

**Assessment of waste management practices on sustainability; A case study of Uganda  
Christian University**

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**UGANDA CHRISTIAN  
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DECLARATION

I ATUHAIRE AGNES, hereby declare to the best of my knowledge that this piece is my effort and original work and that this thesis has never been submitted for an award in any other University or for publication as a whole or in part. However other documents that were consulted have been acknowledged in the references.

Sign.....

Date: .....

ATUHAIRE AGNES

APPROVAL

This dissertation has been submitted for examination with the approval of

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Date: .....18/09/2023.....

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Special thanks to my parents for the financial support, Mubiru Paul, joy kansiime for encouraging me that I can do this on my own.

Thank you so much may Almighty God bless you

*Above all I thank God almighty for enabling finish this report successfully*

## DEDICATION

This thesis is dedicated to my self.

## Table of contents

DECLARATION .....	ii
APPROVAL .....	iii
ACKNOWLEDGEMENT .....	iv
DEDICATION .....	v
1.0 Introduction.....	1
1.1 Background. ....	1
1.2 Statement of the problem. ....	3
1.3 Research Objectives .....	3
1.4 Research questions .....	4
1.5 Conceptual framework. ....	4
1.6 Significance of the Study .....	6
1.7 Scope of the study .....	6
1.7.2 Issue scope.....	6
1.7.2 Geographical scope.....	6
1.7.3 Time scope.....	6
1.8 Limitations. ....	7
CHAPTER TWO .....	8
LITERATURE REVIEW .....	8
2.0 Introduction. ....	8
2.1 Key definitions .....	8
2.1.1 Waste management.....	8
2.1.2 Sustainability. ....	9
2.2 Assess Waste Combustion Practices.....	10
2.3 Evaluate The Efficiency and Effectiveness of Garbage Collection Practices.....	12
2.4 Examine the Viability and Impact of Composting Practices on Sustainability. ....	16
2.4.1 Main composting phases. ....	17
2.4.2 How composting affects the environment.....	18
2.5 Summary of literature review.....	19
CHAPTER THREE .....	20
METHODOLOGY .....	20
3.0 Introduction .....	20

3.1 Research Design .....	20
3.2 Study Population .....	20
3.3 Sample Size and Selection Technique .....	20
3.4 Sampling Techniques .....	21
3.5 Data Collection Methods.....	22
3.5.1 Questionnaire Survey Method .....	22
3.5.2 Interview Method .....	22
3.5.3 Observation method .....	22
3.6 Data Collection Instruments .....	23
3.6.1 Interview Guide.....	23
3.6.2 Data Collection Procedure .....	23
3.7 Data Management and Analysis .....	23
3.7.1 Quantitative Analysis .....	23
3.7.2 Qualitative Analysis .....	24
3.8 Limitations of the study .....	24
3.9 Conclusion .....	24
CHAPTER FOUR.....	25
DATA PRESENTATION AND ANALYSIS.....	25
4.0 Introduction.....	25
4.1 Characteristics of Respondents .....	25
4.1.1 Gender of respondents.....	25
Table 1 Showing gender of respondents.....	25
4.1.2 Educational Qualification.....	26
4.1.3 Occupation of The Respondents.....	27
4.2 Findings of the benefits of waste management practices.....	28
CHAPTER FIVE .....	32
SUMMARY DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS .....	32
5.0 Introduction .....	32
5.1 Summary and discussion of findings .....	32
5.2 Conclusions.....	33
5.3 Recommendations .....	33
REFERENCES .....	34

## **ABSTRACT**

The rapid population growth in higher institutions of learning are threat to the Environment. This result in more waste and concurrently the development result in New Life Patterns, Standard of living and attitudes change the waste composition to include more and more waste which calls for various waste management practices. The study was about analyzing waste management practices on sustainability a case study of Uganda Christian University.

The objectives of the study included Assess waste combustion practices on sustainability at Uganda Christian University, Evaluate the efficiency and effectiveness of garbage collection practices at Uganda Christian University to determine their contribution to waste reduction and sustainable waste management, Examine the viability and impact of composting practices on sustainability by evaluating the quantity and quality of compost produced at Uganda Christian University.

The study was carried out in Mukono District. The study employed both Qualitative and quantitative techniques in date collection. In addition, the data was analyzed using descriptive statistics and relational statistics and sampling and purposive techniques were used in interview and questionnaire methods of data collection. The research used a total population of 380,38 respondents in Uganda Christian University.

## CHAPTER ONE

### 1.0 Introduction

This chapter provides an introduction to the study, including the background, problem statement, research objectives, significance, scope, and limitations.

### 1.1 Background.

According to a report, about 2.01 billion tons of municipal solid waste is generated globally each year. The amount is projected to increase to 3.40 billion tons by 2050. Waste management is a crucial aspect of the modern world. With the amplifying population and industrialization, waste generation is sure to rise. North America generates the most volume of waste per capita, with Europe and Asia being the next. In North America, the average person generates 4.40 pounds of waste per day. Paper and paperboard products account for the largest amount, 23.1% of all the materials in municipal solid waste (MSW). Paperless offices are trending, yet the average office employees produce around 2 pounds of paper and paperboard waste every day. (PATEL, 2023).

Sustainable waste management is among the policy priorities for Africa, and various continental, regional, and country-specific policy initiatives and strategies are being implemented (UNEP 2018). According to the first 10 Year Implementation Plan 2014-2023 of the Agenda 2063: The Africa We Want, by 2023 the targets for African countries include “At least 50 per cent of urban waste is recycled” and “At least 10 percent of waste-water is recycled for agricultural and industrial use”. According to UNEP, the value of Municipal Solid Waste generated in Africa is estimated at USD8 billion annually, but the opportunities remain largely unexploited due to lack of awareness and a negative attitude by the public towards waste management that contribute to poor practices such as littering, open dumping and burning of waste; poor management of the existing dumpsites; limited budget allocations for waste management especially infrastructure investments; weak governance including compliance with and enforcement of existing policy and regulatory framework; and lack of adequate systems that support material recovery.

The Republic of Korea, in collaboration with several partners, including the Global Green Growth Institute (GGGI), is implementing a waste management project in the Ugandan capital. The aim is to strengthen waste management services for Kampala's 3.6 million inhabitants. The city produces between 1,200 and 1,500 tons of waste per day, according to the Ugandan authorities, to improve sanitation in Kampala, new facilities will be built including wastewater treatment and sludge drying plants. The project also includes the construction of solid waste collection and treatment centers in several municipalities in Kampala. (Mangoum, 2022).

On 15th December 2022, the KOICA-funded "Strengthening Solid Waste and Faecal Sludge Management (FSM) Capacity for Greater Kampala Metropolitan Area (GKMA)" project registered a landmark achievement with the Solid Waste Management (SWM)&Faecal Sludge Management (FSM) strategy and inception workshop. This workshop was a two-way participatory approach designed to aid in the development of a feasible strategy between GGGI and Mukono Municipality.

To better support Mukono Municipality based on their needs with solid waste and faecal sludge management capacities, GGGI is supporting the government to develop strategies for both components which will include the situational analysis with specific targets which will address and fill in the gaps Mukono is currently facing. Given that the Mukono-Katikolo site was selected for the feasibility studies and detailed designs of a Faecal Sludge Transfer Plant (FSTP) for the FSM component and a Material Recovery Facility (MRF) for the SWM component of the project, reviewing the strategies for both together with the Municipality made it visible for both GGGI and the Municipal council i.e. increase of waste collection to about 65%, Maximize waste to resource and material recovery by at least 35%. Setting up effective waste treatment and disposal tools. (KOICA, 2022).

Universities generate significant municipal solid waste. Various activities involving students, lecturers, administrative staff, and other parties contribute to the consumption patterns of energy, water, and other resources that influence the environment either directly or indirectly. The effects can be in the forms of increased air pollution, water pollution, and generated waste, particularly solid waste. As an educational institution, universities have moral and ethical obligations to work fairly with the environment and lead in environmental waste management. In many studies, solid

waste management (SWM) has been a major component in achieving institutional sustainability. The adaption of SWM sustainability within the university campus has enormous potential to reduce the amount of municipal solid waste, establishing a model for the community. (Budihardjo, M.A.; Putri, S.A.; Ramadan, B.S.; Syafrudin, 2021).

Uganda Christian University (UCU) is a leading institution of higher learning in Uganda, committed to academic excellence, character development, and social transformation. As an institution that strives to instill ethical values and promote sustainable practices, UCU recognizes the importance of effective waste management in achieving its sustainability goals.

## **1.2 Statement of the problem.**

Solid waste is one of the most serious environmental problems in urban areas especially in developing countries. As the levels of urban section continue to increase the urban population increases, levels of economic and industrial activity increase, and also an increase in change of Consumption patterns lead to increased generation of solid waste, some of which are costly and difficult to manage. Consequently, poor solid waste management causes serious environmental and health problems which affect the livelihoods of the population and beauty of the urban areas as well as the financial budgets of urban local governments because of the increased need for resources to manage the waste.

Despite UCU's commitment to sustainability, there is limited empirical research and assessment of waste management practices within the university. This gap in knowledge hinders the development of informed policies and strategies to address waste management challenges effectively. Therefore, there is a need to assess the current waste management practices at UCU and their impact on sustainability.

## **1.3 Research Objectives**

- i. Assess waste combustion practices on sustainability at Uganda Christian University
- ii. Evaluate the efficiency and effectiveness of garbage collection practices at Uganda Christian University to determine their contribution to waste reduction and sustainable waste management.

iii. Examine the viability and impact of composting practices on sustainability by evaluating the quantity and quality of compost produced at Uganda Christian University.

#### **1.4 Research questions**

i. What are the current waste combustion practices on sustainability at Uganda Christian University?

ii. What is the quantity and quality of compost produced through the current composting process at Uganda Christian University?

iii. What are different waste streams collected and how are they transported to waste management facilities for sustainability at Uganda Christian University?

#### **1.5 Conceptual framework.**

Waste reduction is a complex problem that cannot be looked at solely

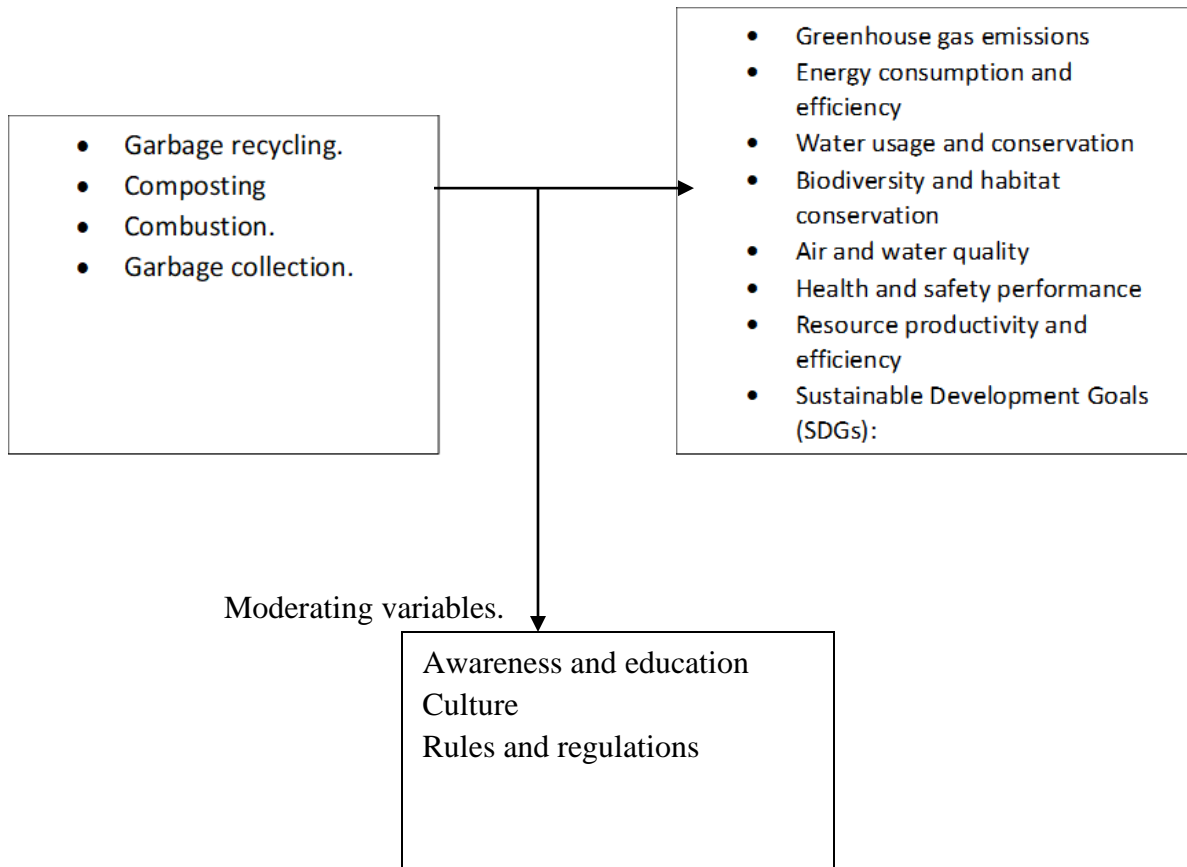
Technical consideration. It encompasses the political, social, financial, and economic aspect.

Figure 1: CONCEPTUAL FRAMEWORK SHOWING WASTE REDUCTION AND SUSTAINABILITY.

Independent variable      Dependent Variable

Waste management

Sustainability



Source: Adopted and modified from (contereau, 2006 Moeller, 2005; Houston, 2009).

## **1.6 Significance of the Study**

The findings of this study will contribute to the existing body of knowledge on waste management practices in higher educational institutions, specifically in Uganda. The assessment of waste management practices at UCU will provide valuable insights into the current state of waste management, identifying strengths and weaknesses. The study's recommendations will guide UCU in developing and implementing sustainable waste management strategies that align with its commitment to environmental stewardship.

Additionally, this research will benefit other higher educational institutions in Uganda and similar contexts facing waste management challenges. By examining the specific waste management practices and their implications for sustainability, the study will generate practical recommendations and best practices that can be replicated and adapted to other institutions.

## **1.7 Scope of the study**

### **1.7.2 Issue scope.**

This study will focus specifically on waste management practices at Uganda Christian University. The assessment will cover waste generation, segregation, collection, transportation, and disposal within the university campus. However, the study will not delve into broader waste management issues outside the university's jurisdiction, such as municipal waste management.

### **1.7.2 Geographical scope**

Uganda Christian University is one of Uganda's leading teaching and research universities located in the town of Mukono, approximately 25 kilometers (16 mi), by road, east of Uganda's capital city, Kampala, on the Kampala-Jinja Highway Kyetume is situated 5 km southeast of Uganda Christian University.

### **1.7.3 Time scope**

The study was carried out in Mukono district at Uganda Christian University this covered a reference period of three months from March to August 2023.

## **1.8 Limitations.**

One limitation of this study is that it relies on self-reported data and may be subject to recall bias or inaccuracies. To mitigate this limitation, data triangulation techniques will be employed, combining quantitative and qualitative methods. Additionally, the study will consider the availability of resources and time constraints, which may affect the comprehensiveness of the assessment.

## CHAPTER TWO

### LITERATURE REVIEW

#### 2.0 Introduction.

In this chapter, literature from different articles, books, journals will be reviewed about garbage collection, combustion and composting.

#### 2.1 Key definitions

##### 2.1.1 Waste management.

Waste management is defined as the different approaches and procedures designed and implemented to identify, control and handle the different types of waste from generation and until disposal. (McDougall, F. R. (2008). Waste in waste management refers to unwanted or unusable material that is produced through the activity of humans and can have different forms. Waste can be liquid, solid, or gas with each having its disposal method and way of managing the waste. (Van Velden, E. (2020)

Dijkema et al, (2000) pointed out that, wastes are materials that people would want to dispose off even when payments are required for their disposal. Although, waste is an essential product of human activities, it is also the result of inefficient production processes whose continuous generation is a loss of vital resources (Cheremisinoff, 2003). Besides the state of the matter, there are also different types of waste, such as household, biological, commercial and industrial waste. Some types of waste can form a threat to the environment and human health, such as radioactive and chemical waste. These types of waste are called hazardous waste.

However according to the researcher, Waste is the useless by product of human activities. Wastes can also be defined as any product or material which is useless to the consumer. Waste management refers to the activities or practices carried out to manage waste.

### **2.1.2 Sustainability.**

In awareness of this conundrum, the Brundtland Report of 1987 defined the concept of sustainable development as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs”, and again, recognizing the fundamental link with the social dimension, noted that “even the narrow notion of physical sustainability implies a concern for social equity between generations, a concern that must logically be extended to equity within each generation.” A Global Guide (1992) stated that “sustainability for a business enterprise means adopting business strategies and activities that meet the needs of the enterprise and stakeholders today, while protecting, sustaining and enhancing the human and natural resources that will be needed in the future”.

Paulraj (2011) on the other hand stated that achieving sustainability requires organizations keeping a close eye on the supply side practices. This study similar to the previous ones explored the need to look at the environmental and social aspects of sustainability while providing economic growth. The study of Porter and Kramer (2006) showed that organizational sustainability lies at the intersection of the economic, environmental and social aspects of sustainability which can ultimately lead to a long lasting competitive advantage. The study identified some components of supply management such as supplier selection, environmental collaboration and supplier evaluation which helps in improving the synergy between supply partners.

However, there are three components of sustainability the natural environment, society, and economic performance. The authors did not encourage undertaking social and environmental goals relating to the supply chain as this would be socially irresponsible from a sustainable supply chain management perspective. This must be looked at from a broad context of a firm’s overall strategic and financial objectives. The authors also left a gap of how supply chain professionals are in an outstanding position to impact on sustainability practices by implementing activities such as reducing packaging, improving working conditions, using more fuel-efficient transportation, and obliging suppliers to undertake environmental and social programs.

## 2.2 Assess Waste Combustion Practices.

The environmental protection Agency (EPA) 2001. Describe combustion as the process of burning solid waste under controlled conditions. Combustion is also known as Open waste burning and incineration which is a potential source of emissions in major cities of many low- and middle-income countries (Das et al., 2018; Lal et al., 2016; Nagpure et al., 2015). Combustion releases many hazardous compounds that may pose risks to the public and environment around the burning areas (Powrie et al., 2021). Combustion is an adverse practice to several sustainable development goals (SDGs), such as good health and well-being, clean water and sanitation, sustainable cities and communities, responsible consumption and production (Mihai et al., 2021). Some open dumpsites with diverse waste characteristics may be burnt uncontrollably. For instance, a recent study reported that open burning at a Nigerian landfill site contributes to the emission of greenhouse gases (GHGs) into the atmosphere (Daffi et al., 2020). Additionally, according to Sharma et al. (2022), the largest contributor of particulate matter (PM) emissions in India may be combustion by 2035 in the case of lack of appropriate political intervention.

According to (Ramadan et al. 2022a), the environmental and health risks of combustion exposure have attracted much research attention because it emits greenhouse and trace gases, Particulate matter, black carbon (BC), and other bound compounds. The IPCC 2006 methodologies have been extensively used to calculate the environmental impact of combustion practices. However, black carbon is not considered in these calculations and must be quantified using a separate procedure (Premakumara et al., 2018). Because it produces a greater environmental impact than carbon dioxide or methane (Reyna-Bensusan et al., 2019). Furthermore, combustion emissions are more dangerous because of their potential to emit hydrocarbons and metal-bound particulates (Chi et al., 2022). In particular, a number of polycyclic aromatic hydrocarbons (PAHs) can be released during the burning process because of the presence of plastic waste that is burned together with other domestic waste (Hoffer et al., 2020). And can be released through volatilization and can bind particulate matter. Importantly, some typical heavy metals with carcinogenic risk, such as lead, Nitrogen and Cadmium may be bound to fly ash (FA) generated from 0.01 to 14.16 mg kg<sup>-1</sup> of burned waste posing carcinogenic and chronic health risks.

Several studies have reported the health effects of the open waste burning. According to (Velis and Cook 2021) dioxins and related compounds (DRCs) and presence of potential hydrocarbons (PAHs) were identified during the combustion incidents and informal recyclers are susceptible to high risk from direct inhalation and ingestion.( Shih et al. 2015) estimated that combustion at landfill site increase concentrations in the environmental media. Several cancer deaths reported in Nairobi, can be related to the dioxin emissions from combustion. However, estimation of the cancer posed by dioxin is differs among the populations, uncertainty occurred in the estimation. (Kodros et al.2016) made estimation related to the global mortalities to the ambient emissions from combustion. The results interestingly showed that the 9% of mortalities from emissions is due to biomass burning and since it is coarse model estimation, smaller scale of study in regional, national, or city scale is needed to reduce the uncertainties of the estimated model.

However combustion should be considered a disposal option. Following combustion, there is still some quantity of ash to be disposed off (probably in a land fill), as well as the dispersal of some ash and constituent chemicals in to the atmosphere. It should instead be considered more items of its waste – reduction potential, which can be 80-90% in terms of waste volume (Rand 2000). This appears to be an extreme attractive option, however with occasional exceptions. Combustion is an inappropriate technology for most low- income countries like Uganda due to the high financial start up and operational capital required to implement combustion facilities hence a major barrier to successful adoption in developing countries (Rand 2000).

According to (micheal, 2013), combustion is not a preferred method of disposal because it can result in the emission of dioxins and other atmospheric pollutants, and it contributes to global warming. The potential contaminants could also decrease the lifetime of the incinerator.

Furthermore, the high moisture content of some solid wastes impedes the incinerators from running at maximum efficiency because the incinerators must expend extra energy in order to evaporate off the moisture in the waste. In combination with enforced clean air regulations, which led to the shutdown of several waste incinerators, the cost for the disposal of plastics by incineration is expected to increase. Additionally, incineration (combustion) cannot recover monomers that constitute the wasted polymer, and are therefore unfavourable to the economy

(micheal, 2013) Argues that combustion should be used for the disposal of biodegradable items originating from the health care sector (like hospitals) or other medical wastes that are hazardous to public health and require special treatment before disposal. Transfer of these materials to an incineration facility is required, so a special designed incinerator must often be installed in the neighbourhood where the waste is generated. Because the wastes are contaminated with hazardous materials such as putrefied organic materials or pathogenic microorganism's hence special countermeasures for protection against bad smell or infection are required during transfer to a disposal facility.

Although biodegradable resins are satisfactory from the perspective of environmental safety, their compositions could be damaging to the environment. Biodegradable resins containing halogen-based flame retardant additives yield halogen gases on combustion, so complex processing is required in order to make the halogen gases innocuous to humans.

Bamukwasha (1998) states that burning of solid waste in Kampala was done at house hold level in small scale as a way of reducing the amount of garbage produced. Incineration is capital intensive which requires high maintenance costs and temporary trained operators hence commonly adopted in developed countries. According to ( Rand, Harkol and Marxen. 2000), combustion prevents the generation of wastes and it is the most preferable method of waste management most especially in developing countries like Uganda, Kenya , Tanzania among others and it goes a long way towards protecting the environment

### **2.3 Evaluate The Efficiency and Effectiveness of Garbage Collection Practices.**

Waste collection is a critical component to waste management. The economic and environmental performance of the entire system can be impacted by the way that materials are collected and sorted. In many instances, the collection point will be an interface where waste generators and waste collectors that must be carefully managed if the system is to be effective. Waste generators require waste collection with minimal inconvenience, while collectors must be able to collect waste in a way that is compatible with the planned treatment and processing methods if the waste management system is to be sustainable (McDougall et al., 2001).

Within many firms, waste is generally handled in one of two ways for example custodial collection, or self-haul collection. Custodial collection involves custodial staff collecting and

transferring of waste. This typically involves emptying out and maintaining publicly accessible collection bins and transferring them to a larger storage container which is typically located in a centralized area with controlled access. With self-haul collection systems, employees are responsible for ensuring that their waste is managed and sent to a collection point. This essentially means that there are no custodial staff who are responsible for handling waste. Employees are responsible for collecting and handling waste as part of their regular activities (McDougall et al., 2001).

Larger organizations often require services from an external waste service provider. These companies are required to ensure that any bins they provide customers meet local area requirements. When contacting a commercial waste service provider, they will be able to provide customers with a range of potential options to suit their needs. Hiring a waste service provider will typically require forming a contract. There are some elements which need to be known in advance to ensure that an effective contract for both the waste service provider and the firm or organization requiring the services (UCDavis, n.d.). There are many different factors which can be negotiated in a contract including the frequency of collection, the equipment being used, the fees, volumes collected, and rates for different streams. It can be useful to conduct a waste characterization study before approaching external waste service providers to ensure that contract provisions will allow for implementation of the waste management strategy in a cost effective manner (CCME, 1996).

However, there are organizations which may not have dedicated custodial staff include restaurants, supermarkets and convenience stores. With organizations like this, a greater number of people are involved with managing and handling waste. This is an important consideration, particularly with respect to educational efforts. Storage containers and storage areas must have enough room to allow for the easy movement of collection carts, access to the larger storage bins, and compliance with health and safety regulations (CCME, 1996).

In 2008 the local government of Bahir Dar contracted a newly formed private company to collect, transport and dispose of the city's waste. The company claimed that it could provide a better service at a lower cost (Lohri et al. 2014). Waste is collected from outside houses and businesses by 270 collectors which carry or use hand-carts to take the waste to a network of

around 100 collection points. At these collection points the collectors load the waste onto open trucks which are driven to an open dumpsite 7 km outside the city. The money to set up the scheme was provided by the government (56%), the United Nations (34%) and the company (10%), and the only income stream was from fees paid by the householders for the collections. The scheme was successful in that the proportion of waste collected rose from 50% to 67%. However, the fee income was only half the level expected, so the company had to use grants provided for capital equipment (vehicles, etc.) to pay staff wages. This meant that the scheme could not continue in the long term.

According to Tefera and Negussie (2015), the municipality subsequently organised four additional MSEs to extend the system and improve waste collection rates across the city. Solid waste management systems are developing in many Ethiopian towns and cities, but there is still considerable scope for improvement. Based on a study of Addis Ababa, Desta et al. (2014) identified several ways of increasing efficiency including raising awareness of the public health implications of poor waste management, improving planning decisions and the enforcement of regulations, increasing the number of transfer stations at accessible sites.

Solid Waste Management Collection cannot stay behind without being affected if human behaviour changes globally. There are new Solid Waste Management Collection practices that have come up as innovation to modify the existing one. Solid waste tons by day are approximately 1.3 billion per year around the world. In 2025 it expected to reach approximately 2.2 billion tons per year. This represents a significant increase in per capita waste generation rates, from 1.2 to 1.42 kg per person per day in the next fifteen years (Hoornweg, 2012).

Uncollected waste and poorly disposed waste cause significant health and environmental problems. Especially solid wastes from households are a serious health hazard and can cause the spread of serious infectious diseases (Word bank, 2018). After tedious to manage with the permanent increase in the amount of solid waste and the number of people who wish to use the solid waste collection service, there is a need to develop a Mobile Application model for solid waste collection management, the traditional method has lost its effectiveness. The challenge facing the municipality in waste management today includes customer and billing management, routing planning, and report filling (Mitsuo, 2018).

Solid waste has to be properly stored, collected, transferred, treated, and disposed off, and the main effort was to minimize the impact on the environment and health. Thus, the engineering and logistics tools were sufficient to plan and implement waste management systems. But today, resource management and social behaviour are an integral part of all waste management systems, increasing the need to develop mobile applications for the sector (AntonisMavropoulos, 2015). Mobile technology is starting to change the way solid waste and recycling companies do business. New tools enable business owners and the average consumer of waste and recycling to take advantage of access to information on services, planning, etc., while helping them make smarter decisions about results.

Private sector operators became eligible to obtain permits to take part in waste collection, transport and treatment when the Solid Waste Management Proclamation was published in 2007 (FDRE, 2007). By April 2011, 524 firms in Addis Ababa had been permitted to collect solid wastes, employing 5800 people (PPIAF, 2011). Over the four years, the proportion of the city's waste collected had risen from 60% to 80%, providing waste collection services to an additional 600,000 people. Many of these private sector operators are 'micro-enterprises' Under these PPP schemes, the planning and administration is the responsibility of the kebele authorities, who remain owners of the service (Tilaye and van Dijk, 2013). They collect waste from individual households, taking a fee from each household served and also receiving a fee from the kebele based on the amount of waste deposited at the central collection points/transfer stations. This helped to raise the proportion of waste collected, but the scheme was only semi-regulated, resulting in several collectors working in the same (well-off) areas and no collectors working in areas where residents could not afford to pay the collection fees.

Raising awareness about different waste management programs can have positive effects, but there are several methods which can be used to change behavior to improve participation or correct problems (Timlett& Williams, 2008). Once new initiatives are introduced, people will need time to adjust until the new plan becomes normal behavior, but once this behavior is established it is difficult to break (Timlett& Williams, 2009).Establishing certain behavior patterns in transient populations such as student groups and military populations, and also in high density residential areas can be challenging. Targeted strategies which are aimed at specific areas

and groups (Purcell & Magette, 2010) and which focus on providing instructions on how, what, and where efforts should be focused can result in greater success rates (Smyth et al., 2010). It is also important to take into account the socio-economic conditions of the group that is expected to participate in the program (Matsumoto, 2011).

Ethiopia has a long way to go to achieve adequate waste collection systems in all its towns and cities. For example, in Addis Ababa, only 65% of the city's solid waste was collected in 2003 (Regassa et al., 2011). More recent data indicates that this figure has since increased to 80% (Tessema, 2010; PPIAF, 2011). Even so, the city still has considerable progress to make. In other towns, the situation is worse. In Dessie, 48% of residents practice 'open dumping' of their waste (Sharma et al., 2012). In other words they deposit it on the roadside, on abandoned land, in open sewers or river banks, or around their yard. In Bahir Dar the collection rate was estimated in 2010 to be 67% and in Mekelle, until recently, only a third of total waste generated was collected by the municipality (Tefera and Negussie, 2015).

There are many factors to consider when determining what equipment will be needed to ensure waste management efforts are successful. There are generally two types of equipment which will be required by an organization to manage waste: collection equipment which is used for collecting the generated waste materials; and processing equipment for reducing the volume of materials and for storage (CCME, 1996).. The size and type of collection equipment most suitable for any firm will depend on a variety of factors such as facility size, waste volume and weights, storage space available, characteristics of the waste being handled, and costs (CCME, 1996). The desired outcome will impact the chosen resources devoted to a waste management framework.

#### **2.4 Examine the Viability and Impact of Compositing Practices on Sustainability.**

Cooperband (2000) has described the composting process as 'the transformation of raw organic materials into biologically stable, humus substances...' This definition is based on the end product, composting is also defined as 'an aerobic process of decomposition of organic matter into humus-like substances and minerals by the action of microorganisms combined with chemical and physical reactions'. A generalized equation of composting follows

Fresh organic matter + O<sub>2</sub> → Humus-like substances +  
CO<sub>2</sub> + H<sub>2</sub>O + Energy (heat) + mineral product

#### **2.4.1 Main composting phases.**

The first micro-organisms to colonize the compost heap are mesophilic such as Mesophilic bacteria, actinomycetes, fungi and protozoa. They grow Between 10 and 45 °C (Cooperband, 2000) and break down easily degradable components such as sugars and amino acids (Hellmann et al., 1997). Organic fresh matter degradation starts as soon as the compost heap is made, and because of the oxidative action of microorganisms, the temperature increases. Despite a drop in pH at the very beginning of composting, the degradation of acids brings about a pH increase. When the temperature reaches 45–50 °C, thermophilic microorganisms replace mesophilic ones (Hellmann et al., 1997).

The second phase is called the thermophilic phase and can last several weeks. It is the active phase of composting where most of the organic matter is degraded and consequently most oxygen is consumed. According to Tuomela et al. (2000), lignin degradation starts during this phase. Indeed, the optimum temperature for thermophilic micro-fungi and actinomycetes which mainly degrade lignin, is 40–50 °C. Above 60 °C, these microorganisms cannot grow and lignin degradation is slow (Hellmann et al., 1997).

After the thermophilic phase which corresponds to a peak of degradation of fresh organic matter, the microbial activity decreases, as does the temperature. This is called the cooling phase. The compost maturation phase begins when the compost temperature falls to that of the ambient air. More specifically mesophilic microorganisms colonize compost and continue to degrade complex organic compounds such as lignin. This last phase is important because humus-like substances are produced to form mature compost (Cooperband, 2000).

Mineralization and mummification occur simultaneously during composting and are the main processes of the degradation of the fresh organic matter. Several gases are emitted during composting for example carbon dioxide (CO<sub>2</sub>), ammonia(NH<sub>3</sub>), nitrous oxide (N<sub>2</sub>O), methane (CH<sub>4</sub>), hydrogen sulphide (H<sub>2</sub>S), nitrogen oxides (NO<sub>x</sub>), and Volatile Organic Compounds (VOCs) (Hellmann et al.1997).

### **2.4.2 How composting affects the environment**

Kirchmann and Bernal (1997) demonstrated that composting reduces the loss of Carbon dioxide compared to the non-decomposed treatment when the calculation of the total loss takes into account the loss during the treatment of the fresh material and the loss after its application to fields. Non-decomposed material may present more easily decomposable carbon compounds than well-composted material, so the microbial community degrades more organic compounds after application of fresh material on fields and the expansion of microbial activity also improves degradation.

According to the US Environmental Protection Agency (EPA), compost promotes higher yields of fruits and vegetables. Therefore, you benefit from more fresh produce, and you'll have more of it. Additionally, you'll save money on buying fertilizer since you can use your compost as a natural fertilizer. You'll also decrease the need for manmade fertilizers. Since compost can help keep pests away, you also won't have to treat for them as often. This saves you money and reduces the need for chemicals.

The study found that composting organic waste versus landfilling it can reduce more than 50% of carbon dioxide-equivalent greenhouse gas emissions, for a total of 2.1 gigatons between now (2020) and 2050 if climate change is curbed to a 2 degree Celsius rise in the average global temperature. However the emission savings from landfill diversion is only one benefit of compost.

Compost is a natural way to provide nutrients to plants to enhance productivity while storing carbon in soils. As such, compost not only reduces carbon emissions by the aforementioned amount, but shares emissions savings through many of the other climate solutions in Project Drawdown by acting as a carbon sink or "sponge" that can soak up emissions currently in the atmosphere and limit the impacts of climate change which is already causing devastating wildfires, flooding, and droughts to name a few. (EPA, 2017).

In 2015, an estimated 38 percent of food waste was composted in the US; 57 percent was composted in the EU. If all low-income countries reached the US rate and all middle-income countries achieved the EU rate, composting could avoid methane emissions from landfills equivalent to 1.13–1.40 gigatons of carbon dioxide by 2050. That total excludes additional gains

from applying compost to soil. Compost facilities cost less to construct than to operate, which is reflected in the financial results (Zaman et al. (2016).

Food waste treatment by the anaerobic digestion combined composting process results in an environmental impact across all impact categories. However, the environmental burden is compensated through the power generated when biogas is used as a fuel and when synthetic/chemical fertilizer is replaced by compost. In addition, the energy demand during the composting process in the integrated AD combined and composting system is sourced from the heat generated by CHP. The use of a fossil-fuel system with heat and electricity generated in the AD–CHP system causes a significant reduction in most LCA impact categories. Furthermore, significant savings are achieved for fossil fuel depletion and ozone layer depletion for an almost 100% reduction.

Although the energy demand during the composting step in the anaerobic digestion pathway was sourced from the heat generated by the CHP, different parameters could potentially affect the impacts significantly. These are related to the use of different feedstocks for biogas production and the efficiency of energy generation in the CHP plant. Notably, the key driver for ADP is reduced by almost 100% in the final end-use phase. This reduction is because minerals extraction is avoided when compost replaces commercial fertilizer. Due to the risks for human health from toxic materials, handling and processing of food waste via AD must be highly regulated. For instance, the use of reactive adsorption technology for the removal of H<sub>2</sub>S from biogas produced in anaerobic digesters.

## **2.5 Summary of literature review.**

There's a lot of literature on waste management practices as cited which provides a valuable input to this research problem. It clarifies the variables on the relationship between waste reduction practices and sustainability; however the literature leaves out gaps on the effects of these practices on sustainability. The literature concentrates mostly waste management practices and as per the literature reviewed on any research has been carried out on the waste management and sustainability in Uganda Christian University. Therefore, the proposed research will contribute to filling the gaps identified.

## **CHAPTER THREE**

### **METHODOLOGY**

#### **3.0 Introduction**

This chapter presents the research design, study population, sample size and selection technique, Sampling techniques, data collection methods, data collection instruments, data collection procedures, data management analysis and conclusion.

#### **3.1 Research Design**

According to Amin (2005) a research design is a conceptual structure where research is conducted and it constitutes a blue print for collection, measurement and analysis of data. This study will use a cross-section study design using both qualitative and quantitative approaches (Amin, 2005). The cross-sectional approach will be used because the assessment of waste management practices on sustainability will be studied at that point in time (Amin, 2005). The study will use a quantitative and qualitative approach because qualitative methods provide in-depth explanations to events while quantitative methods provide the data needed to meet required objectives and to test the hypotheses (Mugenda&Mugenda, 1999).

#### **3.2 Study Population**

Uganda Christian University consists of a total population of comprising of 145 lecturers, 380,200students, and 40cleaners. The study will be carried out on an accessible population of 380,386. This population will be considered because they regulate a lot of waste since it is a large population of different people who do different activities.

#### **3.3 Sample Size and Selection Technique**

According to (Sekeran, 2003) a sample is a subset of a population. It comprises some selected members who are referred to as elements. Sampling is the process of selecting a sufficient number of elements from the population so that a study of the sample and an understanding of its characteristics would make it possible to generate such characteristics to the population

elements. The study will select respondents based on Krejcie and Morgan Sampling Guidelines (see appendix III) as shown in table 1 below.

**Table 1: Population Category and Sample Size of the Respondents**

Population category	Total population	Sample size	Sampling Techniques
Lecturers	145	20	Simple random
Students	380,200	5000	Simple random
Cleaners	40	10	Simple random
Guild president	1	1	Purposive
Total	380,386	5031	

*Source: Uganda Christian university*

As table 1 indicates, a sample of 20 lecturers will be considered out of a population of 145 based on Krejcie and Morgan's (1980) sampling guidelines (see appendix III). In this study purposive sampling technique will be used for the guild president since its one person and Simple random sampling will be used for the remaining sub categories.

### **3.4 Sampling Techniques**

A sampling technique is the name or other identification of the specific process by which the entities of the sample were selected. There broadly two sampling approaches thus probability and none probability sampling techniques. The probability sampling approach will involve selecting a sample in such a way that all the elements in the population have some chances of being selected (Amin, 2005). This study will use simple random sampling which is a sample obtained from the populations in such as way that samples of the same size have equally chances of being selected (Amin, 2005). As indicated above in table 1 above, the study will use simple random sampling for the students, cleaners and staff. In using simple random sampling, the study will use the lottery approach where names in each category were written on tag and one picked at a time until the required number is reached. To arrive at the sample size the study will use proportionate sampling ( $50/150000 \times \text{the No in the population category}$ ).

In the non-probability approach, the elements in the population will not have a well-defined chance of being selected (Amin, 2005). This study will use purposive sampling which involved the researcher using own judgment or common sense regarding the participants from whom the information will be collected. Thus the selection of the respondents will be based on the researcher's experience with the respondents' possession of the required information. This study will use purposive sampling for the guild president.

### **3.5 Data Collection Methods**

The study will use a survey approach where both qualitative and quantitative data will be collected. There will be several survey approaches, however for the purpose of this study the questionnaire, interviewing, and observation approaches will be used as discussed below.

#### **3.5.1 Questionnaire Survey Method**

The questionnaire will be issued to all the 5031 respondents who are students, lecturers and cleaners expected to generate waste around the university. The respondents will record their answers within closely defined alternatives. The study will use a questionnaire basing on the fact that the variables cannot be observed such as views, opinions, perceptions and feelings of the respondents such as attitude and competencies. The questionnaire will also be used because it is less expensive for data collection (Amin, 2005). The questionnaire will be used to collect primary data from the selected respondents by personally delivering them to the respondents.

#### **3.5.2 Interview Method**

Interviews will be conducted with the guild president and few lecturers since they all generate waste. In this method the researcher will interview the respondents face to face to obtain in depth qualitative information on waste management practices on sustainability at Uganda Christian University.

#### **3.5.3 Observation method**

This will involve observing and making observations on waste management practices practiced in the university using an observation checklist.

### 3.6 Data Collection Instruments

#### Self-Administered Questionnaire

A total of 5031 questionnaires will be distributed to the targeted population. The study will use a close ended questionnaire divided into sections of background information, attitudes, competencies and waste generation. A standard Questionnaire on a five point Likert scale will be used to get quantifiable primary data from individual respondents.

#### 3.6.1 Interview Guide

Interview schedule will be structured along areas of waste management practices, attitudes, competencies and waste generation from which the study intends to extract qualitative data to explain the status quo.

#### 3.6.2 Data Collection Procedure

After successful defense of the proposal, an introductory letter from the school of business at Uganda Christian University will be issued to seek permission to conduct the study. Anonymity and confidentiality of the respondents will be observed by not asking the respondents to put their names on the questionnaires. The questionnaires will then be distributed to the lecturers, students and cleaners for one week and collected in the following week. The filled questionnaires will then be entered in SPSS in preparation for analysis.

### 3.7 Data Management and Analysis

#### 3.7.1 Quantitative Analysis

Quantitative data will be presented in form of descriptive statistics of frequency and percentages, mean and standard deviations for each of the variables used in the study. Strongly agree and agree will be combined to indicate agree while strongly disagreed and disagree will be combined to indicate disagree. Pearson's correlation statistics will be used to test the relationships at 99 and 95 confidence limits. A positive correlation indicates a direct positive relationship between the variables while a negative correlation indicates an inverse, negative relationship between the two variables. A regression analysis using ANOVA statistics of adjusted R<sup>2</sup> values, beta, t values and significance values will be used to determine the magnitude of the influence of the independent variables on the dependent variable (Amin, 2005).

### 3.7.2 Qualitative Analysis

The useful qualitative data will be analyzed using content analysis where information gain through the interviews will be arranged in major themes of waste management practices, attitudes and competencies related categories. These will then be presented using the narratives as presented by the interviewee. Implications, conclusions and inferences of qualitative information on waste management practices on sustainability in UCU. Effort will also be directed to cross-examine the qualitative data with the quantitative findings on their level of agreement or disagreement.

### 3.8 Limitations of the study

The study will be limited by the time frame since the researcher will have to finish the study within the specified period offered by the university. The study will also be limited by the biased respondents

### 3.9 Conclusion

This chapter will provide the methodology that will be used to gain data, measure variables and test the quality of the questionnaire and interviews.

## CHAPTER FOUR

### DATA PRESENTATION AND ANALYSIS

#### 4.0 Introduction

This chapter deals with the analysis and interpretation of the data collected on the field. These aim to process the data into information so that findings of research could be established in order to answer the questions raised in chapter one

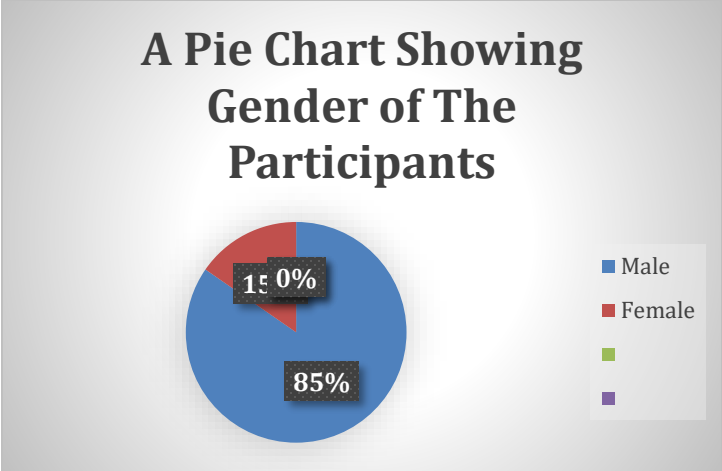
#### 4.1 Characteristics of Respondents

##### 4.1.1 Gender of respondents.

Table 1 Showing gender of respondents

Gender	Frequency	Percentage
Male	281	85%
Female	51	15%
Total	332	100%

From the above table, 281 respondents representing 85% are female and 51 respondents representing 15% are male Of the entire questionnaire retrieved. This showed the researcher that women pay more attention to waste management in order to achieve sustainability than men do. During the collection of the data, female respondents admitted to raising of more waste in campus than the male respondents



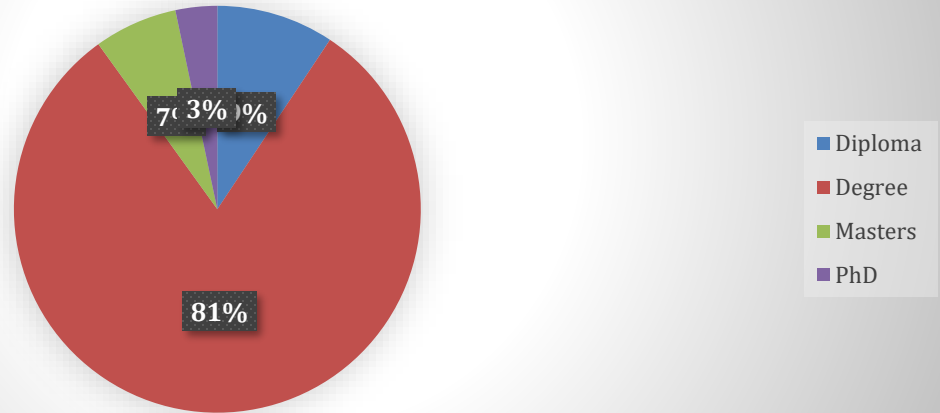
4.1.2 Educational Qualification.

Table 2 Showing Educational qualifications

Qualification	Frequency	Percentage
Diploma	31	9%
Degree	268	81%
Masters	22	7%
PhD	11	3%
Total	332	100

The table above shows that the majority of the respondents are literates which has aided in collection of information needed for the research work. 31 respondents representing 9% are diploma holders, 268 respondents representing 81% are degree holders, 22 respondents representing 7% are master’s holders and 11 respondents representing 3% are PhD holders respectively. These also told the researcher that they advocate for waste management in their respective qualifications in order to achieve sustainability at the campus.

## Pie chart showing qualification of the respondents



### 4.1.3 Occupation of The Respondents.

The table below shows the occupation of the respondents in Uganda Christian university

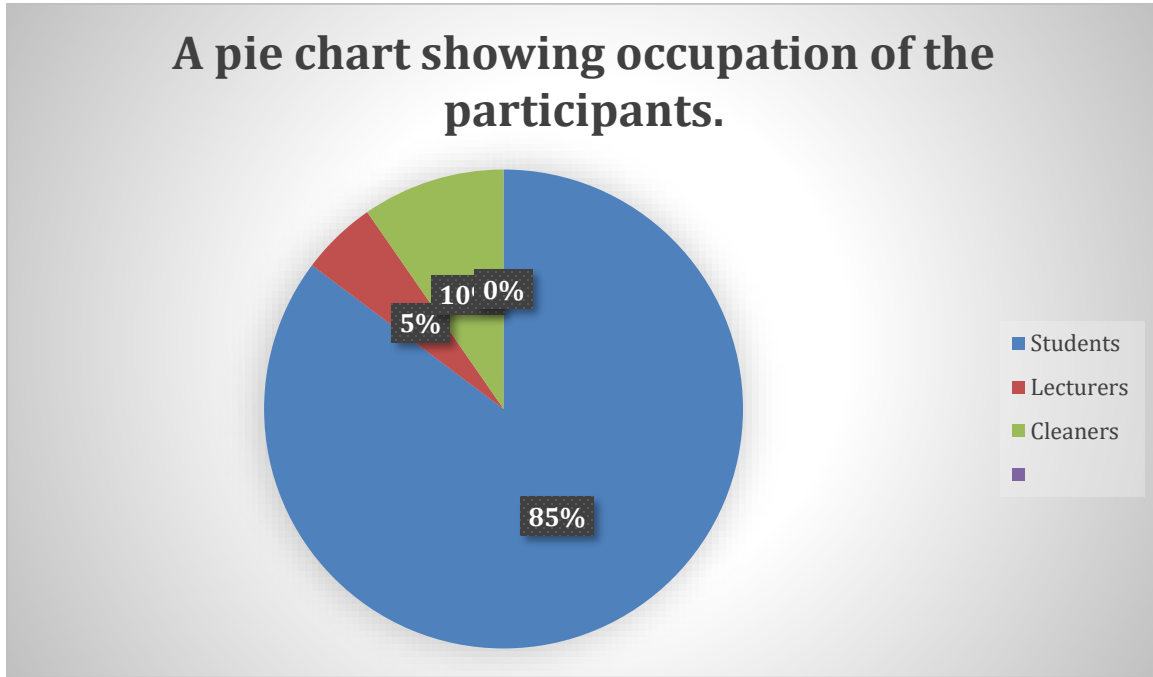
Occupation	Frequency	Percentage
Students	283	85%
Lecturers	17	5%
Cleaners	32	10%
Total	332	100

The table above shows that the majority of the respondents are students as a total number of 283 respondents which represent 85%, the lecturers are 17 of the respondents representing 5% and then 32 are cleaners who also represent a percentage of 10%.

This shows that students generate a lot of waste at Uganda Christian university where they are provided with bins to collect the waste generated. The cleaners carry out waste segregation, waste collection, combustion and also dig composting pits in case there need.

Lecturers at the campus also generate waste but it's not so much like the students. They are also encouraged by their bosses to teach students the importance of managing waste and attaining sustainability. Like one of the lecturers the researcher interviewed said that he teaches

sustainability as a course unit to the business students hence contributing to waste management in the university.



4.2 Findings of the benefits of waste management practices.

The table below shows the responses from the respondents on the benefits of waste management practices in relation to Strongly Agree S/A, agree A, strongly disagree S/D, disagree D.

S/N	BENEFITS OF WASTE MANAGEMENT PRACTICES	S/A		A		S/D		D		TOTAL	
		F	%	F	%	F	%	F	%	F	%
	Proper garbage	F	%	F	%	F	%	F	%	F	%

1	collection and disposal prevent littering and illegal dumping which is critical for maintaining a healthy environment.	332	0	0	0	0	0	0	0	332	100%
2	Composting facilities are well-maintained and odor-free environment	156	48%	61	18%	32	10%	80	24%	332	100%
3	Combustion is clean and environmentally friendly way to dispose of waste	57	17%	249	75%	0	0%	0	0%	306	92%
4	Proper garbage disposal protects us towards any danger in terms of health	287	86%	45	14%	0%	0%	0%	0%	332	100%

According to the table presented above, all the 332 respondents representing 100% strongly agreed that proper garbage collection and disposal prevent littering and illegal dumping which is critical for maintaining a healthy environment, 48% Of the respondents strongly agreed that composting facilities are well-maintained and odor-free environment, 18% respondents agreed, 10% respondents strongly disagreed and 24% of the respondents disagreed. The ones that disagreed said that the composing materials have a smelling stage thus polluting the air.

Furthermore, 20% respondents strongly agreed that combustion is clean and environmentally friendly way to dispose off waste, 73% of the respondents agreed because they believe that it destroys the waste and 7% disagreed. These respondents that disagreed believe that combustion pollutes the environment with the smoke thus destroying the ozone layer.

On addition to that, energy recovery through waste-to-energy facilities is a sustainable approach for waste disposal was not answered by all the respondents though it was answered by the majority 17% strongly agreed and 75% agreed to it. However, 86% strongly agreed that garbage collection protects us from danger in terms of health, 14% also agreed,



## CHAPTER FIVE

### SUMMARY DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

#### 5.0 Introduction

In the preceding chapter the discussion on key findings were made. This chapter provides waste management practices, conclusions and recommendations from the study.

These conclusions and recommendations are derived from the findings of the study which are presented in this dissertation.

#### 5.1 Summary and discussion of findings

The purpose of the study was to assess Waste management practices on sustainability in Uganda Christian University. To achieve the above purpose of the study a case study design was used as research design. The target population selected include students, cleaners and lecturers. Sample population size was selected using the Krejcie and Morgan table, and the following sampling techniques were used i.e. purposive and simple random sampling. In order to collect data, two key methods were used namely questionnaire and interview. In addition, the following were the data collection instruments used i.e. the self-administered questionnaire and the interview guide. Furthermore, the study also found out that waste management practices at Uganda Christian University are very effective and students carry out proper garbage collection which keeps the environment in campus clean which is done through providing bins almost everywhere in campus. The study also found out that sustainability is taught to some business courses as a course unit. This encourages lecturers to motivate, mobilize students to attain sustainability around campus even in the neighboring communities.

Continually, combustion is done in incinerators which are located far from the students. This prevents students from inhaling the smoke hence becoming an environmentally friendly. Compositing on the other hand leads to air pollution as it leads to bad odor in the environment. But it was also stated as one of the best way to deal with waste since it's burnt down completely.

Finally, the researcher also found out that Uganda Christian University has a connection with the management of Mukono thus collecting rubbish every Monday and Friday around campus. Also reduces costs of UCU since rubbish is picked and taken elsewhere by the council.

## 5.2 Conclusions.

The main objective of the study was to assess the waste management practices on sustainability in Uganda Christian University and basing on the study findings the researcher concluded that the management at the campus ensured good Garbage collection through providing bins around campus, construction of incinerators to carry out combustion of the waste produced in the university. The study also concluded that Uganda Christian university is a very clean campus which also teaches its students sustainability as a course unit. This enables students learn the concepts of sustainability and put them in to practice.

## 5.3 Recommendations

The study recommended the following basing on the results of the study.

In order to maintain the waste management practices at campus hence resulting to sustainability, the university should continuously engage students, lecturers and other staff so that waste is not littered around the campus.

The organization should have to give a critical emphasis on assigning adequate budget for managing waste around campus through developing better financial system this achieving sustainability. The university should also endeavor to train the staff and students importance of being sustainable since everyone generates the waste.

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# UGANDA CHRISTIAN UNIVERSITY

A Centre of Excellence in the Heart of Africa

SCHOOL OF BUSINESS

1<sup>st</sup> Aug 2023

TO WHOM IT MAY CONCERN

Name: *Atuhaire Agnes* Reg. No. *S20B12/202*

A bachelor's student who is seeking permission from your office to collect data for his/her dissertation titled

"*Assessment of Waste Management Practices on Sustainability*"

We shall be grateful if you could render assistance to him/her in collecting the necessary data for his/her dissertation

The Uganda Christian University School of Business thanks you in advance

Mukisa Simon Peter  
Research coordinator