper weekly, 17% discarded paper monthly and 1% never discarded paper while at CUC, 48% of total respondents discarded paper daily, 33% discarded paper weekly, 17% discarded paper monthly and 1% never discarded paper. Sixty four percent (64%) and 60.7% of respondents in UG and CUC respectively never discarded electronic waste. It can therefore be deduced that there is potential for waste materials generated by students to serve as input for composting and plastic/paper waste recycling if these wastes are properly management to prevent contamination.

Respondents were asked to indicate the waste storage methods adopted in their various institutions and their responses are presented in Table 6.1.

Table 6.1 Waste storage methods

Method of waste storage	UG (%)	CUC (%)
Closed container	29.0	40.0
Open container	27.0	24.0
Polythene bag	44.0	36.0
Total	100.0	100.0

Source: Fieldwork, 2013

While majority of respondents (44%) in UG stored all kinds of waste in used polythene bags before putting them in bins provided by the institutions, closed containers were used by majority of respondents (40%) in CUC. A significant number of respondents (36%) in CUC also stored all kinds of waste in used polythene bags before putting them in bins

provided by the institution. This therefore indicates that reuse of plastics is being practiced by students, however, plastic waste was the second largest waste generated by students (see Figure 6.1) in both institutions.

Respondents were asked to indicate how waste was disposed of on their respective campuses. Their responses are illustrated in Table 6.2

Table 6.2 Waste disposal methods

Method of disposal	UG (%)	CUC (%)
Burning	1	2
Bins	82	98
Dumpsite	17	0
Total	100	100

Source: Fieldwork, 2013

Table 6.2 shows that waste bins provided by the institutions are the most common methods in use for disposing of waste in the two institutions under study. A total of 82% of respondents in UG disposed of waste using bins while in CUC 98% of respondents adopted waste bins as method for disposing of waste. The study therefore revealed that at UG, bins were limited and were not easily accessed by students while at CUC, management had put more bins at vantage places where students could easily have access to. This result indicated that recycling was not being practiced as clearly evidenced in Table 6.2. Respondents were further asked to give reasons for the disposal method adopted. Their responses are summarized in Table 6.3

Table 6.3 Reasons for the choice of disposal practice

Reason	Number of respondents		Percentage (%)	
	UG	CUC	UG	CUC
Distance	64	80	43	53
Convenience	15	48	10	32
Availability	26	10	17	7
Peer pressure	30	7	20	5
Religious reason	3	5	2	3
Presence of waste workers	12	0	8	0
Total	150	150	100	100

Source: Fieldwork, 2013

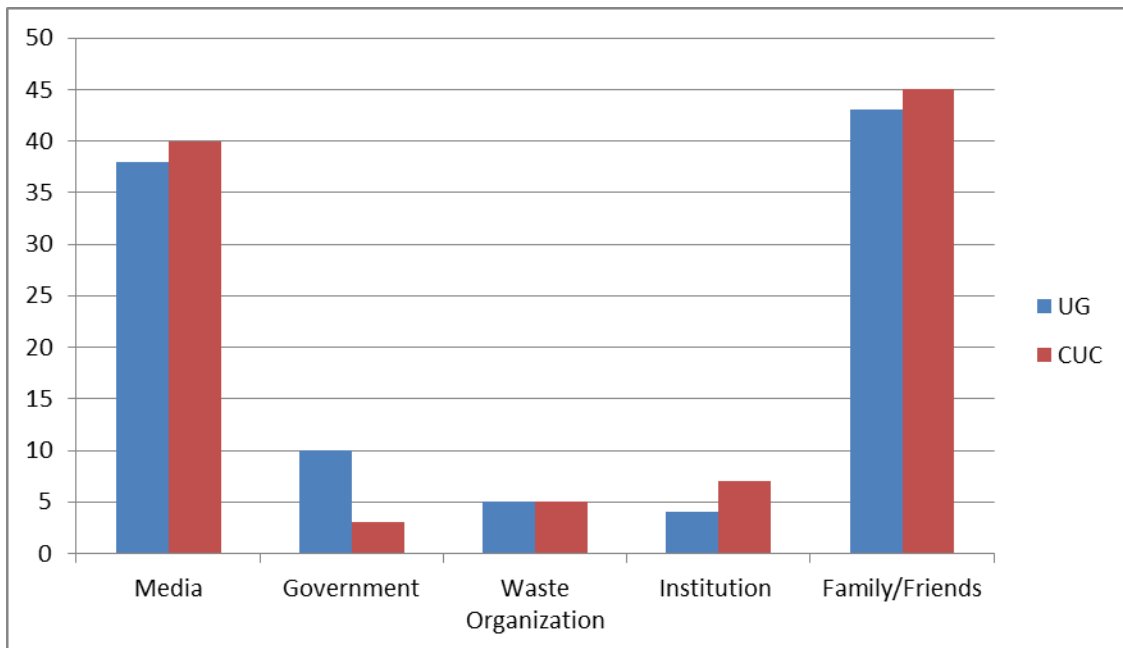
Convenience, availability of waste disposal containers, distance and peer pressure were the dominant reasons given by respondents in both institutions under study as factors which influenced their choice of waste disposal practices. Accessibility to waste disposal containers was a very important consideration by the respondents. Sixty four percent (64%) of respondents in UG said street bins were not easily accessible as a result of long distances between bins as well as where they were placed while 80% of respondents in CUC said bins were easily accessible since street bins were sited 50 meters apart and were available almost everywhere. The respondents were of the view that, they were responding accordingly to the waste management arrangement put in place by the institutions. Thus, they used the available waste disposal methods adopted by the institutions. Furthermore, peer pressure was also identified as a factor that contributed to the waste disposal methods adopted by respondents. The study revealed that, respondents imitated the waste disposal

practices adopted by their colleagues and they see it as a norm once their actions are not questioned by authorities of the institutions.

In UG 54% of respondents were dissatisfied with the way wastes are handled by their institutions' management especially with the siting of central waste containers/bins as well as open dumping of waste. Most of the containers were sited close to students' hostels. Respondents raised concern about odour emanating from the containers. Litter from the containers or bins were blown over the place causing littering of the environment and creating unsightly environment. Furthermore insects as well as vultures were seen hovering around the place where the containers were posing threat to health. This suggests that indiscriminate littering, open dumping and irregular collection of waste were the common waste problems found in UG. However in CUC, 98% of respondents were satisfied with the way waste is handled by authorities of the institution. Waste containers were not placed near hostel facilities and there were no sights of open dumpsites. Respondents however raised concern about inadequate bins and request for more bins to be provided in their various classrooms where littering occurred.

6.4 Interrogating Respondents' Knowledge and Practices of Waste Disposal Practices

The study also sought respondents' knowledge or awareness level on SWM. Thus, respondents were asked how frequently information on waste management was received and the source of such information? Their responses are shown in Figure 6.2.

Figure 6.2 Source and frequency at which information on SWM is received

Source: Fieldwork, 2013

From Figure 6.2, it can be deduced that respondents in both institutions of study have similar levels of awareness with regard to waste disposal practices from different sources. At UG, 43% of total respondents received information about how to properly dispose of waste from family and friends and 38% of the respondents received information from the media. Similarly, at CUC 45% of respondents received information from family and friends and 40% of the respondents received information from the media. This therefore shows that the authorities in both institutions of study have done little to educate the people within their community on waste disposal practices. Such information serves as knowledge that is needed to change behavior such as indiscriminate dumping of rubbish (Abrahamse *et al.*, 2005). In this regard, students as well as staff need education on how to dispose of their waste properly. This will go a long way to reduce littering. Education therefore plays a vital role in promoting environmentally responsible behaviour. Scholars in the field of environmental studies such as Quimbita and Pavel. (1996) and Salehi (2010)

believe that there is a relationship between environmental knowledge and significant environmental behaviour and this research has confirmed this.

Respondents were given the opportunity to select their preferred choice for handling waste put in their bins. A summary of the answers given is shown in Figure 6.3.

Table 6.4 Preferred Choice of SWM for Different Waste Types

Material	Reuse%		Recycle%		Landfill%		Don't k	
	UG	CUC	UG	CUC	UG	CUC	UG	CUC
Paper	16.0	16.0	6.7	8.0	71.3	70.0	5.3	5.3
Plastic	16.0	16.7	0.7	0.7	83.3	82.7	0.0	0.0
Drink cans	1.3	1.3	7.3	8.7	75.3	75.3	16.0	14.7
Electronic	8.0	9.3	9.3	8.7	48.7	49.3	34.0	32.7
Glass	23.3	25.3	6.0	7.3	53.3	52.0	17.3	15.3
Food waste	6.0	4.7	62.7	68	8.7	7.3	22.7	20.0

Source: Fieldwork, 2013

When asked about the preferred choice of handling plastic waste, 83.3% of respondents at UG preferred plastic waste to be recycled in their institutions and similarly in CUC, 82.7% of respondents preferred plastic waste to be recycled (Table 6.4). When asked how paper waste should be handled, 71.3% of respondents in UG preferred paper waste to be recycled and similarly in CUC, 70% of respondents preferred paper waste to be recycled. According to them, plastic and paper wastes are easily blown away and this results in littering the environment. When plastic and paper wastes are recycled, littering will be reduced. This is an indication that recycling is not a common method of waste management in institutions. Students will recycle plastic and paper when systems are put in place for recycling activities.

Respondents were further asked about their preferred choice of handling food waste. In UG, 62.7% of respondents preferred food waste to be landfilled and in CUC 68% of respondents also preferred food waste to be landfilled. This is because, they complained about the unpleasant stench emanating from decomposing food waste and as such food waste should be kept far from human residencies. Concerning how electronic waste could be handled, 34% of respondents in UG did not know the preferred method for electronic waste. Similarly, 32.7% of the respondents in CUC did not know the preferred method for electronic waste. This therefore calls for more public education on the best methods of managing food and electronic waste in both public and private institutions.

When asked what they would do if they had the opportunity to separate waste in their respective institutions, majority (94.6%) of respondents in UG agreed to separate their waste when the necessary logistics were provided by management. Similarly, majority (93.3%) of respondents in CUC also agreed to separate their waste when provided with the needed logistics. It is not surprising therefore that 84% of respondents in UG believe that separation of waste adds value to waste resources. Similarly, 88% of respondents in CUC are also of the view that separation of waste adds value to waste resources. Moreover, when respondents were asked if they would expect any economic gain from separating their waste in institutions, 44.6% of respondents in UG gave negative responses, 38% of respondents gave positive responses and the remaining 17.3% were undecided (see Figure 6.4). Similarly in CUC, 44% of respondents disagreed to receive any economic incentive from the school authorities, 38% of respondents however agreed to receive economic benefits for separating their waste and the remaining 18% were undecided (Table 6.5).

Table 6.5 Respondents' opinion on waste separation

Reason for waste separation	Agree %		Unsure %		Disagree %	
	UG	CUC	UG	CUC	UG	CUC
Separation of waste adds value to waste resources	84.0	88.0	10.0	10.7	6.0	0.06
Will separate waste when provided with needed logistics	94.6	93.4	5.3	6.0	0.2	0.7
Will separate waste when provided with economic incentives	38.0	38.0	17.3	18.0	44.6	44.0

Source: Fieldwork, 2013

This therefore reveals that majority of respondents in the study expressed willingness to participate in waste separation and waste management activities in their respective institutions. They however requested for logistics to be put in place for separation of waste to be done. This therefore shows that both the public and private institutions have failed to put the necessary systems in place for the practice of separation of waste.

6.5 Barriers to Managing Waste in Institutions

The study further ascertained the challenges being faced in the solid waste management practices and the possible solutions to such challenges in order to inform decision makers on the way forward so far as waste management was concerned. The administration of questionnaire as well as interviews with key respondents revealed three factors that contributed to indiscriminate/ poor disposal of solid waste in institutions. These factors are education/awareness, political commitment and level of law enforcement.

6.5.1 Education/Awareness

The study revealed that authorities and people in UG are aware of the problem of littering, indiscriminate disposal of solid waste within their institution and irregular collection of waste. It was observed and confirmed by cleaners from the waste department at various grounds in UG that, it took less than an hour for the swept grounds to be littered again, especially, during special occasions and ceremonies. However, according to the officer in charge of waste management in CUC, the major problem confronting waste management was littering which occurred in the classrooms.

Ghanaians have very poor attitude towards environmental sanitation in general and waste disposal in particular and this is shown by the ‘throw-it-where-you-like’ manner in which people discard waste, a situation which greatly contributes to waste accumulation in the cities (*Daily Graphic*, 2005). Furthermore, walk within the environs of UG and CUC will show the extent to which people litter the environment. This poor environmental attitude among the populace can largely be attributed to the lack of awareness of the impacts of their action on the environment. This is blamed on the lack of public education on waste disposal and general environmental sanitation which keep the majority of the populace ignorant about the harmful consequences of improper waste disposal.

The Environmental, Health Services Unit and the Estate Department Unit of UG and CUC respectively are seen as leaders in matters concerning waste management and sanitation issues. Even though the units’ primary goal is to keep the environment clean and healthy by the provision and delivery of effective and efficient waste collection services and programs, and environmentally acceptable disposal practices, they are unable to enforce the bye- laws and regulations that would assist them to achieve the set goal.

According to the WMD, there is no formalized program to educate people about sanitation in the University. The officer in charge of Environment, Health and Sanitation in UG however did not think the problem had so much to do with education as with law enforcement. He said:

We can launch an educational campaign, but I do not know if it is educational campaign that is needed, more than enforcing the bye laws, because every sane person knows that throwing garbage indiscriminately is not proper. But in this institution, you can see educated people throwing garbage all around. So I do not think it is an issue of educating people, but it is an issue of enforcing the bye-laws. Well, this is what we can start with, and then we go all out to monitor our solid waste contractors.

Concerning the education of the public with regards to proper disposal practices (something that a considerable number of respondents expected from their respective institutions), 70% and 65.3% of respondents in UG and CUC respectively indicated that they never received any information or education from the institution's authorities with regards to waste management (see Figure 6.2). Most of the respondents who participated in the survey were of the view that the public was not well-informed on the importance of proper waste disposal. However they receive the information through family and friends and through the media. Among the solutions that they proposed to the problem was public education on environmental sanitation which shows their conviction that ignorance is an important factor affecting waste disposal in both UG and CUC.

The lack of environmental awareness with regard to proper waste disposal practices from authorities of both institutions under study can, in turn, be attributed to management commitment to environmental issues and the waste problem in particular. Low

commitment results in the failure of institutions' authorities to sensitize the populace on good waste disposal methods and the need to live in harmony with the environment.

6.5.2 Management Commitment

Political neglect is believed to be the cause of waste problems in developing countries. Several studies point this out including Onibokun and Kumuyi (1999) who have noted the fact that most local governments do not accord high priority to waste management. The situation is not different in institutions. According to the officer in charge of waste management at UG, waste management and general environmental sanitation ranked very low on the priority lists of top management of the institution and this explains why the status of waste management (as discussed earlier in Chapter Four) was very poor in UG. According to the study, it is realized that little attention is paid to environmental sanitation in UG so very few resources are committed to waste management. The poor solid waste disposal situation that is confronting UG can therefore be attributed to weak management commitment in the provision of logistics or establishing any recycling opportunities though the institution has the population size to support such initiative. The management neglect of the solid waste problem according to the officer in charge of waste management is further shown by the meager resources allocated for waste management operations. Also, UG experiences limited technical capability such as inadequacy of tools, equipment, logistics, dustbins, trucks and the ability of the waste management unit to conduct research and to carry out their day to day activities. Out of the 3 trucks counted at the Department only one was observed and confirmed to be in good state and could be used for loading waste. All the rests were in the state of disrepair and needed replacement rather than maintenance. Tools and equipment were observed to be inadequate. The limited available bins were observed to be overflowing with garbage most of the time. Litter from these

overflowing bins was seen being carried away by the wind contributing to littering within the surrounding. Commitment through participation is also expected from all stakeholders in order to achieve effective waste management practices.

On the other hand, management in CUC has shown strong political commitment to solving the waste problem in the institution and this is reflected in adequate investment committed by establishing a sewage recycling plant, putting street bins at vantage points and recycling examination papers. These measures put in place by CUC have resulted in improved waste disposal and sanitation conditions in the institution. Unlike UG which started recycling only examination papers quite recently (2011), CUC is a step ahead in commitment through the development of paper and sewage recycling schemes since 1991 and the adequate allocation of resources needed for effective waste management practices. However, as discussed in Chapter Four, CUC waste stream is still filled with valuable waste resources and needs to be exploited by adopting source separation of waste.

The study however reveals that, top management commitment as well as participation from staff and students is strongly required to ensure a successful and efficient solid waste reduction and recycling geared towards sustainable development

6.5.3 Inadequacy of Legislation and Enforcement

An environmental sanitation policy was formulated in 1999 and revised in 2010 to guide waste management practices in Ghana. The revised version promotes reduction, reuse, recycling and recovery of all types of waste as a way of minimizing the volume of waste that ends up at landfills. UG and CUC however have not adopted the policy to assist them deal with waste management issues and they fail to enforce the regulations with regards to

indiscriminate disposal practices. Both institutions have put in place schemes to recycle their examination papers.

At UG, there are several mandates given to various units connected to the management of waste, a situation which greatly constrains the waste sector by not clearly defining roles as well as the lack of coordination among them. Ogawa (2002) has observed that legislation related to solid waste management in developing countries is usually fragmented and several acts (such as public health, local government and environmental protection acts) include clauses relating to solid waste management. Such rules and regulations are, therefore, to be enforced by different agencies with duplication of responsibilities and gaps in the regulatory provisions which constrain the development of effective solid waste management systems. However at CUC, the Estate Department supervises the waste management services carried out by the private waste companies working in the institution,

The study therefore shows that, there is also the inability of authorities of the institutions to enforce existing laws on environmental sanitation including waste disposal (Onibokun and Kumuyi, 1999). This situation is particularly severe in UG where there is a general lack of public compliance with waste disposal by-laws. Then lack of enforcement of waste disposal laws results in lack of fear of the law among the public and encourages negative waste handling practices such as littering and dumping of waste in drains and at roadsides. Such practices worsen the waste disposal situation. Thus, inadequate legislation and non-enforcement of waste disposal laws greatly constrain efforts to address the solid waste problem that currently confronts developing country cities.

6.6 Conclusion

The research aimed to understand the knowledge and practice of waste management of respondents in private and public universities. The findings indicate that most respondents understand waste management as a major environmental problem in their institutions. The findings also indicate that there are poor waste management practices by both students and institutional management especially in the public sector. The study has revealed the need for behavioural and attitudinal change which is essential for effective participation in waste reduction, reuse and recycling. The study therefore confirms the general perception that, the private institutions does better than the public institutions with regards to waste management. However, there are improvements in the public sector as they have started recycling initiatives.

CHAPTER SEVEN

SUMMARY, CONCLUSION AND RECOMMENDATION

7.1 Introduction

This study sought to investigate the solid waste management practices in two Ghanaian universities. This is in order to provide a foundation for recommending improved waste management strategies for adding value to institutional solid waste and diverting solid waste from ending up at the landfills. This chapter therefore gives a summary and conclusion of the study as well as the recommendations. Additionally, limitations and suggestion for future research are also indicated in this chapter.

7.2 Summary and Conclusion

The study analysed institutional solid waste management practices in UG and CUC. The study achieved its main objective by analyzing methods of waste storage, collection and disposal practices. It also analysed the composition of solid waste generated and how it was disposed of within academic and administrative units. It further assessed the attitudes, knowledge and opinions of students towards the current solid waste management practices in their respective institutions.

The study has shown that, significant quantities of solid waste are disposed of at the landfills by both study sites. An arrangement of bins at every 50 meter radius throughout CUC resulted in little littering while the inadequacy of bins as well as inappropriate location of available street bins and “non use” of street bins in UG resulted in indiscriminate dumping of waste.

In terms of solid waste composition, the study has revealed that recyclables such as paper wastes form major components of the waste generated and disposed of within academic and administrative units in both institutions under study. However, these paper wastes are contaminated by mixing it with other types of waste such as food waste. Contamination is a major hindrance to recycling.

It was realized from the study that 488.3 tons (488,300 kg) of annual solid waste was generated from administrative and academic areas in UG while in CUC, 27.2 tons (27,200 kg) of annual solid waste was generated from administrative and academic areas. Most of these wastes end up at the landfills/dump sites. It was also estimated that an annual cost of GH¢193,440 was incurred by UG for the management of waste while in CUC GH¢142,776 was spent for the management of waste. If separation of waste was practised by UG and CUC, annual savings of GH¢29,298 and GH¢1,632 could be made respectively. UG and CUC gained GH¢1,500 and GH¢480 respectively from the recycling of examination papers. Both institutions will therefore gain more if recycling is extended to other sources of paper waste by adopting source separation of waste. The other sources of paper waste generation included various faculties.

On respondents' attitudes, knowledge and opinion with regards to solid waste management, the study revealed three factors that contribute or influence effective solid waste management in academic institutions and these are education/awareness, political commitment and level of law enforcement.

The study has shown that majority of respondents are willing to separate their waste when the needed logistics are made available for such practice. Surprisingly, these respondents are not interested in any economic gain from the practice of waste separation. However, both institutions have failed to put systems in place for the practice of source separation of waste. UG and CUC practise recycling with focus on mainly examination papers. However, unlike UG, CUC is challenged with the problem of irregular collection of waste paper and lack of storage space.

The study has realized that, there is sufficient ground to organize source separation and recycling programs in both study sites. This was supported by students and officers as they expressed their willingness to partake in such an endeavor. The success of such programs has the potential to reduce the quantity of waste that is disposed of at landfills and promote value addition to waste resource for economic gain as well as protection of the environment against pollution

7.3 Recommendations

Following from the analyses and discussions that have been carried out in the study, this section seeks to provide a number of recommendations for policy consideration in waste management.

In order to practice source separation of waste, support from top management is needed. Support/commitment can be won from top management by emphasizing on the potential cost savings that can be attained from waste separation. Leading by example is one way sustainable techniques can be implemented and so to ensure success of separation of waste schemes, a pilot scheme should be set up in one or two departments. To start with,

appropriate containers should be purchased and distributed to appropriate locations for the segregation of waste. To avoid mix up, four different bins should be put at the same location for segregation of waste to be effectively carried out. Cost savings resulting from diverting waste from landfill could be communicated amongst other departments to strengthen their motivation and to help extend the scheme. Communication will be needed between staff and management, between office staff, students and cleaning staff. Thus everyone needs to cooperate especially with sorting out waste types such as office paper. Types and sources of waste produced should be reviewed and monitored by collecting information on quantities involved. This can be achieved by conducting yearly waste audits to come out with waste data and priority areas where biggest savings can be made. Recyclable materials should be collected regularly and environmental awareness raised on the need to separate waste.

In order to reduce the quantities of waste generated, waste reduction initiatives are recommended. There should be a reduction in the use of paper by printing and photocopying on both sides. Provision of quick and easy access to information electronically to reduce paper requirements should be encouraged in order to reduce the printing of messages.

Waste reuse initiatives are equally necessary and this can be done by reusing scrap paper for printing draft copies, internal notices and for making notes. Cardboard boxes and plastic bags can also be reused internally to store materials. This will help to reduce the quantity of plastics found in the waste stream.

Recycling extends the time over which consumables and products which are no longer serviceable are used. It is therefore recommended the separation of solid waste into various components (ie paper, plastic, organic and hazardous) in institutions that have no such scheme and intensify recycling activities in institutions that have existing recycling practice to ensure that office paper, plastics and food waste, which cannot be reused, are recycled. Partnerships with waste recycling contractors, to take recyclables for recycling materials that are needed by the institutions, are highly recommended.

Where reducing, reusing and recycling are not possible, waste streams such as hazardous waste should be properly managed and residual waste could be properly landfilled (as indicated in Figure 2.2).

The study recommends to stakeholders of institutions to embark on education of students and staff on waste disposal practices. They must be educated to change the attitude of indiscriminate dumping of waste. Education will also help to redirect the minds and attitudes of people towards a new level of appreciating that waste can be a resource if separated from other waste. People should also be informed to practice waste prevention, waste reduction and recycling.

7.4 Conclusion

The findings and recommendations provided in this research constitute information that could go into a road map for the adoption of appropriate waste management methods that will add value to waste resources and also reduce waste disposal cost. Source separation is an instrumental step in providing more efficient MSWM. With majority of respondents in both institutions of study willing to participate in source separation for paper and plastic

recycling (with no economic incentives), this is an opportune time to begin a source separation project in academic institutions where none exists. Such a project would therefore require community sensitization on proper source separation, including public education, print advertisements, provision of an adequate number of recycling bins at vantage points so that plastics, organics, paper and laboratory waste can be separated. With careful planning, determination and capable partners, both institutions can begin to carry out source separation projects in their communities. If source separation of waste in institutions is executed successfully, it can be adopted or extended to other institutions and organizations.

7.5 Limitations and Suggestion for Future Research

The research was focused on institutional solid waste. The limitation of this research is that the results cannot be generalized for first and second cycle schools in the country. However, it provides insights on what private and public university students know and feel about waste management and practices. This knowledge will be valuable for curriculum development and education programs. In the future, an extended study could be conducted to cover more institutions and include first and second cycle schools. Due to case study approach, findings may not give a general picture of how institutional waste is managed in other institutions.

With the audit baseline information provided by this study focused on academic and administrative units, future work could look at the total domestic, clinical and commercial waste generation at the institutions. Green purchasing practices and resource use which will cover energy, water and labour are also suggested for future research.

REFERENCES

- Accra Metropolitan Assembly (2010). Accra, the Millennium City: A New Accra for a Better Ghana. Urban Planning Department Lecture, Spring 2010. Columbia University, New York, NY
- Agbola, T. (1993). Environmental education in Nigerian schools. In Filho W.L. (ed) Environmental Education in the Commonwealth, the Commonwealth of learning, Vancouver.
- Agyepong, J. S. (2011). Barriers in Private Sector Participation in Sustainable Waste Management Experiences of Private Operators and Waste Service Providers in Ghana. Zoomlion Ghana Limited Presentation at the UN on Building Partnership for Moving Towards Zero Waste.
- Akuoko-Asibey, A., & McPherson, H. (1994). Assessing Hygiene and Health Related Improvements of a Rural Water Supply and Sanitation Programme in Northern Ghana. *Natural Resources Forum*. 18(1), 49-54
- Anku, S. E. K. (2000). Solid Waste Management in Ghana. Paper presented at a training workshop on Environmental Management for selected District Assemblies in Ghana (12th-23rd June, 2000)
- Annorbah-Sarpei, A. J. (1998). Urban Market Gardens, Accra, Ghana. The Mega-Cities Project MCP-018C, 26
- Armah, N. A. (1993). Waste Management, in The Future of Our Cities. Proceedings of the Ghana Academy of Arts and Sciences. Volume 28, 78-83. Accra.
- Attahi, K. (1999). 'Abidjan, Côte d'Ivoire'. In: Onibokun, A.G. (ed.) Managing the Monster: Urban Waste and Governance in Africa. International Development Research Centre, Ottawa.
- Boigner, J., Ahmed, M., Diaz, C., Faaij, A., Gao, Q., Hashimoto, S., Mareckova, K., Pipatti, R., & Zhang, T. (2007). Waste Management in Climate Change Mitigation. In Metz, B., Davidson, O. R., Bosch, P. R., Dave, R. and Meyer L. A.(Eds), *Climate Change Mitigation: Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge, United Kingdom and New York
- Campbell, M. (2009). Factors for the presence of avian scavengers in Accra and Kumasi, Ghana. *Area*, 41, 341-349

- CHF International (2010). *Accra Poverty Map: A Guide to Urban Poverty Reduction in Accra*. CHF International, Accra, Ghana.
- Cointreau-Levine, S. (2000). *Occupational and Environmental Health Issues of Solid waste Management: Special emphasis on middle and low-income countries*. World Bank, Washington, DC
- Cole, V., & Sinclair, A. J. (2002). Measuring the Ecological Footprint of a Himalayan Tourist Center. *Mountain Research and Development* 22 (2), 132–141.
- Crusading Guide. (2007). *Ministry of Defence Fails to Pay Compensation for Apremdo Land*. Accra.
- Da Zhu. P., Asnani. H, Zurbrugg. C., Anapolsky.S & Mani.S (2008). *Improving Municipal Solid Waste Management in India, A Source Book for Policy Makers and Practitioners*. World Bank, Washington D.C
- Daily Graphic, (2005). *Daily Graphic*, 3rd November, 2005, Accra, Ghana, pp 14.
- Danso, G., Drechsel, P., Failor, S., & Giordan, M. (2006). Estimating the Demand for Municipal Waste Compost via Farmers' Willingness to Pay in Ghana. *Waste Management*. 26,1400-1409.
- Daskalopoulos, E., Badr, O., & Probert, S. D. (1998). An integrated approach to municipal solid waste management. *Resources, Conservation and Recycling*, 24, 33-50.
- Davies, A. R. (2008). *The Geographies of Garbage Governance: Interventions, Interactions and Outcomes*. Burlington, VT: Ashgate
- Drescher, S., & Zurbrügg, C. (2006). Decentralised composting: lessons learned and future potentials for meeting the Millennium Development Goals. In: *Solid Waste, Health and the Millennium Development Goals*. CWG –WASH Workshop 2006, 1 – 5 February in Kolkata, India
- Earth Institute (2010). *Millennium Cities Initiative Report: Findings of Waste Composition Study for Ayidiki Electoral Area, Accra, Ghana*. New York, and University of Ghana, Legon.
- Environmental Protection Agency (2002). *Ghana's State of the Environment Report* EPA, MES, MLGRD, *Ghana Landfill Guidelines: Best Practice Environmental Guidelines*. Accra, Ghana
- El Fadel, M., Findikakis, A. N., & Leckie, J. O. (1996). Numerical modelling of generation and transport of gas and heat in sanitary landfills: I. Model formulation, *Waste Management & Research, ISWA*, 14, 483-504.

- Fobil, J. N., Armah, A. N., Horgan, J. N., & Carbo, D. (2008). The Influence of Institutions and Organizations on Urban Waste Collection System: Analysis of Waste Collections in Accra, Ghana (1985-2000). *Journal of Environmental Management*, 86, 1, 262-271
- Fobil, J.N., Carboo, D., & Armah, N.A. (2005). Evaluation of Municipal Solid Wastes (MSW) for utilisation in energy production in developing countries. *Int. J. Environ. Technol. Manage.*, 5: 76-86.
- Freebody, P. (2003). *Qualitative Research in Education: Interaction and Practice*. London: Sage Press
- Furedy, C. (1992). Garbage: Exploring non-conventional options in Asian Cities. *Environment and Urbanisation* Vol. 4, No 2, 42-61.
- Gbogbo, F., & Awotwe-Pratt, V. P. (2008) .Waste management and Hooded Vultures on the Legon Campus of the University of Ghana in Accra, Ghana, West Africa, *Vulture News*, 58, 16–22
- Ghana Meteorological Agency (2010) Synoptic weather stations data. Unpublished, Accra
- Ghanaian Times. (February 1, 2007). Landfill Project under Threat. Accra.
- Gilpin, A. (1996). *Dictionary of Environment and Development*. John Wiley and Sons, Chester and New York.
- Girling, R. (2005). *Rubbish! Dirt on Our Hands and Crisis Ahead*. Eden Project Books. London, Transworld Publishers Ltd.
- Government of Ghana (2002). Guidelines for Management of Healthcare and Veterinary Waste in Ghana. *Environmental Protection Agency, No. 2*
- Government of Ghana, Ministry of Local Government and Rural Development (2003): Second Urban Environmental Sanitation Project (UESP II). Environmental and Social Assessment volume 1, 48 –110
- Hansen, J. E., & Sato, M. (2001). Trends of measured climate forcing agents. *Proc. Natl. Acad. Sci.*, 98, 14778-14783
- Hardoy, J. E., Mitlin, D., & Satterthwait, D. (2001). *Environmental Problems in an Urbanizing World*. Earthscan Publications Ltd. London.
- Jessen, M. (2002). The Ripple Effect of Zero Waste. Recycling Council of British Columbia (RCBC)

- Johannessen, L. M., & Boyer, G. (1999). Observations of Solid Waste Landfills in Developing Countries: Africa, Asia, and Latin America. Report by Urban Development Division, Waste Management Anchor Team. World Bank, Washington, D.C
- Jones, G., & Hollier, G. (1997). *Resources, Society and Environmental Management*. Paul Chapman, London
- Kinnaman, T. C. (2006). "Policy Watch: Examining the Justification for Residential Recycling." *Journal of Economic Perspectives*, 20(4), 219-232.
- Kobus D. (2003). *Practical Guidebook on Strategic Planning in Municipal Waste Management*. Bertelsmann Stiftung.
- Kocasoy, G. (2001). Solid Waste Management in Developing countries: Proposed Amendments in the existing Situation – Proceedings Sardinia 2001, Eighth International Waste Management and Landfill Symposium, Cagriali, Italy; 1 - 5 October, 2001.
- Koufodimos, G., & Samaras. Z. (2002). Waste management options in southern Europe using field and experimental data, *Waste Management*, 22, 47-59.
- Kulkarni, S. (2008). *Solid Waste Management*. Environmental Engineering, Kolhapur.
- Lardinois I., & Furedy C. (1999). *Source Separation of Household Waste Materials: Analysis of Case Studies from Pakistan, The Philippines, India, Brazil, Argentina and the Netherlands*, Urban Waste Series 7, WASTE, The Netherlands.
- Lehmann, M., Christensen, P., Thrane, M., Herreborg, T.H., (2009). University engagement and regional sustainability initiatives: some Danish experiences. *Journal of Cleaner Production* 17, 1067-1074
- Linden, O., Gomez E. D., & Ngoilie, M. A. K. (1997). Common Constraints to Waste Management Programs on the East Asian Seas Region: Top Ten Constraints, GEF/UNDP/IMO Regional Programme 1997, National profiles for Brunei, Darussalam, Cambodia, China, Indonesia, Japan, Malaysia, Philippines, Singapore, Thailand and Vietnam.
- Ludwig, T. D., Gray, T. W., & Rowell, A. (1998). Increasing recycling in academic buildings: A systematic replication.. *Journal of Applied Behavior Analysis*, 31,683-686
- Mbuligwe, S. E. (2002). Institutional solid waste management practices in developing countries: a case study of three academic institutions in Tanzania. *Resources, Conservation and Recycling*, 35(3), 131-146.

- Medina, M. (2002). *Globalization, Development, and Municipal Solid Waste Management in Third World Cities* : El Colegio de la Frontera Norte, Tijuana, Mexico.
- Menel, J. (1994). A Comparative Review of Solid Waste Workers and Construction Workers, Unpublished information of the Waste Management Department, Accra, Ghana
- Mesharch, W., Katusiimeh, K. B., & Arthur P. J. M. (2013). Informal waste collection and its co-existence with the formal waste sector: The case of Kampala, Uganda. *Habitat International*, 38,1-9
- Millennium Ecosystem Assessment. (2005). Living Beyond Our Means: Natural Assets and Human. Millennium Ecosystem Assessment. Available at: <http://www.millenniumassessment.org/en/Reports.aspx>. Accessed on 02/11/12
- Miller, G. T. (2000). *Living in the Environment: Principles, Connections and Solutions (11th ed.)*. Brooks/Cole, Thomas Learning. Belmont, California, USA.
- Ofori-Budua, G. K., Horgarh, J. N., Fobil, J. N., Quaye, A., Danso, S. K. A., & Carbo, D. (2010). Harmonizing procedures for the evaluation of compost maturity in two compost types in Ghana, *Resources, Conservation and Recycling*, 54: 205-209.
- Ogawa, H. (1997). Sustainable Solid Waste Management in Developing Countries. WHO Western Pacific Regional Environmental Health Centre (EHC). Kuala Lumpur, Malasia.
- Onibokun A. G., & Kumuyi, A. J. (1999). In: Governance and Waste Management in Africa. Managing the Monster. Onibokun AG, editor. Ottawa: IDRC
- Oteng-Ababio, M. (2010). Solid Waste Management in Ghana -Beneficiaries Willingness to Pay for Improved Services, *Ghana Geographical Journal*. Vol. 2; 87-112
- Oteng-Ababio, M, (2010). Private sector involvement in solid waste management in Ghana: the case of the Greater Accra Metropolitan Area (GAMA). *Waste Management and Research*, 28(4):322-329
- Oteng-Ababio, M (2014). Rethinking waste as a resource: insights from a low-income community in Accra, Ghana. *City, Territory and Architecture* 1 (10), 1-14.
- Palmer, P. (1998). Definitions of Waste. Available at: <http://www.interleaves.org/recycling/wastedef.html>. Accessed on 20/10/12
- Quimbata, H. G., & Pavel, M.(1996). Assessing On Environmental Attitude Development Model: Factor Influencing the Environmental Attitude of College Student. Paper

- presented at the Annual Meeting of the American Educational Research Association (New York, April 8-12, 1996)
- Republic of Ghana (1996). National Building Regulations (LI 1630). Accra: Ghana Publishing Corporation.
- Salehi, S. (2010). *People and the Environment: A Study of Environmental attitudes and Behavior in Iran*. Lambert Academic Publishing, Saarbrücken, Germany
- Sally B. (2004). Solid Waste Management in Accra, Ghana: The Case Of The Teshie Nungua Composting Plant. MSc Thesis, Kwame Nkrumah University of Science and Technology
- Schübeler, P., Karl, W., & Jürg, C. (1996). Conceptual Framework for Municipal Solid Waste Management in Low-income Countries. United Nations Development Program, UMP Working Paper Series no. 9. St. Gallen, Switzerland
- Snow, W., & Dickinson, J. (2001). The end of waste: Zero waste by 2020. Available at <http://www.zerowaste.co.nz/assets/Reports/TheEndofWaste.pdf>. Accessed on 3/10/2013
- Songsore, J. (2004). *Urbanisation and Health in Africa: Exploring the Interconnections Between Poverty, Inequality and the Burden of Disease*. Accra, Ghana Universities Press
- Songsore, J., & McGranahan, G. (1996). Women and Household Environmental Care in the Greater Accra Metropolitan Area (GAMA), Ghana. *Urban Environmental Series Report no. 2. 17-21*. Stockholm.
- Tchobanaglou, G., Theisen, H., & Vigil, S.A. (1993). *Integrated Waste Management: Engineering Principles and Management Issues*. McGraw Hill Publications, New York, USA.
- The Finder. (March 20, 2013). Students eat faeces at Legon daily - Vice-Chancellor. Accra.
- UNESA (2002): Sustainable Development and Solid Waste. Available at http://www.un.org/esa/sustdev/sdissues/waste_solid/wastes.htm. Accessed 20/10/12
- UN-Habitat. (2010). *The State of African Cities 2010: Governance, Inequality and Urban Land Markets* . Nairobi: UN-Habitat.
- United Nations Conference on Environment and Development (UNCED) (1992): Convention on Climate Change, Convention on Biological Diversity, Agenda 21, Rio Declaration, Forestry Agreement, Ocean Conference

- University of Ghana (2012), Basis Statistics 2012. Planning and Management Information Directorate, Legon.
- Velázquez, L., Munguia, N., Platt, A., & Taddei, J. (2006). "Sustainable university: What can be the matter?" *Journal of Cleaner Production.*, 14, 810-819
- Washington State University (2005). Recycling. Available at <http://www.wsu.edu/recycle/>. Accessed on 14/07/13
- Water Resources Commission Act,(Act 522, 1996). Accra, Ghana.
- Waste Watch. (2003). *Rethink Rubbish Western Riverside Doorstepping Campaign: Final Report*. Waste Watch, London, UK
- World Commission on Environment and Development (1987).*Our Common Future*. Oxford, Oxford University Press
- White, P. R, Frank, M., & Hindle, P. (1995). *Integrated Solid Waste Management: A life cycle inventory*. Blackie Academic and Professional, London.
- Williams, P. T. (2005). Waste disposal and treatment. John Wiley, Chichester.
- World Bank. (1999). The World Bank Technical Guidance Report; Municipal Solid Waste Incineration . Washington, D.C
- World Bank. (2012). What a Waste. A Global Review of Solid Waste Management. Urban Development Series . knowledge paper no. 15. Washington D.C.
- World Bank. (2005). Urban Development Working Papers East Asia Infrastructure Development. World Bank, Working Paper No. 9
- Zahur, M. (2007). Solid Waste Management of Dhaka City: Public Private Community Partnership. *BRAC University Journal, Vol. 4 (2), 93-97*
- Zerbock, O. (2003). Urban Solid Waste Management: Urban Solid Waste Management: Waste reduction in developing nations (written for the requirements of CE 5993 Field Engineering in the Developing World). Michigan Technological University, Houghton, MI.
- Zilahy, G., & Huisingh, D. (2009). The roles of academia in Regional Sustainability Initiatives . *Journal of Cleaner Production* ,17,1057-1066.
- Zimmermann, E. (1951). World Resources and Industries. New York: Harper & Brothers
- Zurbrugg, C. (2003). Urban solid waste management in low-income countries of Asia: How to cope with the garbage crisis. Presented at the meeting of Scientific Committee on Problems of the Environment (SCOPE) on Urban Solid Waste Management Review Session, Durban, South Africa.

APPENDICES**APPENDIX 1****QUESTIONNAIRES****INSTITUTE OF ENVIRONMENT AND SANITATION STUDIES****QUESTIONNAIRE SURVEY**

This questionnaire is solely designed for academic research purposes as part of the requirement for the fulfillment of the award of master of philosophy degree. The questionnaire survey aims to explore ways of managing institutional waste more effectively. The information provided will be treated as confidential and used only for the purpose of the research.

PART A: Background of respondents

1. Name of your institution.....

2. level

3. To which age group do you belong?

Under 21 21-30 -40 40-50 50-60 60

4. Gender

Male Female

5. What is your employment status? (If applicable)

Full time Part- time Other.....

PART B: Current waste management practices and characterization of waste

6. How do you store your waste before disposal?

In a closed container

In an open container

In a polythene bag or sack

Other Please indicate.....

7. Why do you store your waste by the above method?

.....
.....
.....

8. Please indicate how you dispose of your waste on campus

Burning

In the bush/ roadside/ drain specify:.....

Waste bins

Other method specify:.....

9. Why do you dispose of your waste by the above method?

.....
.....

10. Do you know of any environmental problems associated with your method of waste disposal?

Yes what is/are they?

.....
.....
...

No

11. Do you have any concerns about the sitting and maintenance of the waste bins/disposal containers in this institution?

Yes what is/are your concerns?

.....

No

12. Does the waste storage facility (containers) pose any nuisance to you?

Yes what nuisance(s) does it cause?

No

13. Please indicate in the following table how frequently you dispose of each of the types of waste.

		Weekly	Monthly	Never
Paper				
Plastic (water bottles, drink bottles, sachet, etc)				
Drink cans				
Electronic waste(multi sockets etc)[-p				
Glass (bottles, etc)				
Newspapers				
Magazines				
Food waste(sandwich, apple, banana, etc)				
Ink cartridge(for only administrative officers)				
Other (please specify)				

14. Do you separate your waste prior to disposal?

Yes why.....

No why.....

15. Do you know what happens to the waste you put in the bin?

Yes indicate.....

No

16. from the following list, please indicate in the appropriate column how frequently you receive information on how to manage your waste

SOURCE OF INFORMATION	Daily	Weekly	Monthly	Never
Television and radio				
Government sources				
Environmental/waste organizations				
Authority from the institution				
Friends and family				
Other (please specify)				

Barriers and possible solution to waste management and separation of waste

17. What do you think are the key barriers to/challenges in managing waste in your bin?

(Order by level of perceived importance) e.g., irregular collection of waste or distance to bin

- 1.
- 2.
- 3.

18. How do you think these barriers/challenges can be overcome?

- 1.
- 2.
- 3.

19. Please indicate in the following table which would be your preferred choice (and indicate the reason) for disposing the waste that you generate. Please tick one box for each type of waste.

	Reuse	Landfill	Recycle	Don't know	Reason (s)
Paper					
Plastic bottles (water bottles, drink bottles, etc)					
Drink cans					
Electronic waste(multi socket, etc)					
Glass (bottles, etc)					
Newspapers					
Magazines					
Food waste(sandwich, apple, banana, etc)					
Ink cartridge					
Other (please specify)					

20. Please tick the box that reflects most accurately your opinion towards separation of waste.

	Strongly agree	Agree	Unsure	Strongly disagree	Disagree
I believe separation of waste add value to waste resources					
If provided with the necessary materials, I will separate my wastes					
I believe there must be economic incentives for me when I separate my waste					

APPENDIX 2

Weekly Data on solid waste composition/ calculations for average quantity of waste per person per day for UG

FIRST WEEK DATA ON SOLID WASTE COMPOSITION IN UG

Date	Source of Waste	Type Of Waste	Weight (Kg)
11/03/2013	Registry/Administration	Paper	16.75
		Plastics	7.75
		Food Waste	4.00
		Other	5.00
		Sub Total	33.50
	Humanities	Paper	12.50
		Plastics	4.00
		Food Waste	5.50
		Other	4.00
		Sub Total	25.00
	Faculty of Science	Paper	8.75
		Plastics	10.25
		Food Waste	3.25
		Other	10.00
		Sub Total	32.50
14/03/2013	Registry/Administration	Paper	12.50
		Plastics	3.75
		Food Waste	3.00
		Other	2.75
		Sub Total	21.00
	Humanities	Paper	6.50
		Plastics	4.50
		Food Waste	4.25
		Other	3.00
		Sub Total	18.25
	Faculty of Science	Paper	2.00
		Plastics	3.00
		Food Waste	1.50
		Other	5.00
		Sub Total	11.50
		Total For Week 1	141.75

Source: Field data, 2013

APPENDIX 2

i. SECOND WEEK DATA ON SOLID WASTE COMPOSITION IN UG

Date	Source of waste	Type of waste	Weight (kg)
18/03/13	Registry/Administration	paper	32.00
		plastics	3.50
		Food waste	3.00
		other	2.00
		sub total	40.50
	Humanities	paper	11.25
		plastics	5.00
		Food waste	4.50
		other	5.00
		Sub total	25.75
	Faculty of Science	Paper	5.95
		plastics	7.00
		Food waste	1.00
		other	6.50
		Sub total	19.00
21/03/2013	Registry/Administration	paper	8.50
		plastics	3.00
		Food waste	2.50
		other	2.00
		Sub total	16.00
	Humanities	Paper	10.50
		plastics	3.75
		Food waste	6.50
		Other	1.00
		Sub total	21.75
	Faculty of Science	Paper	7.75
		plastics	4.75
		Food waste	1.25
		other	5.00
		Sub total	18.75
		Total for week 2	141.75

Source: Field data, 2013

APPENDIX 2

ii. THIRD WEEK DATA ON SOLID WASTE COMPOSITION IN UG

Date	Source of waste	Type of waste	Weight (kg)
25/03/2013	Registry/Administration	Paper	12.5
		Plastics	5.25
		Food waste	2.75
		Other	2.00
		sub total	22.5
	Humanities	Paper	15.5
		Plastics	6.00
		Food waste	6.75
		Other	3.00
		Sub total	31.25
	Faculty of Science	Paper	4.75
		Plastics	3.75
		Food waste	5.50
		Other	10.50
		Sub total	24.50
28/03/2013	Registry/Administration	Paper	8.50
		Plastics	3.50
		Food waste	4.00
		Other	2.50
		Sub total	18.50
	Humanities	Paper	6.25
		Plastics	4.00
		Food waste	3.25
		Other	3.00
		Sub total	15.5
	Faculty of Science	Paper	9.50
		Plastics	5.00
		Food waste	1.00
		Other	4.00
		Sub total	19.50
		Total for week 3	131.75

Source: Field data, 2013

APPENDIX 2

iii. Average quantity of waste generated per unit/day for the three weeks period in UG

Average quantity/person for three weeks=(average quantity for three weeks/number of days/average number of units) ÷ average number of persons

$$\text{i.e } (433.2/6/90) \div 2.5 = (0.80 \div 2.5) = 0.32 \text{kg/person}$$

Source: Field data, 2013

APPENDIX 3

i. FIRST WEEK DATA ON SOLID WASTE COMPOSITION IN CUC

Date	Source of waste	Type of waste	Weight (kg)
1&4 th April, 2013	Mataheko campus	Paper	12.5
		Plastics	3.5
		Food waste	4.0
		Other	7.0
		Total for week 1	27.0

Source: Fielddata, 2013

APPENDIX 3

ii. SECOND WEEK DATA ON SOLID WASTE COMPOSITION IN CUC

Date	Source of waste	Type of waste	Weight (kg)
8&11 April, 2013	Mataheko campus	Paper	8.0
		Plastics	3.0
		Food waste	2.0
		Other	3.0
		Total for week 2	16.0

Source: Field data, 2013

APPENDIX 3

iii. THIRD WEEK DATA ON SOLID WASTE COMPOSITION IN CUC

Date	Source of waste	Type of waste	Weight (kg)
15&18 April, 2013	Mataheko campus	Paper	13.25
		Plastics	4.25
		Food waste	1.25
		Other	2.0
		Total for week 3	20.75

Source: Fielddata, 2013

APPENDIX 3

iv. Average quantity of waste generated per unit/day for the three weeks period in CUC

Average quantity/person for three weeks=(average quantity for three weeks/number of days/average number of units) ÷ average number of persons

$$\text{i.e } (62.75/6/20) \div 2.5 = (0.52) \div 2.5 = 0.21\text{kg/person}$$

Source: Field data, 2013

APPENDIX 4

Annual A4 Paper Consumption

The weight of a ream of A4 paper is 2.8kg in both UG and CUC

Institution	Annual number of reams consumed	Annual Weight	
		Kg	Tons
UG	20,125	$2.8 \times 20125 = 56,350$	$56350 \div 1000 = 56$
CUC	4,273	$2.8 \times 4273 = 11,964$	$11964 \div 1000 = 12$

Source: Field data, 2014

APPENDIX 5

Annual Examination Papers Consumed

The annual average number of booklets used per person is 12 in both institutions

Institution	Weight per booklet (kg)	Total number of people	Annual Weight	
			Kg	Tons
UG	0.054	38,562	$0.054 \times 12 \times 38562 = 24,984$	$24984 \div 1000 = 25$
CUC	0.083	8,400	$0.083 \times 12 \times 8400 = 8,366$	$8366 \div 1000 = 8$

Source: Field data, 2014