A STUDY OF VARIABLES CONTRIBUTING TO QUANTITIES OF SOLID WASTE GENERATED BY BUSINESSES LOCATED WITHIN ANNIVERSARY TOWERS HIGH RISE BUILDING IN THE NAIROBI CENTRAL BUSINESS DISTRICT-KENYA.

RIKA JOHN KAGAI

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A RESEARCH PROJECT PAPER SUBMITTED TO THE DEPARTMENT OF GEOGRAPHY AND ENVIRONMENTAL STUDIES OF THE UNIVERSITY OF NAIROBI, IN PARTIAL FULFILLMENT OF REQUIREMENTS FOR THE DEGREE OF MASTERS OF ART IN ENVIRONMENTAL PLANNING AND MANAGEMENT.

DECLARATION

I, RIKA JOHN KAGAI hereby declares that this project paper is my original work, as part fulfillment for the award of the degree of Master of Arts in Environmental Planning and Management. To my knowledge this work has not been presented for the award of a degree in any other University or Institution of higher learning. Information from other published and unpublished works in this research field has been duly acknowledged and references quoted.

Rika John Kagai Signed…….

Date:

This research project has been submitted for examination with our approval as the University supervisors.

Professor E. Ayiemba Signed: …….

Dated:

Dr. Margaret Kirimi Signed: …….

Dated:

DEDICATION

This research project is dedicated to the following people:

To my Late Brother Elijah whose passing emotionally derailed me, but whose memory spurred me on under the most difficult circumstances.

And

To Ndunge, Hattie and Harrold – my immediate family members who bore the blunt of the stress and absence from home which were concomitant throughout the entire process.

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ABSTRACT

This is a study of the solid waste generation by businesses housed in Anniversary Towers in Nairobi. The organisations housed in this building are broadly identifiable as offices, shops, restaurants, salons and drapery dealers, making the waste essentially of commercial nature. The objective of this study is to identify factors contributing to the waste generation in the building. Staff population and Type of business are the study's main independent variables with the quantities generated as the dependent variable. Influence of other possible factors in solid waste generation is also examined. All Forty-Six organisations based in Anniversary Towers and operating at the time of data gathering were subject of this study. The exception was a Pharmacy located on the building's ground floor whose primary waste was medical in nature hence hazardous and considered beyond the researcher's capacity to handle. The methodology of data collection involved sourcing of solid wastes from all organisations, sorting into the different types, weighing and recording. Data on staff populations came from interviews with persons in charge of staff matters in the various organisations. Structured questionnaires were administered for information on solid waste management practices in each of the organisations. Physical observations and photography were employed to augment the study's data. Secondary data were gleaned by reference to previous research on solid waste generation Data on population versus solid waste quantities was analysed by linear regression. The findings upon this analysis were that a positive though weak relationship existed between staff population and generation of solid waste. Influence of business type on solid waste quantities was analysed by using Chi-Square test, and the findings were that business type influences amount of solid waste generated. Recommendations were made specifically for more sensitization to solid waste generation minimisation especially paper waste, and opportunities for further research in the topic suggested.

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ABBREVIATIONS

ADB	African Development Bank
ANOVA	Analysis of Variance
CED	Cause and Effect Diagram
CBOs	Community Based Organisations
CBS	Central Bureau of Statistics
EMCA	Environment Management and Coordination Act
EPR	Extended Producer Responsibility
ESCAP-UN-	Economic and Social Commission for Asia and Pacific-
GDRC	Global Development Research Centre
GDP	Gross Domestic Product
GPP	Green Public Procurement
ICT	Information and Communications Technology
IBC	International Building Standards
IEBC	Independent Electoral and Boundaries Commission
IMF	International Monetary Fund
ISWM	Integrated Solid Waste Management
ITDG	Integrated Technology Development Group
JICA	Japan International Cooperation Agency
MLM	Multi Level Marketing
KENAO	Kenya National Audit Office

ABBREVIATIONS

KCB	Kenya Commercial Bank
NEMA	National Environment Management Authority
NSW	New South Wales
NGOs	Non Governmental Organisation
NTT	National Task Team
OECD	Organisation for Economic Cooperation and Development
PWGSC	Public Works and Government Service of Canada
SANDEC	Sanitation in Developing Countries
SoER	State of Environment Report
SWM	Solid Waste Management
SWMD	Solid Waste Management Division (Namibia)
UN	United Nations
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational Scientific and Cultural Organisation
WBCSD	World Business Council for Sustainable Development
WHO	World Health Organisation

CHAPTER ONE: INTRODUCTION

1.1 Background

Solid waste is more easily recognized than defined and its' most noticeable character is its being ubiquitous with mountains of matter pilling up every day, encouraged by an affluent throwaway modern culture where items are purchased and discarded as the owner seeks for newer and what is deemed better products. The serious problem of waste is a relatively modern phenomenon with the earliest reference to the word being found in the sixth report of the deputy keeper of public records in England in 1764. Earliest reference to waste disposal which is a waste management strategy was by Michael Faraday in his chemical manipulation experiment of 1827 (Gourlay 1992).

At least 60% of the countries that submitted national reports to the United Nations in advance of the 1992 Earth Summit said that among other environmental concerns solid waste build-up was one of their biggest concerns (GDRC-2010). This is due to inadequate coverage in terms of scope, of the rapidly growing urban populations of the developing countries coupled with operational inefficiencies of solid waste management services. Other handicaps are limited utilization of formal and informal private sectors in recycling activities and existing technology gaps in management of hazardous solid waste (Zurbrugg et al, 1998).

Solid waste is generated universally and is a direct consequence of all human activities. It is estimated that on a global scale, the amount of solid waste generated per day reached 1.84 billion tonnes in 2004, this representing a 7% increase on the 2003 total- (UNEP Paper, 2012) . It is further estimated that between 2004 and 2008 generation of municipal solid waste worldwide rose by 31.1% representing an annual increase of some 7 %. The worldwide generation of solid waste continues to increase and is influenced by growth in consumption mainly in the developed world and by rapid population growth, urbanisation and solid waste management inefficiencies in the developing nations of the world (UNEP Paper, 2012). Overall, low income countries with the lowest percentage of urban populations also have the lowest waste generation rates ranging between 0.15 to 0.33 tonnes per person per year. Generation of

waste also seems to be influenced by GNP per capita with countries having less than United States Dollars 400 producing less than 0.25tonnes per person per year of solid waste. As the GNP increases towards middle income range the per capita generation rates also increase to range between 0.18 and 0.40 tonnes per year (ADB 2002).

In the developed countries, the last two decades (from the 1990s) has seen waste generation increasing nearly threefold. In the United Kingdom approximately 434 million tonnes of solid wastes are generated annually (Themelis et.al,2004) while a 2001 survey of solid waste in America found out that generation of solid waste increased by 11 million tonnes every year between 1990 and 2000-(Themelis et.al,2004). The generation rate for the developed countries is currently on average 1.22 kilogram per capita (Beukering et al, 1999).

In the developing countries data shows that Latin America which is the most urbanised region of the world generates approximately 522,000 tonnes of solid waste on a daily basis and its average is 0.90 kg/day per person. Brazil generates on average 1.106 kg/day per person while Buenos Aires, Argentina's largest city generates an average of 1.5kg/day per person (Waste Management World, 2012).

For Africa's major cities solid waste generation is estimated to range between 0.3-1.4 kilogrammes per person per day- (Beukering et al, 1999). With the rapid economic growth of the world's least developed economies, solid waste generation is expected to grow fivefold by 2025-(ADB Report 2002). The accumulation rates in the developing countries are very high due to increase in urban populations as well as the increase in variety of non-biodegradable materials such as polythene and plastic packaging materials (Muthoka et al 2005).

At National level Kenya has made strides in overall management of the environment. However current institutional framework is characterised by fragmentation (GOK, 2007). The Environment Management and Coordination Act (EMCA 1999) has the primary objective of improving the coordination and management of the environment and does this by operation of relevant laws and regulations which have been legislated. The effort at National level has been commendable; this demonstrated by the country's hosting of United Nations Environment

Programme (UNEP) and United Nations Human Settlements Programme (UN-Habitat) headquarters, which gives the country international exposure to international standards in environmental matters as well as expertise through knowledge transfer to the domestic environment.

In addition the country is a signatory to a number of Multilateral Environment Agreements (MEAs) such as Agenda 21, Montreal Protocol, Basel Protocol, Stockholm Convention, Kyoto Protocol and CITES-(Vision 2030, 2007). The country's Vision 2030 development agenda in terms of control of Pollution and management of solid waste were spelt out as; 1)to establish fully functional solid waste management systems in 5 municipalities/counties in the Special Economic Zones (SEZs); 2) Sustain enforcement of new regulations on plastic bags;3)Development and enforcement of pollution and waste management and hazardous regulations; 4)Design and application of economic incentive/disincentives; 5) Public-Private partnership for municipal waste;6) Reduction of oil with high sulphur content and; 7) Education for sustainable development (GOK 2030,2007).

Among the envisaged flagship projects towards achievement of the solid waste management objectives at National level is the relocation of the Dandora waste dumpsite. In addition the Government subscribes to the requirements of the Agenda 21 Rio declaration which laid out the needs to be met so as to reduce wasteful and inefficient consumption in some parts of the world while encouraging increased but sustainable development in others (Agenda 21, 1992).

Literature on Solid waste associated issues in Kenya is to a large extent concentrated on the Nairobi area. The generation rates are well documented for the Nairobi city with (JICA 1998) study estimating the daily generation to be 1530 tonnes. Of this quantity about 1267tons is from households while approximately 17.2% (that is about 263tons) comes from non-domestic sources. By 2004 the Integrated Technology Development Group estimated the generation rate to have risen to approximately 2400 tons/day. By year 2010 generation rates had risen to 3121 tons per day (Kasozi, 2010) , this representing an increase of close to 30% from the 2004 figures of ITDG and 100% increase on the JICA (1998).

1.2 Statement of the Research Problem

The current state of solid waste generation for the City of Nairobi is a serious concern and recent data has shown progressive increase in absolute quantities as well as in the forms of waste generated in the City of Nairobi over the years from the 1970's when the first citywide data was collected. Two variables are considered in this research for study of the role they play in the prevailing solid waste status of the city of Nairobi.

The first of these factors is population. Having been founded in 1902, it took approximately forty years for the city's population to reach 100,000 persons. By the time the country attained independence in 1963 the city's population had increased to 350,000 (Olima, 2001). The population surpassed 1Million mark in the 1980's (GOK/UNEP, 2009) and was just above 2.1 Million by the 1999 population census data. The early growth of the population was fuelled to a large extent by rural-urban migration with an explosion of such growth taking place between 1979 and 1989 when 772,624 people came to the city from other regions of the country (NEMA, 2003).

The large and growing population is one of the forces compounding the city's environmental challenges among which is a corresponding growth in solid waste generation which in addition has not been accompanied by an equivalent growth in capacity to address the problem. The diminished capacity coupled with institutional inefficiencies only worsens the solid waste build-up problem in the city of Nairobi. The last two decades for instance have seen deterioration of solid waste disposal services with the collection efforts consistently managing only about 25% of the total solid waste generated compared to the 1980's and before when the city authorities were managing over 90% collection rate, (JICA 1998).

The second factor considered is the type of economic or business activity. Social and Economic forces have had an effect on solid waste generation in the city of Nairobi and Kenya as a whole. In 1989, majority of Kenyans were working in family farms and this has been largely constant (World Bank, 2007). However the number of non farm workers has been steadily growing especially in the services sector (World Bank, 2007). The 2009 census indicated that 14.3

million Kenyans were gainfully employed with 6.5 million of these in family farms, 2.7million in non-farm self employment and 5.1 million in wage jobs (World Bank, 2007). Most non-farm jobs in the country are in the urban areas with Nairobi which is home to approximately a quarter of the urban population in Kenya offering up the larger percentage.

The prevailing economic activity of a region has an effect on quantities and type of generated solid waste (Hoornweg, 2012). In addition Solid waste generated is changing in type from easily degradable material to complex forms which is a function of types of productive processes, people's tastes and consumer habits and in Africa for instance these have changed drastically in the last decade especially in relation to production and consumption of electronic goods (Jensen, 2003). From this, it can be inferred that type of business can have an effect on quantities of solid waste generated in an entity such as a commercial building, which is subject of this study.

Invariably the general condition of solid waste generation for an entity such as the City of Nairobi cascades to unitary solid waste generators who may be commercial, industrial, residential, or other entities. The tenets of prudent waste management have at the top of the hierarchy, Prevention followed by Reduction and others emphasizing minimisation in waste volumes generation-(Fatta et al 2003).

This hierarchy deliberately recognises generation as one of the most critical aspects stakeholders should deal with in solid waste management. If generation can be curtailed, downstream management of solid waste would be a lesser challenge. This is important for environmental expediency and for an ecologically sustainable development.

The intention of this research was to examine the role of staff population and business type in generation of solid waste quantities in Anniversary Towers which was the study area. This facility is a commercial highrise building located in Nairobi's Central Business District with University of Nairobi its most prominent neighbour across the University Way. At the time the data was collected in year 2011 approximately 180 kilograms of assorted solid wastes were being generated on a daily basis by all forty-six businesses resident in the building. Evidence of

the generation is in the ubiquitous moulds of solid waste noticeable in working areas, along corridors, basements and naturally in the holding room from where waste is collected for eventual disposal. Generation can fluctuate influenced by seasonal work related activities by major businesses, a classic example being the Independent Electoral and Boundaries Commission (which is a major tenant in the building) in an election year where huge amounts of paper waste are generated.

It can also fluctuate in terms of type constituents and overall quantities depending on activities such as; construction, renovation and repairs undertaken from time to time by both the landlord and tenants. Staff population and business type were the variables hypothesised as contributory to the generated quantities.

1.3 Research Questions

This research was guided by the questions

i) What are the different types of solid wastes generated by different Businesses in Anniversary Towers on a daily basis, and in what quantities?

ii) What is the per capita solid waste generation of each Business organisation?

iii) Is there a relationship between businesses' staff population and the quantities of solid waste generated?

iv) Does type of business influence solid waste quantities generated?

v) What other factors could be responsible for solid waste generation patterns by the different businesses?

1.4 Overall Goal and Objective

The overall goal of this research is to study solid waste generation by businesses in Anniversary Towers.

1.5 Specific Objectives of the Study

The study's specific objectives are;

i) To study the influence of staff populations on solid waste generation.

ii) To study the influence of business type on solid waste generation in Anniversary Towers.

1.6 Hypotheses

H_0: There is no significant relationship between staff population in a business and the amount of solid waste generated.

H_0: There is no significant relationship between the type of Business and amount of solid waste generated.

1.7 Justification of the Research

This research was justified by a need to highlight diverse businesses 'role in solid waste generation in the workplace. Generation of wastes in a productive process is indicative of some level of inefficiency with the less the waste generated the more the efficiency of a business. Economic development in the modern day is expected to be achieved with due consideration to environmental sustainability, hence the principle of eco-efficiency in judging a business's overall performance.

Secondly the study was justified by the need to add to existing research knowledge on solid generation and waste management in general, and especially on solid waste from commercial sources. Much research has been done on residential source solid waste and solid waste in general without focusing on the source question compared to solid waste emanating from commercial sources. The study was also justified by need to increase to existing local data on solid waste generation aspects. General dearth of data relevant to the area of study was a

source of frustration for much of the study. It is expected that future researchers may find this research helpful in investigating similar fields of study.

1.8 Choice of Anniversary Towers

Anniversary Towers was picked as an ideal study area for this study for various considerations.

The building has variety in terms of the tenant mix making it possible Among the factors is the building's good mix of different businesses which makes solid waste generated there-in truly representative of most commercial sources. The building's tenant inventory includes government related organisations, which fall under the public sector category occupying approximately seventy five percent of the office block and private sector organisations occupying about twenty five percent of the office block and the entire shopping complex on ground floor and mezzanine floors. This is important to this research because Public sector organisations are governed and operated differently from the private sector, depending on the objectives for which they exist, which in turn influences the way these two categories generate solid waste.

Apart from categorization as private sector or public sector, the businesses operating in Anniversary Towers represent diverse business sectors. The building has two restaurants, four apparel dealerships, two beauty shops, a dry cleaner, a photographic outlet and a fairly large banking institution. Others are realty professionals, legal practitioners, stationery shops and electronic goods outlets. In addition the building has one foreign Embassy and an international donor agency among its tenant catalogue. This gives the building a truly representative variety of contributors to commercial source solid waste.

The building was also found ideal for this research because most floors especially ones used as offices are occupied by singular tenancies making it convenient to ensure non cross contamination of solid waste from one tenant to the other.

Finally a most important factor considered in the choosing this building as the study area was the researcher's familiarity with the building having operated from within for a considerable period of time. This was an advantage in data collection for the reason that the respondents from whom information was sought were comfortable divulging such information to a fairly well known person. Collection of solid waste from each business before it mixed with the general stream required a level of trust, which could only be realised if the businesses and the building management were familiar with the researcher.

This research was designed to address the research questions; how much solid waste is generated by different businesses in Anniversary Towers on a daily basis, what are the different types, what is the per capita and per unit area generation and if type of business has an influence on the amounts generated. It also looked at possible role of other factors in generation of solid waste.

1.9 Scope and Limitations

The study was restricted to Solid waste generation in Anniversary Towers' building environment. In gathering data on generated wastes, the research excluded hazardous wastes from a Chemist Shop on the building's ground floor. The shop was not solely dispensing medicine but also undertaking minor laboratory related operations and the research considered its incapacity to deal with wastes so generated.

Factors that favoured this research included the relatively readily available general information on solid generation and management from which inference could be made in the absence of information specific to the study topic. Material on solid waste generation is widely available in form of literature from books, journals, newspapers and increasingly from the internet. Much of the information is quite recent and hosts of scholars have covered the subject.

Easy access of information from the specific organizations which were subject of this study was anticipated and realised. Invariably some challenges were expected and encountered in researching on this topic. Lack of readily available specific information was encountered

especially with government associated Businesses. Apart from confidentiality, grasp of solid waste management topical issues was a challenge. Apathy towards information gathering was also an impediment to quick data collection.

1.10 Definition of Terms

1. **Waste**- The National Environment Management Act of Kenya (NEMA) -2006 regulations describes waste to be any substance or object a person discards or is required to discard. The object is deemed to retain the status of waste until it is fully recovered and no longer poses potential threat to human health or the environment. The Basel Convention (1992) defines waste as substances or objects which are disposed off or intended to be disposed of or are required to be disposed of by provisions of national laws-(Basel Convention Publication 1992). The W. H O defines waste as something the owner no longer wants at a given place and time and which has no current perceived market value-(Suess 1983). Dictionary definition of waste is in synonyms such as superfluous, refuse, reject, unused materials etcetera-(Chambers Dictionary-1986). Zero Waste America a non profit environmental organization's definition of waste introduces the concept of waste as a resource that has not been safely recycled back into the environment or the market place.

2. Solid Waste is defined as any solid or semi solid garbage, refuse or rubbish and other discarded material remaining from industrial, Commercial, Institutional, Residential or Community activities (Habitat, 2010)

3. Commercial solid waste or business waste is defined as waste arising from premises which are used wholly or mainly for trade, business, sport recreation or entertainment excluding municipal and industrial waste-(www.cips.org, 2007)

4. Ecodesign-Design in line with environmental considerations

5. Solid Waste Management- is the management of wastes emanating from productive processes in the case of this study commercial productive processes. An efficient solid waste

management system should be guided by modern concepts of waste management key of which is Waste Hierarchy. This (waste hierarchy) concept is used to grade waste management strategies according to their desirability. Waste prevention is perched at the top, followed by prevention, reuse, recycling energy recovery and disposal at the bottom- (Russell et.al-2009).

6. Eco-efficiency-is defined by the United Nations Economic and Social Commission for Asia and Pacific(ESCAP) as a key element for promoting fundamental changes in the way societies produce and consume resources and thus for measuring progress in green growth-ESCAP-UN Publication (2009)

7. Multi Level Marketing- is a marketing strategy used by companies in which the use of middlemen is eliminated. Independent agents serve as distributors instead and are paid commissions (Business dictionary .com, 2013)

8. Waste Hierarchy- Ranking of waste management options in terms of desirability. Prevention of generation is ranked at the top, followed by Reduction/Minimization, Reuse, Recycling, Energy Recovery and Disposal-(Russell et.al, 2009).

CHAPTER TWO: LITERATURE REVIEW

2.1 Background

This Chapter looks at existing literature on the solid waste problem in the world specifically highlighting solid waste generation aspects. The inevitability of generation of waste necessitates proper management of the waste to ensure safeguarding of the environment as well as avoid the cumulative effects of improper solid waste management. Different researchers in different regions of the world have explored different aspects of solid waste generation coming up with proposals addressing specific problems.

This study is specifically on solid waste generation at the work place. The review of existing literature is organised in thematic approach arranged to deal with generation issues at global level, developed countries, developing countries, Africa, Kenya and Nairobi. Gaps in the reviewed studies are pointed out and opportunities for further research stated. The research picked a few of the more compelling and relevant past studies in the topic which are reviewed in substantial details.

2.2 Global Solid Waste Generation:

(Hoornweg et al, 2012) estimated current global generation of solid waste to be 1.3 billion tonnes per day and projected the generation to increase to approximately 2.2 tonnes per day by 2025 (Hoornweg et al, 2012). The study projected per capita generation to increase from the current 1.2 kg per person per day to 1.42 kg per person per day in the next fifteen years. The study stated that solid waste generation rates are influenced by level of economic development, degree of industrialization, communities' habits and local climate. It noted a high correlation between income levels and urbanization which translates to high disposable incomes and high living standards leading to corresponding increase in generation of waste.

Further, (Hoornweg, 2012) approximated that Sub-Saharan Africa generates approximately 62 million tonnes per year with the average per capita waste generation at approximately 0.65kg/capita /day. East Asia and the Pacific region was estimated to generate approximately

270 million tonnes per year with per capita generation ranging between 0.44 to 4.3 kg per person per day and the average being approximately 0.95 kg/capita/day. East and Central Asia was estimated to churn out 93 million tonnes of solid waste annually with per capita generation ranging between 0.29 to 2.1 kg per person per day and on average 1.1 kg/capita/day

Latin America including the Caribbean was estimated by the same study to generate approximately 160 million tonnes and per capita range between 0.1 to 14 kg/capita/day with an average of 1.1 kg/capita/day. Middle East and North Africa generation was estimated at 63 million tonnes per year with per capita generation of between 0.16 and 5.7 kg. Organisation for Economic Cooperation and Development (OECD) countries at 572 million tonnes per year are the heaviest solid waste generators according to the study. Their per capita values range between 1.1 and 3.7 kg and an average of 2.2kg/capita/day. South Asia was estimated to generate approximately 70 million tonnes of solid waste annually with a per capita range of 0.12 to 5.1 kg per person per day and an average of 0.45 kg/capita/day. Overall the study noted that the normal trend is for high income countries to generate more solid waste per capita while low income countries produce least solid waste per capita.

The study's findings were; that average waste collection rates are directly related to income levels with low income countries having low collection rates at around 41% while high income countries have high collection rates at an average of approximately 98%. The study concluded that waste composition was a function of factors such as level of economic development, cultural norms, geographical location energy sources and region's climate.

The gaps identified in Hoornweg were that the study being global in geographic reach looked at waste generation in Macro terms. Its primary concern was not the primary generator of solid waste but the regional geographical contributions to the global total. The gap to be filled in this study is to concentrate on primary generators and focus on a smaller study area.

(Tchobanoglous et al, 1996) was a global research on the issue of Solid waste generation and management in terms of efficiency in SWM responses in all the regions of the world**.** The study addressed solid waste management by proposing an integrated approach of managing the

problem suggesting that the approach should be comprehensive and most importantly collectively address the issues of waste generation, handling, collection, sorting, its transfer, transport and eventual disposal.

These tasks according to the study should be executed in a manner conforming to the best principles of public health, economics, engineering, conservation, aesthetics and other environmental considerations as well as in tandem with prevailing public attitudes. The study's main finding was that an integrated solid waste management approach recognises the importance of many factors; environmental, economic, social and cultural and how they interrelate in influencing the efficiency of a solid waste management programme. These are important for the success of any integrated solid waste management regime.

(Schubeler, 1996) was another research with a geographical global reach. It summarised the goals of solid waste management as being to protect environmental health, to promote the quality of the urban environment, to support the efficiency and productivity of the economy, to generate employment and income. The study by Schubeler stated that the essential condition for sustainability implies that 'waste management systems must be absorbed and carried by the society and local communities'. The study emphasized a strategy for sustainable solid waste management aiming at; minimisation of solid waste generation, maximisation of recycling and reuse and ensuring safe and environmentally sound disposal of waste.

The above two were studies on integrated approach in solid waste management. They were specifically advocating recourse to a particular management method and at global level. The issue of factors involved in generation of solid waste or the source issues were not primary objectives of the studies, and this is the gap in knowledge that further research is called for to narrow the existing gap.

2.3 Regional Solid Waste Generation

(Pfammater et al, 1996), dealt with solid waste generation issues by looking at collection of refuse in low income urban areas by non-governmental bodies. The study was done in low income urban areas in Asia, Africa and Latin America in the cities of Panaji (India) Receife (Brazil), Cajamarca (Peru) Shanghai (China) and Ouagadougou (Burkina Faso).The concern that prompted the study was that despite substantial resource allocation to solid waste collection efforts, authorities in many urban regions of the least developed countries were unable to adequately cover much of the needy population in terms of service provision. The research found the reasons for this failure to be; limited awareness of solid waste management issues, poor allocation of resources to this effort, low political priority of solid waste management issues, adoption of inappropriate technologies, operational deficiencies and rapid urbanisation, fuelled by rapid growth of urban population.

The study proposed adoption of user friendly waste management regimes in terms of technology employed, suitable operational patterns and technical coordination, as factors that would influence efficiency of the chosen solid waste management regime and support its sustainability. In addition the study stressed the importance of appropriate organisation and management in establishment of successful solid waste management schemes. The key actors in a successful solid waste management scheme were stated to be the inputs of local Government, NGOs, formal private sector and informal private sector.

The above research was primarily concerned with solid waste collection effectiveness. It did not address generation in terms of prevention, reduction and other proactive solutions and was therefore reactive. The study was global dealing with several countries and regions and therefore comparatively large geographical area and was not specific on solid waste generation source whether commercial, residential or industrial but rather on solid waste management efficiency in the regions subjected to the study. The study gap lies in the necessity to add to the knowledge by filling in the omissions.

2.4 Solid Waste Generation in Developed Countries

(DeGeare et, 1971) in studying commercial solid waste generation rates in **United States of America** considered thirty two commercial establishments for analysis. The study was based on eight independent variables relating to quantity of solid wastes generation, which were; number of hours businesses were open per week, number of business days open per week, average annual gross receipts, square footage, average inventory in dollars, equipment value in dollars, number of delivery days per week and number of employees. It also included five independent variables to identify the five different types of establishments studied, which were clothing, drug, grocery, restaurant and hardware stores. The **staff numbers** and the number of hours open were considered the most significant variables to predict commercial solid waste generation rates. The study showed that the measured solid waste generation at different businesses could be correlated against multiple independent variables using stepwise regression analysis to generate a statistically significant relationship.

The above study addressed the issue of solid waste by way of attempting to predict solid waste generation rates. The issue of what was responsible for the generation did not feature and was not a primary concern. A gap in knowledge exists in exploring the causes of generation which once identified, may help in management of solid waste.

(Howell et al, 2002) addressed generation of solid waste by restaurants in **Brevard County Florida**. The researcher was trying to ascertain if billing rates for solid waste collection was appropriate or if a different rate structure should be implemented. The weight and volume of solid waste generated was measured daily for two weeks in winter and two weeks in summer. Data was collected on weight of waste per collection, volume per collection, container utilization factor, building area and contract collectors' bill. Other aspects for which data was collected were; yearly property tax, yearly solid waste tax, number of employees, average collections per week, restaurant type, storage container size, density of waste, number of hours open per week and weekly collection capacity. Multiple regression analysis was used to determine relationship between the dependent variable (weekly solid waste generation rate)

and the independent variables. Of all the independent variables tested the number of employees was found to have the highest partial correlation a strong indication of its influence on solid waste generation **(Howell et al, 2002).**

(Howell et al, 2002), was primarily a research on billing correctness for disposal of solid waste generated by restaurants. It examined roles of multiple variables some of which (like yearly solid waste tax) are not yet relevant in the Kenyan solid waste management landscape. It was less concerned with factors contributing to solid waste build-up in the first place leaving this as a gap in knowledge which needs further study.

2.5 Solid Waste Generation in Developing Countries

(Phuntsho et al, 2007) was a study of solid waste generation in **Bhutan,** a country in eastern Himalaya wedged between China, India and Tibet. The study covered ten towns in the country covering both domestic and non domestic solid waste generation sources.

For commercial generators, the research estimated per capita generation to range between 1.6Kg per day and 3.1 Kg per day. The highest generator town had a mean of 3.12 Kg per day followed by the second at 3.1Kg per day. These two towns had the highest number of hotels and resorts implying that hotels and resorts are the highest generators of commercial source solid waste compared to **other businesses**. Office originating solid waste ranged between 1.0 Kg and 2.9Kg per day with a mean of 1.57Kg per day. The offices had an average staff population of 16.5. Overall the highest solid waste composition was organic matter at 50%-66% followed by paper at 11.5%-25%, plastics at 9%-16% followed by textiles 3%-11%, glass 2%-9%, metals 0-3%, electronics 0-2% and others classification. The research noted average annual population growth to be 1.28% but the urban population growth to be at 7.3%.

The above study was a country wide research and had a good balance classifying waste in terms of sources it was generated from. The gap identifiable for further study is in its non concentration on a specific generator source for instance commercial or residential. More

research would be necessary to highlight quantities and rates specific to a particular generator and in more details.

(Palczynski, 2002) did a research on solid waste generation and management in several **African countries**. The study's main objective was to contribute to the improvement of solid waste management systems in Africa and to promote appropriate management policies on national, regional local and sectorial levels. The study addressed solid waste generation and management issues in the municipalities of Cairo-Egypt, Capetown-South Africa, Nairobi-Kenya and Accra-Ghana.

Among its findings, the study highlighted that; Waste characterization data specific to African Cities is generally not available, that composition of solid waste varies depending on variables such as urbanisation, commercial enterprises, manufacturing and service sector activities. It also concluded that Solid Waste Management (SWM) in most of African countries is characterised by inefficient collection methods, insufficient coverage and improper disposal. In addition none of the countries researched on had specific waste management legislation though in some the legislation process was ongoing. There was also lack of regulatory initiatives towards solid waste generation prevention or minimization. The study crucially pinpointed a lack of proper communication channels between stakeholders in SWM especially between government and civil societies as well as existence of secrecy and misinformation which are major hindrances to proper SWM in the African Countries. On a positive side the study noted emergence of initiatives in waste management at home, in schools, offices, businesses, local governments and public institutions.

For Nairobi the study noted a proportional increase in generation of solid waste as the population grew. Its principal source of data on solid waste generation was the (JICA, 1998) study based on which the research summarized waste generation as 6.79 kg/day for mixed areas, 2,400kg/day for zoned market areas and 0.654, 0.595 and 0.565kg/capita/day for high, middle and low income neighbourhoods respectively. In terms of percentage solid waste makeup the research had food waste at 51.5%, Paper-17.3% plastics at 11.8% while glass, wood, metals rubber and others completed makeup. The research gave the percentage

contribution of households as the highest at 50% followed by industries at 20%, and schools (and institutions) at 20%. Among the problems cited by the study as hindering efficient waste management for the City of Nairobi were; inadequate financing, policy makers apathy towards SWM and inadequate training of managers.

The above study looked at the existing situation of waste generation and management in several African cities but it did not address the issue of causes of generation and the effects. This is a gap that requires further study. The study in addition did not address the primary generator and focused on downstream issues of solid waste management like disposal, collection and transfer and the handling of the already generated solid waste. These omissions are the gaps for which further research is necessary.

(Babayemi et al, 2009) researched on solid waste generation, categories and disposal options in developing countries with **Nigeria** as the case study. The study's objective was to provoke those concerned with environmental management in Nigeria to rescue the country from what the study construed to be an alarming rate of solid waste generation. The study used extensive literature review, administration of questionnaires, interviews and personal observations for collection of data. Data so collected gave the overall per capita generation in the country to be 0.58kilogrammes of solid waste per person per day. Some cities sampled had generation rates of; Abeokuta- 0.60kg/person/day, Ile-Ife- 0.46/person/day and Ibadan- 0.71Kg/person/day. In terms of quantities Lagos with an estimated population of 10.3 million dwellers was approximated to generate 3.7 million tonnes per year in 1990. Other estimates were for Kano 450 tonnes per day with a population of 1.4 million in 1994 and Warri in Delta state at 164,029 tonnes per year in 2002. The study's findings were that quantity and generation rate depended on a **region's population**, level of industrialisation, **socio-economic** status of the citizens and the predominant commercial (i.e. business) activities.

The above study recognised the role of population and business type in determining quantities of solid waste generated. The identifiable gap is in the study's generality of its topic choosing solid waste generation as a whole without discriminating the source.

(Hasheela, 2009), in his unpublished PhD. thesis addressed the issue of Municipal Waste generation and management in **Namibia** with the City of **Windhoek** as the Case Study. The case study research was used as an approach to establish an understanding of the topical issue by focusing on a specific town instead of being general. Its overall aim was to investigate how waste was being managed at municipal level so as to recommend a system for handling waste across urban Namibia in future.

The research's specific objectives were; to identify the principles of waste management in Namibia, Stakeholder identification, establishment of an understanding of Windhoek's waste management systems and identifying areas of improvement in terms of waste management in Namibia as a whole. The research dealt with general municipal waste which comprises of waste collected by municipalities which includes household waste, business waste, institutional waste and all other sources in a typical municipality. From solid waste audits performed in 2004 and 2008 average daily waste generation per person were 0.37Kg and 0.49Kg respectively. In an economy dependent to a large extent on exploitation of natural resources approximately 14,159 tonnes of building rubbles and 2,204 tonnes of domestic rubbles were generated and disposed of every month. In addition 119,916 tonnes of sand and concrete waste were disposed of in 2008.

The study's findings were that waste generation was dependent on population density, Gross Domestic Product (GDP) and income levels quoting (Christiansen, 1999; (Henry et al, 2006) (OECD, 2002) (SoER, 2001); (SWMD, 2004); (SWMD, 2008) and recommended the importance of Waste auditing as a crucial and practical aspect of waste management. The study concluded that despite many weaknesses, Windhoek and other Namibian cities were managing their wastes and only needed to address the weaknesses.

The above study was not about establishing causal relationship in solid waste generation. It was an exercise in understanding the principles operational, the principle players in waste management issues and after understanding the systems at work suggesting management

improvements. Study of the causal relationship between variables was not featured in this research and is therefore the gap that calls for further study.

2.6 Solid Waste Generation in Kenya

(Gakungu et al 2012), examined solid waste management and generation in Public Technical Training Institutions in **Kenya.** From a population of 42 technical training institutions, a sample of 29 (73%) was selected for study. The solid waste generation data showed that the 29 institutions generated approximately 23 tons of solid waste on weekly basis. The study's main source of information was respondents as well as direct observations which involved collecting waste in bags and weighing it.

Principle among the study's findings was that the basic factor in generation of waste is **population.** It also concluded that waste generation rates for technical training institutions was dependent on institution type with for instance institutions having boarding facilities generating more solid waste than institutions without boarding facilities and institutions of technology having the highest per capita generation at 0.71Kg/week/student while National polytechnics at 0.28Kg/week/student the lowest. Further the study findings concluded that institutions with technical courses produced more waste than institutions offering business courses.

The above research addressed solid waste generation issues in institutions largely under one industry i.e. technical training institutions. The amount and type of waste generated within the different subclasses of these institutions may not find much variance because of the industry homogeneity. The study gap is in the need to add to the knowledge available in this field by examining solid waste generation and management by diverse productive activities in the economy.

An unpublished Project paper by **(Ambuchi 2006)** looked at solid waste generation and management and addressed specifically Plastic waste management in Kenya. The study highlighted the lack and limitations of regulations to deal with the plastic waste menace and the lack of clear guidelines on what constitutes waste. The study's main objective was to review

policies and regulations governing management of plastic bags and bottles solid waste, highlighting the importance of prevention, minimisation, recycling and reuse.

This was a study of effectiveness of legislative compliance measures in management of one form of waste- i.e. plastics. It was largely qualitative in content and was not concerned with the origin issues in terms of who are the primary generators. In addition it covered the country as a whole-unlike the research on solid waste generation and management issues in Anniversary Towers which dealt with the solid waste source issue and concentrated on a smaller geographic area.

2.7 Solid Waste Generation in Nairobi

A study done by **(Kasozi, 2010)** had the objective of explaining the thinking, modeling and assumptions made in development of specific Integrated Solid Waste Management for **Nairobi.** Solid waste generation aspect featured prominently in the research. Data for this research was sourced mainly from studies on waste management in Nairobi, preliminary zone surveys and waste characterization audits carried out by UNEP, City Council of Nairobi and by stakeholder workshops in 2009. The study looked at the aspects of waste in the themes of waste generation, characterization and management options in Nairobi among other themes.

The research estimated total solid waste generation for the city to be 3121tonnes per day in 2010, which represented 30% increase on the 2400tonnes per day estimates for 2004 by ITDG (Bahri, 2005) and a 100% increase on the 1530 tonnes per day 1998 estimates by (JICA, 1998). In linking population growth to waste generation for the City, the study tabulated estimates of both variables from 1998 to 2030. Further the study linked economic growth to solid waste generation noting an upward shift in Gross Domestic Product from Kenya shillings 900,000/- in 1996 to approximately Kenya shillings 1,400,000 in 2008. The research concluded that the upward trends in population growth and welfare were consistent with the upward waste generation trends-Kasozi (2010)

In waste characterization, the research addressed the waste streams from Nairobi's residents, businesses and institutions which included schools, colleges and universities. It also considered

non-toxic solid waste from health providers. The specific objective in characterization of waste was to determine the current character of the city's solid waste and to determine the role of the variables of generator type and zonal location in the character of waste.

The Offices and workplaces dealt with in this study returned solid waste percentages of 25.9% for organic matter, 42.1% paper, 17.1 % plastics, 0.1% Glass, 0.8% metal and 14% other types combined. Overall waste composition for Nairobi sampled at immediate source gave organic matter 51.0%, Paper 17.5%, Plastic 16.1% Glass 2.0%, Metals 2.0% and others combined at 11.4%.

The research's findings were that there was little effect of zones on solid wastes composition hence offering no evidence for specific zone based waste intervention measures. The results proved existence of substantial influence of the type of primary generator on the City's waste character i.e. that waste character in Nairobi is different across generator types and therefore proposed that intervention policies targeting specific waste types should be directed at specific generator groups.

The study by Kasozi covered a considerably large geographical area in the form of the City of Nairobi. In doing so, the study addressed solid waste from virtually all types of generators in terms of residential, commercial, industrial, institutional and even from health facilities albeit the non-hazardous form. It therefore was quite general in this aspect leaving a gap for further studies in terms of focusing on a smaller geographical area while examining more or less the same issues.

Further, the study by Kasozi approached the issue of population and solid waste generation by looking at the effect of increase in population of the City over the years on solid waste generation quantities build-up. This model precludes other factors' (apart from population growth) role in solid waste generation and is this is a gap that requires further study.

(JICA 1998), looked at solid waste generation in Nairobi by the whole spectrum of generators namely; residential, commercial, industrial and from unspecified sources found in market

places and along roads. Among its major findings were that approximately 1,530 tonnes per day of solid waste were being generated in Nairobi.

The study approximated waste generation (then) by restaurants in mixed areas to be is 6.79 kg/day which is four times more than for other mixed class category (1.39 kg/day) while generation rates for residential high, middle and low income were 0.654, 0.595, and 0.565 Kg/capita/day respectively. It estimated generation by markets and roads to be approximately 2400Kg/market/day and 50Kg/Km/day respectively. In terms of percentage consistency of waste type, food waste contributed approximately 51.5%, paper waste-14.5%, plastics 11.8% as the main types **(JICA, 1998).**

From this study it was observed that overall food waste dominated municipal solid waste generation in weight being slightly over half of all generated. This was attributed to the contribution of solid waste emanating from residential sources, eateries as well as commercial sources. In addition the water content in food ensures high mass from relatively smaller collections. General paper waste featured prominently contributing 17.3% of the total basket. This indicated not only a wide usage but also high rate of generation. Higher percentage of recyclable paper (14.5%) compared to other type of paper (2.8%) pointed to need for use of recyclable paper as a worthwhile option. Plastic waste at 11.8% made up a substantial portion of solid wastes generated in Nairobi. Most plastics the study noted could be recycled at minimal cost involving as simple a solution as just cleaning-especially where the plastic involved comprises of containers. The growing problem of increasing plastic waste generation coupled with the non-degradable nature of this waste is a complex problem for resource challenged economies especially in Africa.

The identifiable gaps in this study are to be found in the fact that it examined solid waste management and generation aspects in general and accordingly generated data on general solid wastes from residential, industrial, commercial and all other streams. Study of solid waste generation by a specific generator is called for to highlight that stream's contribution to the whole in terms of waste character and quantities. Studying waste generation in a smaller

geographical setting would bring out more intimate generation patterns that can only arise out of giving more focus to a smaller area.

(KENAO, 2008) did a study whose objective was to assess the level of compliance of the Nairobi City Council's current solid waste management framework and practices with established laws, standards and policies and to examine the economy and efficiency of the solid waste management methods used by the city council. The study examined solid wastes generated by households, commercial enterprises and public organisations among others, leaving out solid wastes generated by hospitals as well as other forms of hazardous solid waste.

The study's findings were that the per capita solid waste generation for Nairobi was approximately 0.29 to 0.66 kilogrammes per day. Approximately 21% of the solid waste generated emanated from industrial areas whereas 61% originated from residential areas the balance (18%) being generated by commercial sources- **(KENAO, 2008).** It recommended that to prevent or minimise waste generation, the city council should revise existing waste management by-laws to include provisions on waste prevention, launch waste management campaigns, encourage formation of business associations and strengthen existing ones. It also recommended seeking of support by other public sector stakeholders and assigning of suitable staff for enforcement of solid waste management by-laws. It also gave advice on control of waste generation and enhancement of recovery of waste.

The above was a study addressing the issue of compliance of the City Council of Nairobi waste management efforts with the existing legislations and regulations and its recommendations were therefore along the lines of solutions to plug loop holes for non-compliance. It examined solid waste management in Nairobi in general without emphasis on the origin in terms of commercial, residential or industrial. The necessity to study the contribution of a stream of solid waste to the total generation is considered necessary in building up knowledge in the overall solid waste topic and this is the gap in knowledge for which further research is necessary.

2.8 Theoretical Framework

In dealing with the topic of solid waste generation researchers have come up with many theories explaining various conditions in solid waste generation and man's response in terms of management options. The theories and concepts have been customised by different scholars to suit specific aspects of subtopics in this wide field of study.

This research was based on a cause and effect theory modeled on **(Pfammater et al, 1996)** Causes and Effects Theory**.** The Pfammater theory originated from a study of Non-Governmental refuse collection in low income urban areas in Asia, Africa and Latin America. The cities of Panaji-India, Receife-Brazil, Cajamarca-Peru, Shanghai- China and Ouagadougou-Burkina Faso were included in the study. The study was prompted by an observation that inadequate solid waste collection (in terms of coverage) persisted in many least developed countries despite considerable allocation of resources.

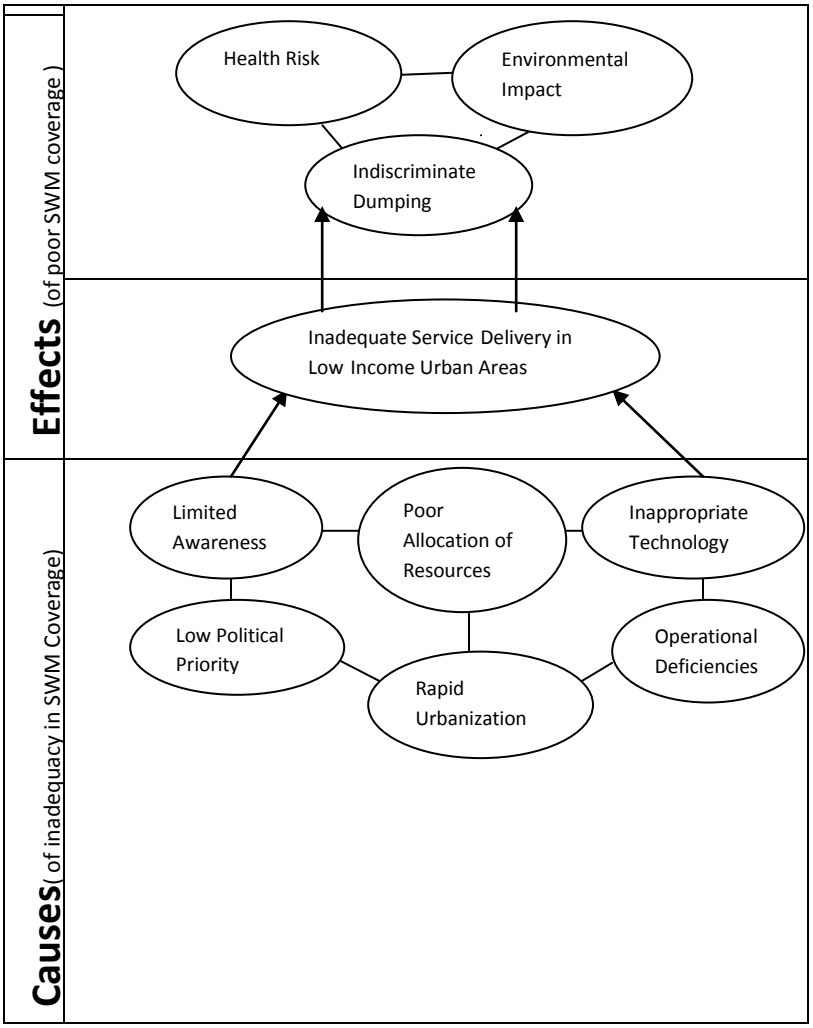
The study theorized the problem or cause of inadequacy in waste management coverage to be; limited awareness among the populace, poor allocation of resources, use of inappropriate technology, low political priority, rapid urbanisation and operational deficiencies in waste management schemes. These were the independent or causal variables. The effects of these variables were; resultant health issues, indiscriminate solid waste dumping and the attendant environmental impacts. These effects were the study's dependent variables. In the long run these effects impair quality of life of the most vulnerable populations and have negative impacts on the national economies.

To improve the situation, the study suggested involvement of affected populations in assuming responsibility for solid waste handling and to achieve this, three aspects of solid waste management would have to be considered. These are: technical and operational aspects, appropriate organisation and management, and thirdly costs and financing.

2.9 Conceptual Framework

The study's conceptual framework derived from the cause and effects model and proposed the causes of inadequate service delivery to be; limited awareness, poor allocation of resources, inappropriate technology, low political priority, rapid urbanisation and operational deficiencies. These shortcomings led to inadequate service delivery which in turn culminated in health risk, indiscriminate dumping and environmental impacts, as depicted by the conceptual figure below.

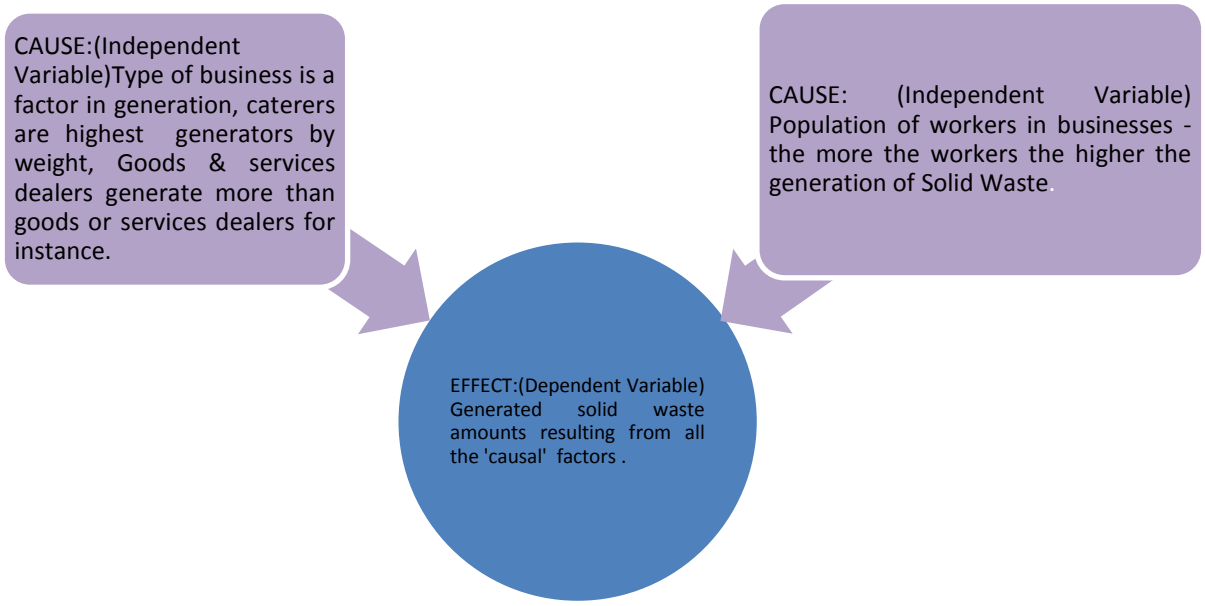
Figure 1.Causes and Effects of inadequate SW services (Pfammater and Schertenleib, 1996)



The study of solid waste generation at Anniversary Towers and variables contributing to quantities generated by businesses was based on the Causes and Effects theory borrowing from

the Pfammater model. The main independent variables examined were; the number of workers in a business organisation and the type of business, (offices or shops, restaurants, beauty shops/salons or other category). Minor variables considered were the policies adopted by businesses in solid waste management, the role of legislation especially the Public Procurement and Disposal Act and the Operational deficiencies and bureaucratic practices inherent in businesses which are deemed to have an influence on solid waste generation.

Figure 2. Conceptual Framework-Solid Waste Generation -Causes & Effects modified - Pfammater and Schertenleib (1996)



The number of workers in a business organisation is considered a significant variable to predict commercial solid waste generation rates- DeGeare et al (1971). Waste generation increases with population expansion-US epa.gov (2012). The higher the population the more the quantity and variation of the solid wastes generated and vice versa. Initial observations suggest that unit area occupied may have a positive influence on solid waste generation rates.

Type of business refers to the nature in terms of being a public body or a private firm, or its operations as a shop or an office or whether an organisation's business is in goods or services or both. The categorization was also broken down further into trades such as restaurants,

beauty shops/salons or apparel concerns. The type of business was demonstrated to have an effect on generation of solid wastes by the study's primary data i.e. the quantities of solid wastes recorded from each of the organisations. The study at the onset considered unit areas occupied to be a factor in generation but testing the hypothesis proved negative. Poor solid waste management policies or non existence of deliberate policies, alongside bureaucratic practices all amount to inefficiency in management which has a positive correlation with generation rates-(Zurbrugg et al, 1998). These factors together with the effect of Legislation's in solid waste generation and management were considered in recognition that the previous factors which were hypothesized as having an influence on generation, may not fully account for all the generation of solid wastes among the organisations.

CHAPTER THREE: THE STUDY AREA

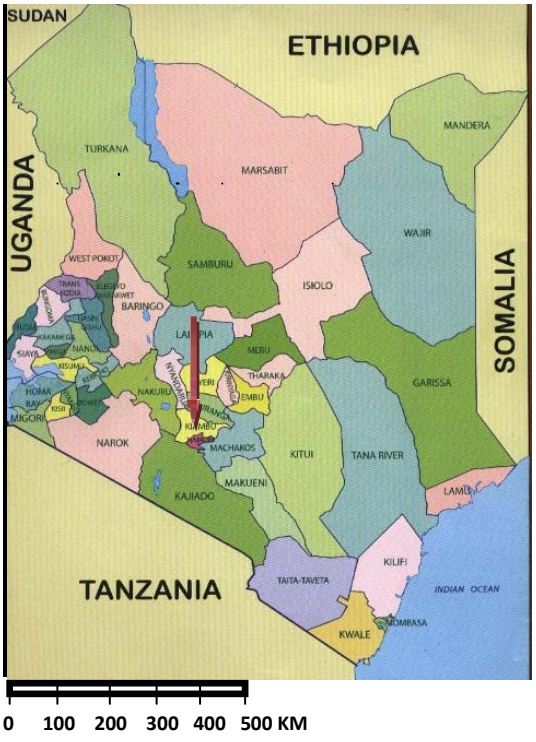
3.1 Introduction

This section introduces the study area in considerable depth and also describes the methods employed in collecting data to achieve the stated objectives and the way the research was designed to give possible answers to the research questions.

3.2 Kenya Background.

This study is focused on waste management aspects in a developing country-Kenya with a current population of approximately 38.8 Million in 2012(CBS 2007). The country spreads over 582,646 Square Kilometres with the Equator dividing it virtually in the middle.

Map 1- Kenya-Source: Nairobi County Location-www.geography website (2013)

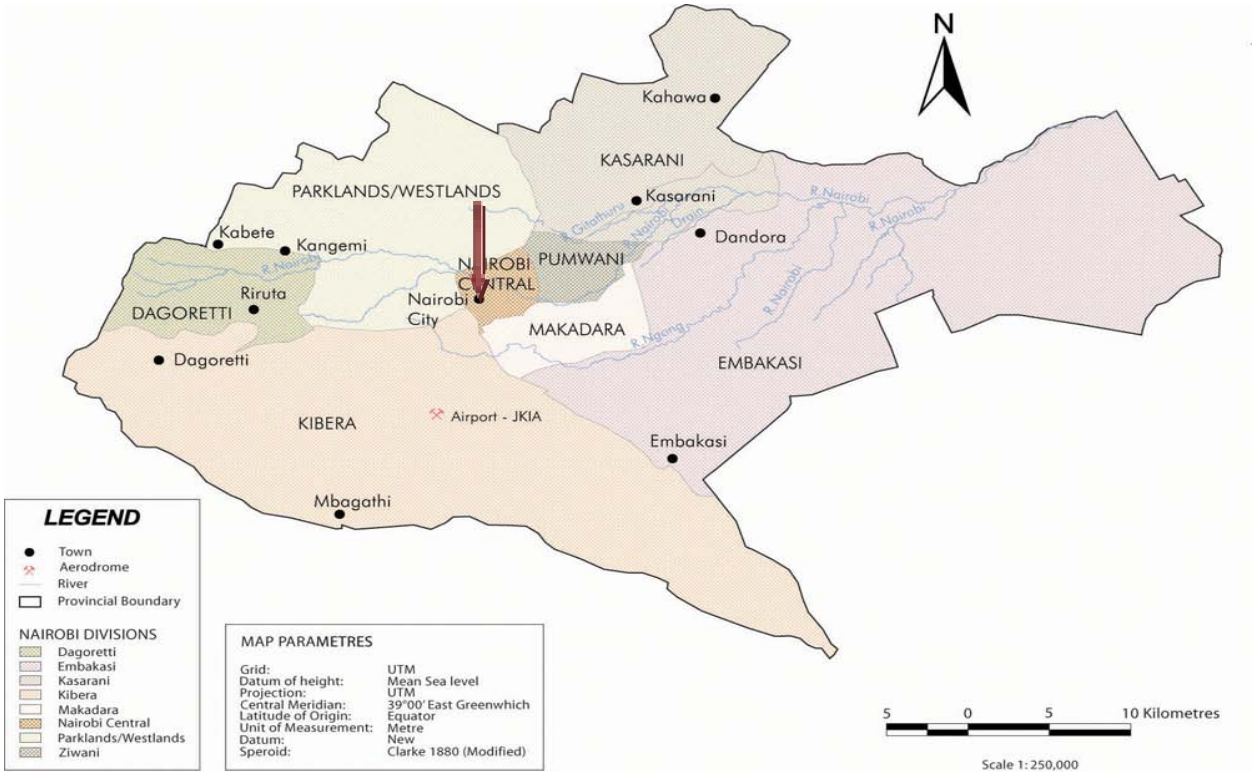


Nairobi County Location on Kenya Map.

Administratively the country has forty seven counties which were created upon promulgation of the new constitution in Year 2010.

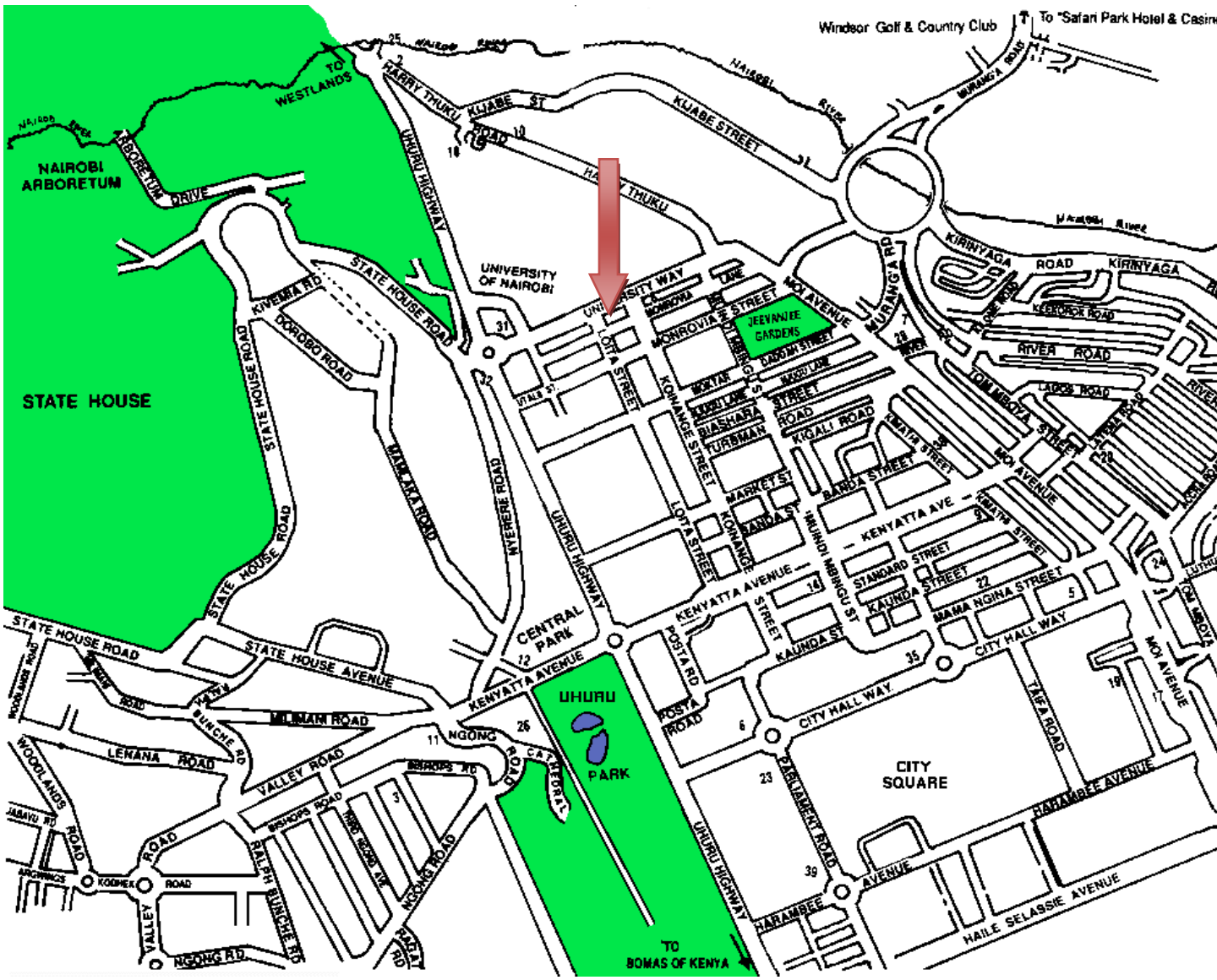
3.3 Nairobi County: Nairobi county is one of the forty seven counties created by the new constitution in 2010 and is also the Nation's administrative, commercial and political capital hosting all the national Government's top institutions such as the President's office, Parliament, The Supreme Court, Ministries headquarters, Central Bank and head offices of many multinational companies which have invested in the country. The County in matters related to environmental protection, holds the enviable position of being the location of the UNEP and Habitat headquarters which are in the Gigiri area in the city's outskirts. The Nairobi County borders the following Counties: Kiambu to the North, Machakos to the South and South East and Kajiado to the South and South West. The City spans over approximately 695.1 Square Kilometres and its Population as per the 1999 population census was 2,143,254 million giving a population density of 3083 Persons per Square Kilometre**-(knbs.or.ke 2013, usaid.gov/sites).** The County's population growth rate 1979-1999 the city's is at between 4.7% and 4.8% annually (Omwenga, 2011)

Map 2 – Nairobi County -source-www.unep.org



Study Area Location Anniversary Towers (in CBD)

Map 3-Nairobi CBD & Study area-Anniversary Towers source: Kijabe.org



LEGEND

Plot Boundaries

Anniversary Towers Location.

Wood/Vegetation Covered Areas

0 1 2 3 4 Hundred Metres

SCALE 1: 10,000

3.4 Commercial Buildings in Nairobi

Commercial buildings in Nairobi have a long history dating back to the first decade of the twentieth century when buildings such as Kipande house along Kenyatta Avenue and the old Provincial Commissioner's office built in (1913) located on the opposite side were erected (Mutunga, 2011). Kipande House was originally used as a warehouse by the Indian coolies involved in construction of the Kenya-Uganda railway line. The building was renovated in the interiors in 2003 and currently houses Kenya Commercial Bank Kenyatta Avenue Branch. It stood as the town's tallest building until City hall was erected in 1935.

The old PC's house in its early days was used for processing of records of births, marriages and deaths. In 2006 it was renamed the Nairobi Gallery and now hosts temporary public exhibitions. Other buildings of that era and still standing are such as the Cameo (built in 1912) along Kenyatta Avenue, McMillan Memorial Library built in 1931, Sarova Stanley (Hotel) reopened in 1913 after first building burning down in 1902 and Pan African House and Westminster House both erected in 1928 and now hosting Standard Chartered Bank and Family Bank Kenyatta Avenue branches respectively (Mutunga, 2011).

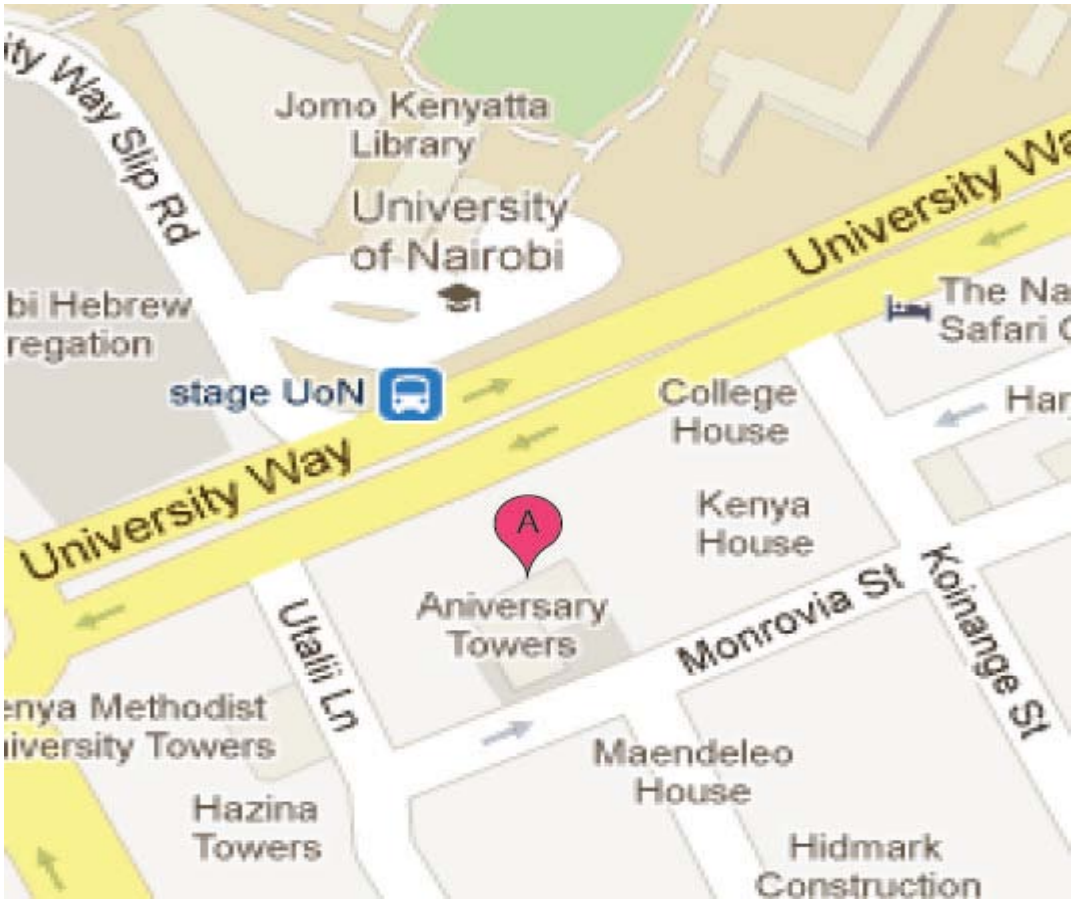
Chapter 2 of the International Building Code (IBC) classifies a highrise building as one with an occupied floor located more than 75 feet (22.86 m) above the lowest level of fire department vehicle access (IBC, 2009). Actual Highrise buildings in Nairobi started mushrooming from 1969 when the Hilton Hotel was completed. Rapidly NSSF building-1973, Kenyatta International Convention Centre-1974, Cooperative House-1981, Nyayo House 1982 and Reinsurance Plaza-1982 followed.

In the 1990s other highrise office blocks were completed such as Lonrho House-1990, Anniversary Towers-1992 and Times Tower which is the highest building in Nairobi completed in 1997(emporis.com 2013). There are currently approximately 69 highrise buildings in Nairobi's Central Business District most of them commercial office blocks. More highrise office complexes are currently under construction especially in the city's Upperhill area (emporis.com 2013).

3.5 Anniversary Towers

Anniversary Towers is a twin-tower building in the Northern part of the Nairobi CBD sandwiched by Monrovia Street to the South, the University Way to the North, Utalii Lane to the West and Koinange Street to the East. It is directly opposite the University of Nairobi, main campus with the other neighbouring landmarks being; The Hebrew Synagogue/ Congregation, Ambank House, Maendeleo House and Kenya House whose ground floor hosts the Uchumi Supermarket Koinange Street Branch.

Map 4 -Anniversary Towers location map-Source Google maps 2012



Plates 1 & 2 -Anniversary Towers photos from University Way and Loita Street: Source (Author-June 2013)

The building is owned by Kenya Reinsurance Corporation as part of the Company's investment in real estate portfolio and is managed by the Landlord's internal management. The development was completed in late 1991, with the first tenancies commencing in early 1992.

The building is a combination of steel reinforcement masonry structure. Walls are predominantly in coloured glass on aluminium frames and mosaic tiles. The property is on twin tower concept, each tower rising to approximately 79.86 meters (262 feet) from ground level to the Penthouse level. A typical floor spreads out to approximately 7,476 Square Feet or 694.5 Square Metres. The building has Two (2) Basement floors, a Ground floor, Two (2) Mezzanine floors, Twenty-Two (22) typical floors and a Penthouse floor with a residential constructed unit on either tower. Office space covers all floors from second Mezzanine to the penthouses while ground floor and Mezzanine one floor, are leased out as shops and offices with the former user

dominant. The penthouse units were originally set out for residential accommodation but later converted into offices and leased out as such.

For vehicle parking needs, the two basement floors have a collective capacity of 155 parking bays. Storage space is provided for in the basements but much of it, due to demand has been converted into offices.

Up and down mobility within the building is facilitated by use of eight elevator cars, two of which are enabled to access the two basement levels as well as the Mezzanine floors. Mains electricity, water and sewer-line services are all provided. The building has an emergency power back-up generator. Waste management is only in the form of disposal with disposal facilities in the form of a waste depository chute and a holding room from where solid waste is collected thrice in a week. Comparable Buildings in the CBD include the Barclays Plaza and Pensions Plaza along Loita Street, ICEA building along Kenyatta Avenue, Reinsurance Plaza along Aga Khan Walk, and International House along Mama Ngina Street.

Among the prominent businesses or organisations housed in Anniversary Towers at the time of data collection were; The Independent Electoral and Boundaries Commission (IEBC) The Higher Education Loans Board (HELB) Kenya National Audit Office (KENAO) and the Export Promotion Council (EPC). The San Valencia Caterers and Kenya Commercial Bank (KCB) have a high profile on the building's ground floor. Other prominent organisations were; The Embassy of the Republic of Korea, Tribunal to vet Judges and the Financial and Legal Sector Technical Assistance Programme. The building is accessible from the University Way and Monrovia Street; with an open arcade connecting the two access points- Anniversary Towers Management-(2012). The total area currently occupied by the organisations is approximately 168,074 Square Feet.

CHAPTER FOUR: METHODOLOGY

4.1 Introduction

This study was guided by several research questions; first on the types and quantities of solid waste generated in Anniversary Towers on a daily basis and the businesses' per capita solid waste generation, and secondly on the factors that could be contributing to the quantities generated principally; the businesses' staff population and the nature or type of the business organisation. The research to a lesser extent examined the possible causative role of other factors on solid wastes generated in the building

4.2 Description of Data Types

This research used both primary and secondary data. To answer the research questions the study required principally; data on quantities and type of solid waste generated by each business organisation, data on businesses staff population and information on the business type. In addition the research required information on solid waste management policies and practices within the businesses in exploring other factors that could be responsible for solid waste generation patterns in the building. The data was therefore quantitative and qualitative.

Quantitative data was primary in nature and its compilation was as the study progressed through various stages. It was in the form of quantities of solid waste collected from individual generator businesses within the building and in the form of staff populations of the businesses. This information could be secondary where staff numbers existed in businesses' records or primary where the research had to count the numbers. The latter scenario prevailed in the small businesses which did not have formal operating procedures or very elaborate systems of records keeping. Qualitative data for the research was in the form of answers to structured questionnaires administered to the businesses as the research progressed. The questionnaires were structured to provide information on the non-quantitative variable of business type. The questionnaire queried other aspects such as type of SWM policies of the organisations, Lack of policies on SWM, Poor implementation of existing SWM policies, influence of legislation and

poor awareness of environmental issues. These would be probable factors in contributing to solid waste generation situation in the building were the Null hypotheses to prove inadequate.

4.3 Data Collection Tools

Data on amounts and type of solid waste was collected by issuing labeled polythene bags (85cm x 68cm capacity) to each business. A research assistant was deployed to ferry the waste to an unoccupied room which was used for the waste's temporary storage. A Tubular hooked balance (25Kg x 500gms) was used for weighing the collected solid waste. The weights were recorded by pen in a register before transfer to electronic form in a computer's hard disk.

Personal interviews were conducted to get information on businesses' staff population. This was employed on human resource officers of the big organisations or the directors of smaller organisations. Questionnaires were also administered to gather data especially the qualitative type. Observation by visiting the businesses was also employed, to have an overview of the solid waste problem in the businesses. Observations were recorded in registers for later analysis. A Camera is another tool the research employed to document by way of photography the generated solid waste evidence and also to visually capture the study area.

4.4 Data Collection Methods

This study collected data from the entire population of business organisations housed in Anniversary Towers and as such there was no need for sampling.

The polythene bags used for collection of solid waste from the businesses were placed over the hatch to the waste chute to ensure all solid waste generated within each business was trapped in the polythene bag as data for the research. The big businesses at times had to have the bags replaced in the course of the day when they filled up. This therefore necessitated close monitoring to ensure no spillage onto floor in case of overflows. Small businesses on the other hand could hardly fill up the bag even when left in place for several days. Amount gathered over several days in bags delivered to such businesses was therefore averaged for an indication of the daily waste output. Once collected, the waste was deposited in a room where it was

sorted into different classifications, weighed and the data recorded in draft form with each business organisation having its specific row. The data was then transferred to electronic storage. The accounted for waste was then disposed into the waste chute. The process of sorting, weighing and recording was largely done at night for minimal interruptions and to ensure maximum capture of daily solid waste generation and as close as possible guarantee data integrity. The researcher employed the services of the building's cleaning staff for this form of data gathering.

Data on unit areas of space occupied by each tenant was raised from the building management's tenant system, specifically the lease schedule which among other items states the particular tenant's unit space occupied. This data was complimentary in the study and though not directly related to the variable being investigated is crucial for further studies related to this research field.

Qualitative data on business type, SWM policies and application of the policies and data on influence of The Public Procurement and Disposal Act) was built up through issuance of structured questionnaires. Information required was to reflect each business's official position and so a questionnaire was issued to one respondent per business organisation. Total number of questionnaires issued was therefore 46 which represented the entire number of organisations in the building. The target respondent was picked on account of position held in the business with consideration to ability to present the organisation's official position on the pertinent issues. These respondents were the same ones subjected to one on one interviews. Photography was also employed as a way of highlighting the waste generation problem in the workplace.

4.5 Data Analysis Techniques Employed

Regression analysis and Chi Square test were used in analysing the collected data for the research. Regression was used to test the strength of association between businesses' staff population and quantities of solid waste generated, while Chi square test was used to measure

the difference between observed and expected values in assessing influence of business type on solid waste generation in Anniversary Towers.

CHAPTER FIVE: RESULTS AND DISCUSSIONS

5.1 Introduction

This chapter presents the findings of the study based on the data collected from the field. The objective of the study was to probe the roles of staff population and the business type as they relate to solid waste generation and management.

5.2 Building's Solid Waste Status

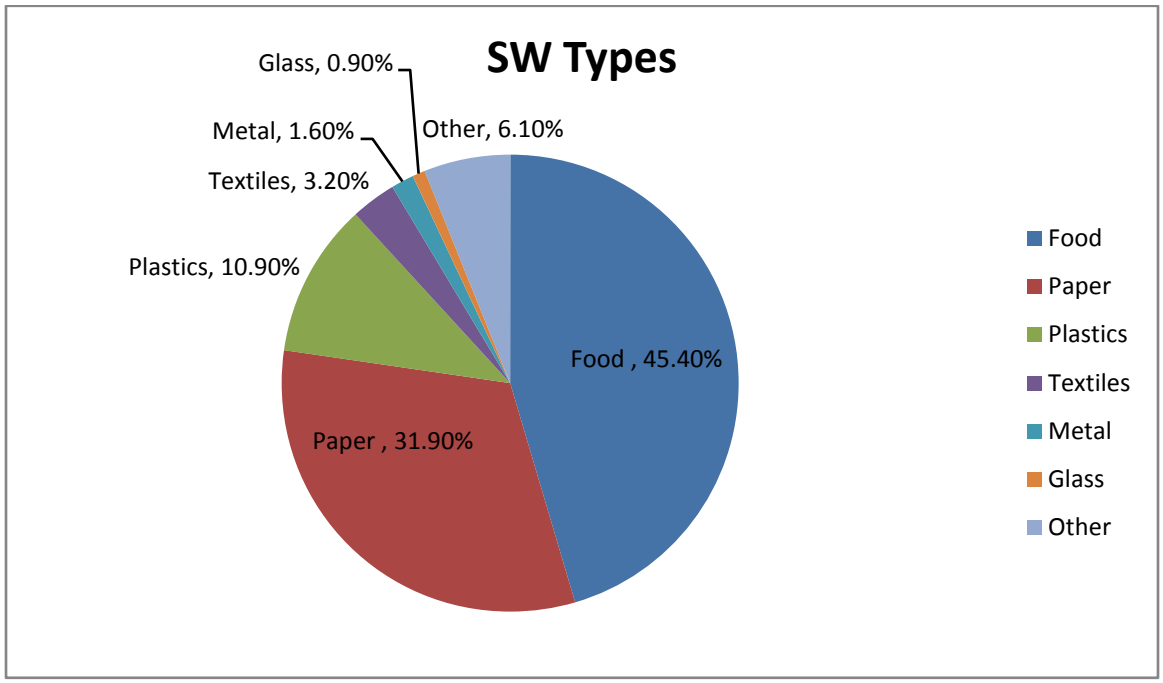
The building has a centralised solid waste collection system whereby each of the floors from 1st Mezzanine to the Penthouse (s) has a retractable hatch through which solid waste is deposited into the chute spiraling all the way to a basement holding room from where it is eventually collected. Chutes have to be constantly cleaned with disinfectants or sanitizers to prevent offensive odours buildup-**(Tchobonoglous et al 1996).**

Plate 3-Anniversary Towers Refuse Chute exit to waste holding room

From data collected in the course of this research, Solid wastes generated in Anniversary Towers amounted to approximately 180 Kilogrammes per day. The solid waste character

consists mainly of food waste (45.4%), paper (31.9%), plastics (10.9%), Textiles (3.2%), Metal (1.6%), glass 0.9 % and other non-specific material 6.1.0%.

Figure 3- Pie Chart-Waste characterization Percentages- Anniversary Towers



Food waste in the building emanated overwhelmingly from the two restaurants and one kiosk on the ground floor. However offices and other businesses did contribute a notable share of food waste by way of leftovers from food consumed in offices during tea and lunch breaks. Paper waste in its various forms whether packaging or printing is by weight the second highest form of solid waste generated in the building and was the most prevalent type generated by the entire the spectrum of businesses. This is a result of the building's main occupation being office operations. The offices in the building are overwhelmingly Government related and not greatly adapted to paperless office operations.

Plastic waste was assorted and in the form of office inventory such as computer parts, stationery material like ball point pens and plastic food containers and polythene paper bags. Its generation was substantial and prolific though its weight contribution stood at only 10.9%. This is largely due to its relative light weight nature. Solid waste in the form of textiles was mainly the contribution of boutiques and salons, while metals and glass were assorted from all

generators. The category covered by 'others' comprised of materials from timber, vegetative banana leaf wrappings other non specifiable materials.

The amounts generated can fluctuate greatly depending on seasonal work related activities of major tenants accommodated in the building, a classic example being the Independent Electoral and Boundaries Commission (I.E.B.C) in an election year.

Plate 4- Solid waste gathered in holding room-Anniversary Towers Upper Basement

The solid waste in the holding room builds up from chute deposits at multiple locations all along the building's height (Anniversary Towers Building Management, 2011). Apart from solid waste getting into the holding room through the chute, other solid waste is deposited into the room by ground floor and basement floor businesses which carry the waste by hand into the room.

The building's management has outsourced solid waste disposal function to the firm that is engaged in the building's daily general cleaning. The firm collects waste from the holding room at least three times weekly using a lorry.

Plate 5- Paper and Polythene waste dumped behind a shop-Anniversary Towers

Dumping of solid waste along corridors, the stairwell and in the basements is common and the building management has to be constantly on the lookout. Apart from waste so dumped creating an eyesore, Public Health and Safety regulations are against chattels being placed on emergency exits. The practice is more prevalent in premises occupied by public bodies.

Plate 6-Construction waste along a corridor-Anniversary Towers mezzanine floor

Construction and renovation related waste can be in tonnes but its generation is occasional occurring during renovation projects by the businesses (tenants) or construction by the landlord. Inclusion of this specific solid waste in the total generated was omitted as it could distort the picture of normal daily generation.

It is the responsibility of the businesses carrying out the project to organize how such waste is to leave the building and where it should end up.

Plate 7 -Form of waste- A grounded vehicle in basement parking-Anniversary Towers

Plate 8 -Form of waste- A grounded vehicle in basement parking-Anniversary Towers

The form of solid waste depicted by plates 7 and 8 alongside other forms like broken down furniture, office equipment and obsolete inventory is a mainly a problem in Government related businesses.

Apart from being aesthetically an eyesore such waste has the potential to harbor pests and vermin. Economically it is a drain especially of public funds as most businesses generating this form of solid waste are public funded bodies. A parking bay at Anniversary Towers for instance is least at a monthly fee of Kenya Shillings 6,500 +Vat and some Government and Parastatal vehicles are abandoned this way for periods in excess of two years (**Anniversary Towers Management, 2011**). Bureaucracy in disposal processes is the main hindrance to efficient management of this form of solid waste.

5.3 Staff population and solid waste Generation.

The businesses in Anniversary Towers for convenience of this research were broadly classified into ten categories. The dominant category comprised of offices both Government and private numbering in total twenty one. Government businesses were Independent Electoral and Boundaries Commission, Kenya National Audit Office, Export Promotion Council, Higher Education Loans Board, Registrar of Political Parties, Kenya Reinsurance Corporation and Judges Tribunals. Embassy of the Republic of Korea is also a Governmental body albeit from a foreign country.

Private Offices comprised of Law firms, Valuers and practitioners of other trades. The amount of solid waste generated by offices was by nature voluminous but light comprising mainly of printing paper waste, cartons and office associated plastic from electronic machinery. Food waste present in the form of snacks' leftovers, food wrappers and drinks plastic containers.

Catering businesses were three in number and the overall biggest solid waste generators by weight. In this category were two Restaurants; San Valencia and Technofrigo as well as a small kiosk all on the building's ground floor. The classification as goods shops referred to outlets dealing more in commodities as opposed to services and comprised of boutiques, home appliances and electronics dealers. They were seven in number, the most prominent being Rialto enterprises, Midas Fabriques and Hurlingham Eye Centre. The form of solid waste emanating from this source was mainly leftovers of garments, assorted papers, polythene and electronic waste. Solid waste was not in large quantities or weight. Media and entertainment

outlets comprised of a studio by the name Creative Photographic Services and a music store-Amani Music Instruments and the waste was in the form of discarded Polaroid photo waste, assorted papers, polythene as well as bits of electronic waste. Salons were two in number – Ellisons and Jostine located on the Mezzanine and Ground floor respectively and dealing in beauty services as well as barber shops. The form of waste was mainly human hair, artificial hair pieces as well as plastic wrappers.

Skyview Travel and Mawared House were the Tours and Travel classification and were engaged in the business of organising travel arrangements. Nature of waste generated by these concerns was largely ordinary paper and plastics but not in large quantities, because the business operates largely electronically. The Financial services firms referred to in the research pertained to businesses involved in money lending and other financial services such as deposit taking. Most prominent of the three was Kenya Commercial Bank University Way Branch. The other two were micro finance businesses-Meridian Acceptances and Wira Capital.

Multi-Level marketing businesses is a marketing concept that cuts off the middleman and limits advertising by engaging in distributor networking. There were two such businesses in the building-Pillartech and Calofrana. These were small organisations generating mainly office type papers as the solid waste.

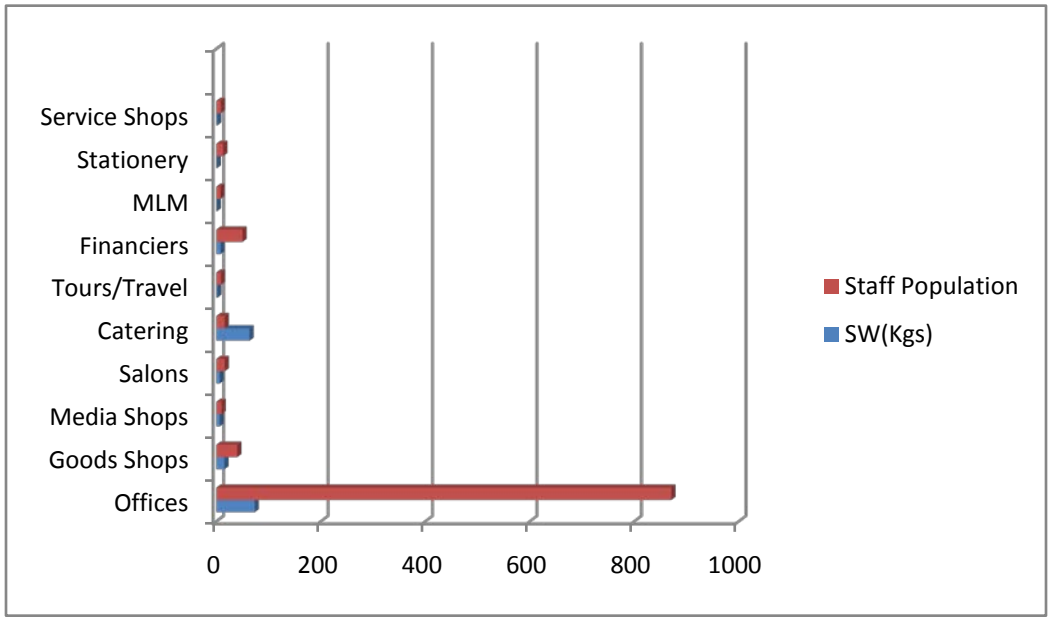
Stationery goods and services category was made up of outlets dispensing books, office printing papers and generally materials needed in office operations. In addition they offer services such as photocopying, printing and binding. Under this category were two businesses-Columbus 2000 and University Way General Supplies. Solid waste generated was largely paper in the form of printing paper, carton packaging waste and wrappers.

The research considered a dry cleaner business and a small equipment repair shop located on the ground floor to be services shops. Waste generated by the equipment repair shop was mainly pieces of plastics, metals, timber and debris associated with the materials repaired in the workshop. The Dry cleaner on the other hand had pieces of discarded cloth materials, paper and polythene as the main generated solid waste. Table 1 below, is a presentation of the categorization with the respective quantities of generated solid waste.

Table 1-Staff population, Business Type and solid waste Generation.

Rank	Tenant	Waste in Kilograms	Staff Population	Waste per head.
	OFFICES			
1	KENAO	17.81	385	0.0463
2	I.E.B.C	19.57	150	0.1305
3	HELB	10.39	130	0.0800
4	EPC	6.16	50	0.1232
5	CODA	1.35	30	0.0450
6	REG. OF POLIT. PARTIES(R.O.P.P)	1.5	25	0.0600
7	SEB ESTATES	1.00	12	0.0833
8	EMBASSY OF KOREA	1.9	12	0.1583
9	FINANCIAL & LEGAL SECTOR	3.24	11	0.2945
10	TRIBUNAL FOR JUDGES	0.68	10	0.0680
11	TRACKCARD SYSTEMS	0.5375	9	0.0597
12	LANDMARK REALTORS	1.84	8	0.2300
13	SUPERGRIP	0.380	8	0.0475
14	MPATA	1.050	7	0.1500
15	JACKLINE P.A ADVOCATES	0.50	5	0.1000
16	RURALVET	1.18	4	0.2950
17	KIKI INVESTMENTS	0.75	4	0.1875
18	ONGATA WORKS	0.060	3	0.0200
19	OTEGA & COMPANY ADVOCATES	0.62	3	0.2067
20	KENYA RE	2.61	3	0.8700
21	BRISKY	0.20	2	0.1000
	SUB TOTALS	**73.3275**	**871**	
	GOODS SHOPS			
22	PAYPOINT SOLUTIONS	1.030	16	0.0644
23	MIDAS FABRIQUES	0.40	6	0.0667
24	RIALTO ENTERPRISES	7.25	6	1.2084
25	SOLECA	5.30	4	1.3250
26	JP'S ITALIAN	0.90	3	0.3000
27	HURLINGHAM EYE CLINIC SERVICES(HECS)	0.325	3	0.1084
28	WAGITHA	0.17	2	0.0850
	SUBTOTALS	**15.375**	**40**	
	MEDIA & ENTERTAINMENT			
29	CREATIVE PHOTOGRAPHIC SERVICES	3.6	5	0.7200
30	AMANI MUSIC INSTRUMENTS	2.89	5	0.5780
	SUBTOTAL	**6.49**	**10**	
	SALONS			
31	ELLISONS	4.32	10	0.4320
32	JOSTINE	2.0	6	0.3334
	SUBTOTAL	**6.32**	**16**	
	CATERING			
33	SAN VALENCIA	49.45	10	4.9450
34	TECHNOFRIGO	12.40	5	2.4800
35	PEDIGREE CANDIES	1.7125	1	1.7125
	SUBTOTAL	**63.5625**	**16**	
	TOURS & TRAVEL			
36	MAWARED HOUSE	0.58	5	0.1160
37	SKYVIEW	1.075	4	0.2688
	SUBTOTAL	**1.655**	**9**	
	FINANCIERS			
38	KCB	6.25	42	0.1489
39	MERIDIAN ACCEPTANCES	1.75	6	0.2917
40	WIRA CAPITAL	0.1625	2	0.0813
	SUB TOTAL	**8.1625**	**50**	
	MULTI LEVEL MARKETING			
41	PILAR TECH	0.700	5	0.1400
42	CALOFRANA	0.175	3	0.0584
	SUBTOTAL	**0.875**	**8**	
	STATIONERY SHOPS			
43	COLUMBUS	0.300	10	0.0300
44	UNIVERSITY WAY GENERAL SUPPLIES	0.265	3	0.0884
	SUB TOTAL	**0.565**	**13**	
	SERVICES SHOPS			
45	WESTGATE CLEANERS	1.075	6	0.1792
46	KIBABII NETWORK	0.475	3	0.1584
	SUBTOTAL	**1.550**	**9**	

Figure 4-Bar Chart Staff Population and Solid Waste Quantities



Linear regression test was applied to test the $H_{0\,(}1$) which stated that there was no relationship between staff population and quantities of solid waste generated in Anniversary Towers.

Table 2- Staff Population and Solid Waste-Regression analysis.

Organisation	Population	Solid Waste in (Kgs)	Organisation	Population	Solid Waste in (Kgs)
1.Pedigree(Kiosk)	1	1.7125	24.Westgate (Drycleaners	6	1.075
2.Wira Capital(Financier)	2	0.1625	25.Meridian(Financier)	6	1.75
3.Wagitha(Goods Shop)	2	0.17	26.Jostine(Salon)	6	2.0
4.Brisky(Office)	2	0.2	27.Rialto(Boutique)	6	7.25
5.Ongata Works(Office)	3	0.06	28.Mpata(Office)	7	1.050
6.Calofrana(Office)	3	0.175	29.Supergrip(Office)	8	0.38
7. University Way(Stationeries)	3	0.265	30.Landmark(Valuers)	8	1.84
8.HECS(Optometrists)	3	0.325	31.Trackcard(Office)	9	0.5375
9.Kibabii Eng.(Workshop)	3	0.475	32.Columbus(Stationery)	10	0.30
10.Otega & Co.(Advocates)	3	0.620	33.Judges Tribunal(Office)	10	0.68
11.JP'S Italian(Boutique)	3	0.900	34.Ellisons(Salon)	10	4.32
12.Kenya Re(Office)	3	2.61	35.San Valencia(Caterers)	10	49.45
13.Kiki Investments(Office)	4	0.75	36.Fin. & Legal S.(Office)	11	3.24
14.Skyview Travel(Travel Agency)	4	1.075	37.Seb Estates(Realtors)	12	1.0
15.Ruralvet(Office)	4	1.18	38.Korean Embassy (Office)	12	1.9
16.Soleca(Electronics Shop)	4	5.30	39.Paypoint (IT dealers)	16	1.030
17.Jackline P.A (Advocates)	5	0.50	40.Registrar of Pol. Parties.	25	1.5
18.Mawared House(Travel Agency)	5	0.58	41.Coda(Office	30	1.35
19.Pillar Tech(Multi-Level Mk)	5	0.70	42.KCB(Bank)	42	6.25
20.Amani Music (Entertainment)	5	2.89	43.EPC (Office)	50	6.16
21.Creative Photography(Media)	5	3.6	44.HELB (Office)	130	10.39
22.Technofrigo(Catering)	5	12.40	45.I.I.E.C(Office)	150	19.57
23.Midas Fabriques(Boutique)	6	0.40	46.KENAO (Office)	385	17.81

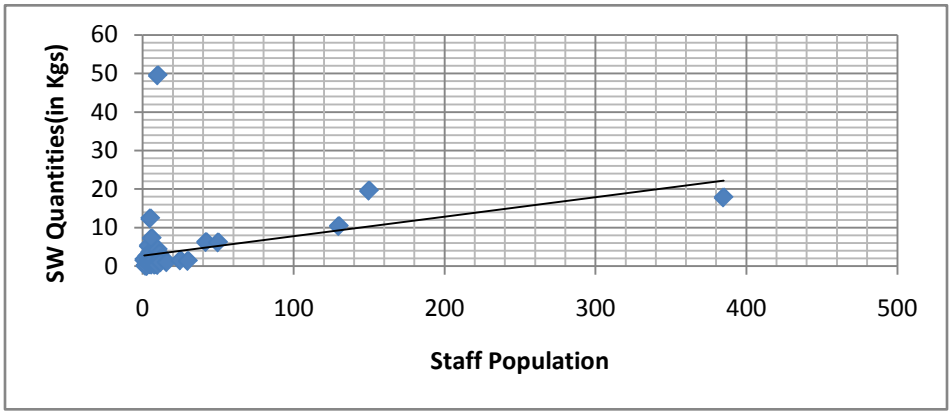
$\sum x=1042$, $\sum y=178$

$\sum x^2=195216$, $\sum y^2=3654.6$, $\sum xy=12630.60$

$$r = \frac{\sum xy - (\sum x)(\sum y)/n}{\sqrt{(\sum x^2 - (\sum x)^2/n)(\sum y^2 - (\sum y)^2/n}} = \frac{12630.60 - 1042 \times 178/46}{\sqrt{(195216 - (1042 \times 1042)/46)(3654.6 - (178 \times 178)/46}}$$

$r = 0383103$

Figure 5-Scatter Graph –Staff Population and Solid Waste Quantities



Staff numbers were the Study's X values while weight of solid wastes in Kilogrammes represented the Study's Y value.

Table 3-Regression-Staff population and solid waste quantities

SUMMARY OUTPUT								
Regression Statistics								
Multiple r	0.383103							
r Square	0.146768							
Adjusted r Square	0.126925							
Standard Error	7.667381							
Observations	46							
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	1	434.8365	434.8365	7.396596	0.009389			
Residual	43	2527.916	58.78873					
Total	44	2962.752						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	2.758171	1.21902	2.262614	0.028767	0.299784	5.216559	0.299784	5.216559
X Variable 1	0.050354	0.018515	2.719668	0.009389	0.013015	0.087693	0.013015	0.087693

Under Null Hypothesis that p=0.05 the correlation coefficient is related to the t-distribution for small sample size (n<500) by the expression: $t = r\sqrt{(n-2)/(1-r^2)}$. Therefore the relationship between solid waste generated in kilograms (y) and staff population (x) is Y= a +bx $y = 2.75 + 0.05x$. Adjusted r^2 is called the coefficient of determination and tells us how the generation in kilograms varied with the staff population.

From Table above, the value of adjusted r^2 is 0.126925. This implies that, there was a variation of 12.69% of SW generation in kilograms with staff population. The conclusion is that the number of workers accounts for approximately 13% of the solid waste generated in Anniversary Towers. Conversely it means 87% of solid waste generated is attributable to other factors.

5.4 Type of Business and Solid Waste Generation

For purposes of testing Null hypothesis Number 2 which stated that there was no relationship between the type of business and amounts of solid wastes generated in Anniversary Towers the study came up with a classification of the businesses into ten different types as in table 1(above). The data was subjected to a Chi Square goodness of fit test progressed as hereunder;

Table 4- Distribution table for Business type and Solid waste quantities.

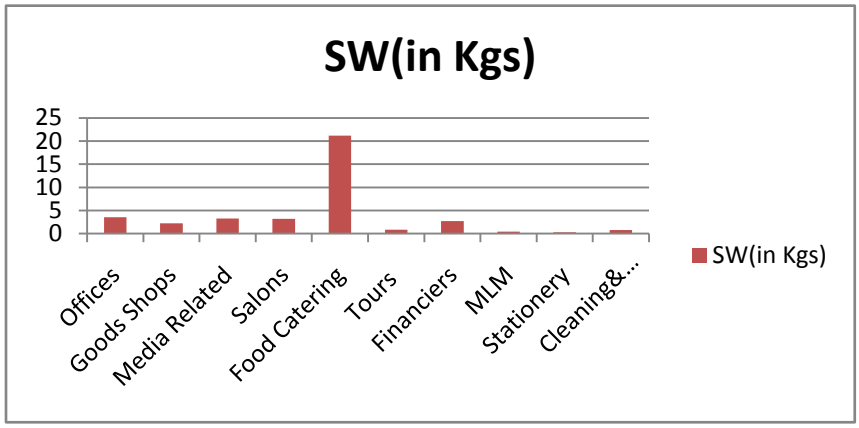
No.	Type of Business	Observed SW in Kgs	Expected	Residual(Observed-Expected)	(Obs-Exp)2	(O-E)2/E
1	Offices	73.3275	81.207	-7.8795	62.087	0.765
2	Goods Shops	15.375	27.069	-11.694	136.75	5.052
3	Media & Entertainment	6.49	7.734	-1.244	1.548	0.200
4	Salons	6.32	7.734	-1.414	1.20	0.155
5	Food Catering	63.5625	11.601	51.9610	2699.95	232.73
6	Tours & Travel	1.655	7.734	-6.079	36.95	4.78
7	Financial Services	8.1625	11.601	-3.4385	11.82	1.02
8	Multi-Level Marketing	0.875	7.734	-6.859	47.05	6.08
9	Stationery Goods & Services	0.565	7.734	-7.169	51.39	6.64
10	Services shops	1.55	7.734	-6.184	38.24	4.94
	TOTAL					**262.362**

$\sum\left(\frac{o-E}{E}\right)2$ = 0.765 + 5.052 + ……. 4.94 = 262.362

So X^2 = 262.362 which is larger than any value for X^2 in the Chi square distribution table. The X^2 measures how far the observed results differ from the expected on the basis of the Null hypothesis being true and the bigger the difference in the two the bigger the Chi-Square (X^2) will become. The largest value in the table at 44 degrees of freedom is 65.41 which is associated with a probability of 0.05. The value 262.362 would be associated with even smaller probability. The observed value is therefore very unlikely if H_0 is true and it is therefore justifiable to reject the hypothesis that there was no relationship between Type of business and the amount of solid waste generated.

The Null Hypothesis **H_0 (2)** is therefore rejected meaning, from the data collected type of business does seem to influence amount of solid wastes generated by organisations based in Anniversary towers.

Figure 6-Bar Chart 1-Organization Type and SW Quantities.



Bar chart presentation depicted existence of a causal relationship between business type and amounts of solid waste generated. From the chart it is apparent that a business tends to produce more solid waste if it's concerned with catering.

Offices, goods shops, media houses, salons and finance businesses tend to generate solid waste in equal manner. Stationery, Multi-level marketers and the service shops- represented by dry cleaner and the small workshop in the building generate negligible solid waste. Apart from the food catering businesses the rest of the businesses are all at an average of below 5 kilograms on the Bar chart 1 scale.

5.5 Other Factors

Other factors which would be summarily described as solid waste management practices were considered as being responsible for the solid waste generation. These factors are such as operational efficiency of a business organisation (leading to less generation), level of green technology adoption, existence and practice of pro-reduction generation reduction policies and others, may be influential and further research focused on these aspects is recommended. An attempt was however made in this research to examine these factors and towards this end questionnaires were administered.

These questionnaires in the case of large business organisations were directed at officials handling portfolios as closely related to the field of research (solid Generation/Management) as possible, and for the smaller organisations to the directors, top managers or personnel responsible for solid waste disposal. These variables were not the study's main thrust and played a rather supplementary role in deepening the study topic.

5.6 Businesses' Policies.

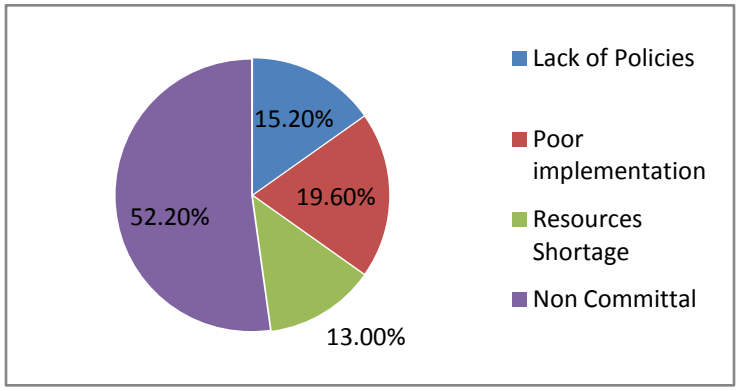
A proactive way of Solid Management is prevention and reduction of generation. Among the tools useful in an organisation's endeavour towards prevention and reduction are; Cost Benefit Analysis ((CBA), Extended Producer Responsibility (EPR), Environmental Impact Assessment (EIA), Polluter Pays Principle (PPP) and Precautionary Principle (PP).

While these principles may not be clearly differentiated by the businesses' the concept of prevention/reduction was generally understood. This section encompassed issues of unnecessary bureaucracy that may interfere with solid waste management efforts. The findings are presented hereunder, and are an indication of the general picture in as far as solid waste generation and management is concerned;

Table 5 Policy and Solid Waste Problem

	Frequency	Percent
Lack of solid waste management policy for the business	7	15.2
Poor implementation of solid waste management policy, Bureaucracy	9	19.6
Lack/shortage of resources to implement solid waste mgt policy	6	13.0
Non Committal	24	52.2
Total	**46**	**100.0**

Figure 7-Pie Chart- Organisations Policies and Solid Waste.



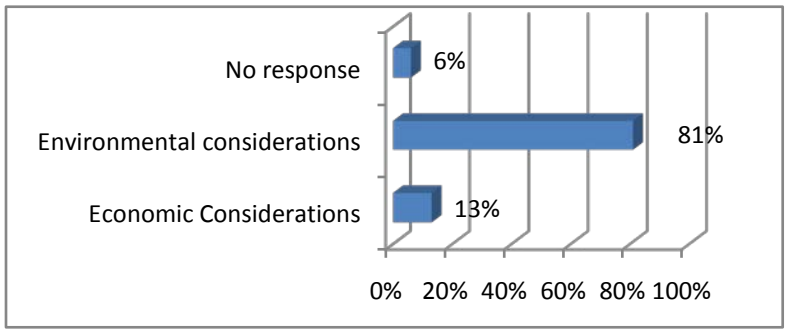
In as far as policy is concerned, 19.6% of the respondents indicated that that the greatest contributor to the solid waste problem was poor implementation of existing solid waste management policies while 15.2% said that an altogether lack of solid waste management policy for the business organization was the problem.

13% of the respondents attributed waste generation to either lack, or shortage of resources to finance policy implementation. However 52.2 % of the respondents were non-committal to this question on whether solid waste generation was a factor of lack of policies or non adherence. This was a pointer to absence of awareness in general environmental issues at the work place

5.7 Considerations in SWM Policies

The research also sought to know what were the considerations of businesses in prioritizing solid waste management. The responses were as depicted in figure 7 below.

Figure 8-Bar Chart- Considerations in SWM Policy.

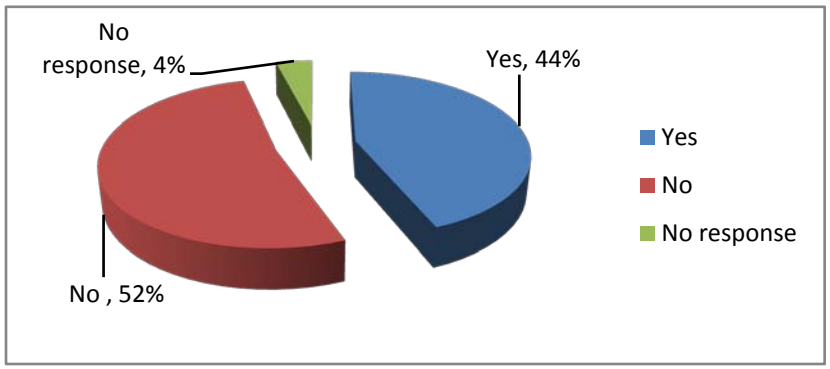


The majority of businesses picked environmental considerations to be the biggest factor at 81% against economic considerations at 13%. However 6% of the respondents were not clear on what drove the businesses' policy on solid waste management.

5.8 Solid Waste Generation and Public Procurement and Disposal Act

Another of the factors considered as having a possible role in SWM condition in the building was legislation. The specific legislation considered was the Public Procurement and Disposal Act (2005) and the response was graphically presented as hereunder;

Fig 9-Pie Chart-Solid Waste and Legislation Effect



According to the findings, 44% of the respondents thought legislation had an effect on solid waste generation and management aspects. These were the Public bodies which take up the largest percentage of office space in Anniversary Towers.

52% disagreed that solid waste generation and management in the business organization was influenced by any law. These were the private companies which though taking up a smaller percentage of the total leasable space are the majority in numbers and are not in the ambit of the Public Procurement and Disposal Act.

CHAPTER SIX: CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

This chapter described the summary of findings, conclusions and recommendations for further research on the overall solid waste management and generation issues.

6.2 Summary of Findings

The following were the summary of the research findings upon which the conclusion and recommendations of the study were made. The summary was guided by the research questions.

The regression analysis showed that there existed a positive relationship between kilograms of solid wastes generated by businesses and the number of staff population in the businesses. That is, the more the number of staff in a building the more the generated solid waste in kilograms. The relationship was however a weak one.

Chi-Square analysis of Type of business (in terms of office, shop, services renderer, goods dealer, combined goods and services dealer, caterer, salons and the others) and quantities of waste generated suggested a positive causal relationship i.e. it was deemed to influence wastes generation. The relationship was also a weak one.

On quantity types generated, the research showed food waste to be the highest percentage in terms of Kilograms. However this is attributable to the sheer weight of food waste generated by the catering organisations on the building's ground floor. In terms of the most prolific (or widespread among all businesses) type generated paper was at the top, this owing to the dominant user in the building which is as office.

6.3 Conclusions

A general lack of environmental issues awareness pervades the workplace. This in reality may be the single most important factor in solid wastes generation and lack of substantial progress

in waste management efforts. Needless generation of waste continues unabated, for lack of sensitization on importance of prevention or control of generation. In most organisations it was noted that there were no deliberate efforts by policy or deed to address waste generation. Instead waste matters are addressed as they occur.

Where policies are in place, they are reactive hence the passing regard to generation as the starting point in waste management. Apart from addressing generation, little or no efforts were notable on other waste management options such as reuse or recycling. The study's results can be used to generalize the solid waste situations in other buildings with similar characteristics to Anniversary Towers in terms of locational factors, building size, business varieties and management models employed.

6.4 Recommendations

This research having been specific to issues of source generation of solid waste has several recommendations to the policy makers which hopefully would go some way in addressing the general issue of solid waste generation and ultimately solid waste management itself. The recommendations are best made to the different segments of policy makers in solid waste generation matters. These are the Businesses' policy makers and the policy makers in the central and county governments.

6.5 Recommendations to Businesses Policy Makers

Solid waste generation prevention or reduction at source is what this research would recommend to the businesses policy makers. This intervention should aim at reducing the volume or toxicity of waste at the source. It should aim at reducing amount of waste materials produced as well as the harmful environmental effects associated with producing and disposing them. This research recommends several alternatives for the businesses policy makers;

Prioritizing SWM: There is an urgent need to place the issue of solid waste management at the forefront of businesses' priorities. It was apparent from the findings that most businesses were

not aware of the problem of solid waste generation or management. The 52% nays to the question whether solid waste was viewed as a problem can largely be attributed to ignorance rather than to issues of efficiency in management. In addition there is very discernible lack of conscious effort towards solid waste management as exemplified by the very low budget allocations (less than 5% in over 69% of the cases).

Employee Environmental Education: This should be an awareness campaign that should be simple, highly visible and inclusive (European Commission, 2013). It should incorporate suggestions of behavioural changes which are easy to adopt. Stakeholders who are the staff members should be encouraged to participate. An education programme should inform employees of the source reduction goals teaching them their individual roles in achieving these goals. Incentives to achieve should be provided **(O' Leary et al, 1995).**

Waste Generation Reduction Policies: Businesses' policy makers should come up with clear, concise and practical solid waste generation reduction policies. Such should be integrated in the businesses' corporate objectives and the vision/mission statements. A waste coordinator should be substantively appointed who should oversee implementation of the broad environmental wellness goals for the specific business **(O' Leary et al, 1995).** A **waste reduction plan** targeting materials and production practices should be put in place. The plan should aim at; reducing inefficiencies in material use, buying of durable products and materials, identifying items that can be reused and identifying sources of over packaging and offering alternatives to disposable products indicating cost associated with each alternative **(O' Leary et al, 1995).**

Accounting of Materials Purchased: is another recommendation to the businesses policy makers. Assessment would provide information on types and quantities of materials purchased, used, recycled composted or discarded. Such information is critical in identifying cost effective and practical source reduction actions a business can take **(O' Leary et al, 1995)**. Bulk buying should be considered to reduce the amount of packaging to be disposed of **(Boardman B. et al, 2001).**

Addressing Paper Waste: Since the highest percentage of waste emanating from offices is paper based, a reduction in generation of this form of waste would go a long way in meeting waste management overall aims. Here are some practical steps to achieve this; Paperless offices should be encouraged. With existing technology this should not be out of reach and the cost implication may be only in regard to training on usage of office technology and investment in affordable equipment. If paper must be used double sided printing and photocopying should be encouraged. This is already a policy in Public organisations but rarely enforced. Businesses should have a practice of having photocopiers and printers checked regularly before using them **(Jael K. et al, 2008)** and office paper-recycling schemes should be considered.

For other frequently used office materials, businesses should enquire from waste management companies on the possibilities of recycling. Items like Compact Discs could be sent for recycling while Ink cartridges could be recycled or refilled for office use. Staff should be encouraged to participate in recycling by keeping them informed recycling programs and could also be trained on waste segregation practices, which could begin at providing them with appropriate waste sorting containers clearly labeled **(Russell. et al, 2009).**

Addressing Catering Waste: To cut down on catering related waste, Businesses should try some of the following measures; Use real utensils rather than disposables or buy food in recyclable or reusable containers, rather than in polythene or carton packets. When catering for meetings or conferences, disposables should not be used **(Charles E., 1997).**

Leasing and Repair: Leasing as opposed to outright buying is increasingly becoming a viable alternative. This takes care of waste that may emanate due to redundancy or obsolescence. Repair and maintenance matters become the responsibility of the lessor (owner) and an organisation can employ its resources more efficiently, becoming more profitable economically and promoting environmental ideals. This alternative is especially viable for fleet/pool vehicles, multi task office copiers as well as computers and complimentary accessories Source-**(General References).**

Apportioning Responsibility over SWM: Specific to a built-in environment the roles of different stakeholders over the process of SWM should be laid bare; Architects and developers of a building should design and develop buildings with adequate waste facilities. Building Managers should implement and maintain building-wide waste management systems with capacity to support waste prevention, minimisation and other interventions such as recycling.

Businesses or the people using a building should strenuously avoid generating waste and utilise the building's waste and recycling system. Cleaning personnel should strive to separate waste sorting out recyclable from non-recyclable. Downstream Waste handlers should provide appropriate efficient and cost effective waste management solutions **(Resource NSW 2002).**

Above all regular awareness campaigns are needed to motivate community to participate in refuse charge payment and cleanliness maintenances, not just on their own premises but also in open and public areas.

6.6 Recommendations to Governmental Policy Makers

The Central or County governments are the main bodies responsible for public policies governing and regulating operations of the public at large. To this class of policy makers, the research therefore recommends;

Public Environmental education: Such an education should be through; Awareness-which entails the general public being made aware of alternative ways of handling solid waste generation **(O' Leary et al, 1995)**. The campaign should be on awareness of mandatory requirements of solid waste generation prevention which should therefore be very clear on what is required, and on voluntary programmes which should be adequately promoted for acceptance. Promotion of awareness among the public can be through; news releases, posters, billboards, bulletins in public places such as churches and television or radio commercials **(Hansen et al, 1983)**

A public education and awareness campaign should strive for adoption of the programmes by the intended public and should put in place measures for the sustainability of the programmes.

As such support systems should be highlighted to which the public can regularly resort for clarifications and any emerging information. For successful implementation of such a programme, political support is needed for such a process can be lengthy taking years and is a commitment of public resources worth millions **(O' Leary et al, 1995).**

Legislations and Regulation is another intervention recommended by this research to governments for control of generation of solid waste. Regulatory strategies measures may include imposition of waste taxes fees and charges as incentives for generation prevention and encouragement of development and use of waste management solutions that increase material use efficiency. Certain solid waste streams can also be excluded from landfills through disposal bans hence obliging generators to recycle materials or eliminate them from production processes **(European Commission, 2013).**

Another Legislative measure is by including waste management principles in the law. This would have a positive effect on generation prevention or minimisation. Extended Producer Responsibility (EPR) for instance would compel producers to bear responsibility over disposal of their products when they reach the end of their useful life. EPR requires producers to begin bearing the cost of waste disposal thus impelling them to invest in material efficiency, reduce eventual quantity of waste and incorporate designs that extend materials lifecycle.

Green Public Procurement (GPP) is another of the principles whose requirements if legislated would help in reducing solid waste generation. Governments could include solid waste prevention criteria as part of green public procurement policy. Design of products that are environmentally friendly (Ecodesign) can be made a requirement through legislation as in the case of Finland which has an Ecodesign requirement for electrical and electronic equipment as part of its national waste plan **(European Commission, 2013)**.

Estimating Future Waste Generation is another intervention this research recommends to policy makers (O' Leary et al, 1995). In making near correct estimations of future generation, factors crucial to consider are population and public policy changes. Population changes are generally well monitored and realistic predictions can be made. Public policy shifts can change

and affect the quantities and type of waste materials generated. Estimating future generation of solid waste and having adequate data can best prepare authorities for future interventions. **(O' Leary et al, 1995).**

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Appendix

A primary objective of this research was to study whether there is a relationship between amount of solid waste generated and businesses' populations. The table below is arranged in highest to lowest generators to advance this objective.

Table 6- Staff population and solid waste quantities

Rank	Tenant	Waste in Kilograms	Staff Population	Waste per head.
1	SAN VALENCIA	49.45	10	4.9450
2	I.I.E.C	19.57	150	0.1305
3	KENAO	17.81	385	0.0463
4	TECHNOFRIGO	12.40	5	2.4800
5	HELB	10.39	130	0.0800
6	RIALTO	7.25	6	1.2084
7	KCB	6.25	42	0.1489
8	EPC	6.16	50	0.1232
9	SOLECA	5.30	4	1.3250
10	ELLISONS	4.32	10	0.4320
11	CREATIVE PHOTOGRAPHY	3.6	5	0.7200
12	FINANCIAL & LEGAL SECTOR	3.24	11	0.2946
13	AMANI MUSIC INSTRUMENTS	2.89	5	0.5780
14	KENYA RE	2.61	3	0.8700
15	JOSTINE SALON	2.0	6	0.3334
16	EMBASSY OF KOREA	1.9	12	0.1584
17	LANDMARK REALTORS	1.84	8	0.2300
18	MERIDIAN ACCEPTANCES	1.75	6	0.2917
19	PEDIGREE CANDIES	1.7125	1	1.7125
20	REG. OF POLIT. PARTIES(R.O.P.P)	1.5	25	0.0600
21	CODA	1.35	30	0.0450
22	RURALVET	1.18	4	0.2950
23	SKYVIEW	1.075	4	0.2688
24	WESTGATE CLEANERS	1.075	6	0.1792
25	MPATA	1.050	7	0.1500
26	PAYPOINT SOLUTIONS	1.030	16	0.0644
27	SEB ESTATES	1.00	12	0.0834
28	JP'S ITALIAN	0.90	3	0.3000
29	KIKI INVESTMENTS	0.75	4	0.1875
30	PILLATECH	0.70	5	0.1400
31	TRIBUNAL FOR JUDGES	0.68	10	0.0680
32	OTEGA & COMPANY ADVOCATES	0.62	3	0.2067
33	MAWARED HOUSE	0.58	5	0.1160
34	TRACKCARD SYSTEMS	0.5375	9	0.0598
35	JACKLINE P.A ADVOCATES	0.50	5	0.1000
36	KIBABII ENGINEERING	0.475	3	0.1584
37	MIDAS FABRIQUES	0.40	6	0.0667
38	SUPERGRIP	0.380	8	0.0475
39	HURLINGHAM EYE CLINIC SERVICES(HECS)	0.325	3	0.1084
40	COLUMBUS	0.30	10	0.0300
41	UNIVERSITY WAY GENERAL SUPPLIERS	0.265	3	0.0884
42	BRISKY	0.20	2	0.1000
43	CALOFRANA	0.175	3	0.0584
44	WAGITHA	0.17	2	0.0850
45	WIRA CAPITAL	0.1625	2	0.0813
46	ONGATA WORKS	0.060	3	0.0200
	TOTAL	**177.8825**	**1042**	

Table 7- Area Occupied and Solid Waste Generation

Rank	Tenant	Waste in Kilograms	Area Occupied (Sq Ft)	Waste per SqFt.
1	KENAO	17.81	59330	0.0004
2	I.I.E.C	19.57	28374	0.0007
3	HELB	10.39	17450	0.0006
4	EPC	6.16	10470	0.0006
5	KCB	6.25	7812	0.0009
6	EMBASSY OF KOREA	1.9	6980	0.0003
7	TRIBUNAL	0.68	3490	0.0002
8	REG. OF POLIT. PARTIES(R.O.P.P)	1.5	3490	0.0005
9	FINANCIAL & LEGAL SECTOR	3.24	3490	0.0010
10	CODA	1.35	2500	0.0006
11	PAYPOINT	1.03	1667	0.0007
12	MPATA	1.05	1540	0.0007
13	SEB ESTATES	1.00	1420	0.0008
14	SAN VALENCIA	49.45	1280	0.0387
15	TRACKCARD	0.5375	1106	0.0005
16	LANDMARK	1.84	996	0.0019
17	ELLISONS	4.32	938	0.0047
18	JACKLINE P.A	0.5	926	0.0006
19	SKYVIEW	1.075	785	0.0014
20	MERIDIAN	1.75	785	0.0023
21	WESTGATE	1.075	785	0.0014
22	HECS	0.325	785	0.0005
23	JOSTINE	2.0	785	0.0026
24	MIDAS	0.4	785	0.0006
25	RIALTO	7.25	730	0.0100
26	MAWARED	0.58	680	0.0009
27	SUPERGRIP	0.38	678	0.0006
28	BRISKY	0.2	626	0.0004
29	COLUMBUS	0.3	605	0.0005
30	WIRA CAPITAL	0.1625	600	0.0003
31	CREATIVE	3.6	594	0.0061
32	UNIVERSITY WAY GENERAL SUPPLIERS	0.265	594	0.0005
33	KIKI	0.75	570	0.0014
34	ONGATA	0.06	536	0.0002
35	OTEGA	0.62	431	0.0015
36	RURALVET	1.18	414	0.0029
37	PILLARTECH	0.70	383	0.0019
38	JP'S ITALIAN	0.90	383	0.0024
39	WAGITHA	0.17	383	0.0005
40	SOLECA	5.3	380	0.014
41	TECHNOFRIGO	12.4	380	0.0327
42	AMANI MUSIC INSTRUMENTS	2.89	358	0.0081
43	KENYA RE	2.61	322	0.0082
44	CALOFRANA	0.175	308	0.0006
45	PEDIGREE CANDIES	1.7125	98	0.0175
46	KIBABII ENGINEERING	0.475	52	0.0092
	TOTAL	**177.8825**	**168074**	

Table 8 Solid Waste Characterisation-Anniversary Towers

	Business.	Paper	Food	Glass	Plastic	Metal	Text.	Others	Total.	Area	Pop.
1	I.I.E.C	10.4	5.9	0.2	2.5	0.1	0.06	0.41	19.57	28374	150
2	KENAO	10.92	4.5	0	1.39	0.1	0	0.90	17.81	59330	385
3	EPC	4	1.4	0	0.76	0	0	0	6.16	10470	50
4	HELB	5.88	2.6	0	1.25	0	0	0.66	10.39	17450	130
5	TRIBUNAL	0.5	0.06	0	0.12	0	0	0	0.68	3490	10
6	KENYA RE	1.5	0.4	0	0.01	0.3	0.2	0.2	2.61	322	3
7	R.O.P.P	0.54	0.50	0	0.36	0.1	0	0	1.5	3490	25
8	FINA.&LSAP	1.6	0.8	0.02	0.60	0.2	0	0.02	3.24	3490	11
9	COLUMBUS	0.1	0.1	0	0.1	0	0	0	0.3	605	10
10	SKYVIEW	0.5	0.1	0	0.075	0.1	0.1	0.2	1.075	785	4
11	CODA	0.8	0.25	0	0.30	0	0	0	1.35	2500	30
12	ONGATA	0.05	0.01	0	0	0	0	0	0.06	536	3
13	MPATA	0.3	0.45	0	0.2	0.1	0	0	1.05	1540	7
14	BRISKY	0.2	0	0	0	0	0	0	0.2	626	2
15	LANDMARK	1.2	0.45	0	0.15	0.04	0	0	1.84	996	8
16	RURALVET	0.07	0.07	0	0.04	1.0	0	0	1.18	414	4
17	KIKI	0.5	0.25	0	0	0	0	0	0.75	570	4
18	CALOFRANA	0.125	0.03	0	0.02	0	0	0	0.175	308	3
19	TRACKCARD	0.225	0.25	0	0.0625	0	0	0	0.5375	1106	9
20	PAYPOINT	0.33	0.3	0	0.1	0	0	0.3	1.03	1667	16
21	OTEGA	0.30	0.3	0	0.02	0	0	0	0.62	431	3
22	SEB ESTES	0.40	0.40	0	0.10	0	0	0.1	1.0	1420	12
23	SUPERGRIP	0.3	0	0	0.06	0	0	0.02	0.38	678	8
24	MAWARED	0.2	0.2	0	0.0.16	0	0.02	0	0.58	680	5
25	WIRA	0.125	0	0	0.0375	0	0	0	0.1625	600	2
26	MERIDIAN	0.5	0.250	0	0.65	0	0.25	0.1	1.75	785	6
27	CREATIVE	1.0	0.5	0	1.1	0	0	1.0	3.6	594	5
28	JACL.NE P.A	0.4	0	0	0.1	0	0	0	0.5	926	5
29	SOLECA	4.0	0.2	0	1.1	0	0	0	5.3	380	4
30	TECNOFRIG.	1.1	10.5	0	0.7	0.1	0	0	12.4	380	5
31	RIALTO	1.0	1.7	0	1.25	0	3.0	0.3	7.25	730	6
32	WESTGATE	0.25	0.125	0	0.375	0.075	0.125	0.125	1.075	785	6
33	HECS	0.125	0.125	0	0.075	0	0	0	0.325	785	3
34	JOSTINE	0.4	0.45	0	0.65	0	0.40	0.1	2.0	785	6
35	ELLISONS	0.76	1.0	0	0.96	0	1.40	0.20	4.32	938	10
36	MIDAS	0.2	0.16	0	0.04	0	0	0	0.4	785	6
37	PEDIGREE	0.25	1.0	0	0.35	0.1	0	0.0125	1.7125	98	1
38	AMANI	1.33	0.1	0	0.9	0.2	0.15	0.21	2.89	358	5
39	U.WAY GEN	0.125	0.100	0	0.040	0	0	0	0.265	594	3
40	KIBABI. ENG	0.05	0.125	0	0.0375	0	0	0.2625	0.475	52	3
41	San val.	0.50	41.75	1.3	0.60	0.30	0	5.00	49.45	1280	10
42	KCB	2.00	2.80	0	0.95	0	0	0.50	6.25	7812	42
43	Pillar Tech	0.30	0.10	0	0.30	0	0	0	0.70	383	5
44	JP'S Italian	0.20	0.25	0	0.45	0	0	0	0.90	383	3
45	Wagitha	0.1	0.02	0	0.05	0	0	0	0.17	383	2
46	Korea EMB.	1.1	0.20	0	0.40	0	0	0.20	1.90	6980	12
	TOTAL	56.755	80.775	1.52	19.4925	2.815	5.705	10.82	177.8825	168074	1042