DETERMINANTS OF SUSTAINABLE SOLID WASTE MANAGEMENT: A CASE OF CONSTRUCTION PROJECTS IN IMENTI NORTH, MERU COUNTY

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A Research Project Report Submitted in Partial Fulfillment of the Requirements for the Award of the Degree of Master of Arts in Project Planning and Management of the University of Nairobi

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DECLARATION

I declare that this research project report is my own original work and it has not been presented in any other institution of higher learning for any award.

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L50/83825/2016

This research project report has been presented for examination with my approval as the university supervisor.

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DEDICATION

This work is dedicated to my loving children Delwyn Eve Omondi and Derwin Atella Omondi for their unwavering support and understanding during the preparation of this work. Their contribution towards my success is invaluable.

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ABBREVIATIONS AND ACCRONYMS

C & D	Construction and Demolition
CTC	Cradle to Cradle
C W	Construction Waste
CSWM	Construction Solid Waste Management
LCAM	Life Cycle Assessment Model
MSW	Municipal Solid Waste
NCA	National Construction Authority
NEMA	National Environmental Management Authority
PVC	Polyvinyl Chloride
SWMP	Site Waste Management Plan
SWR&RP	Site Waste Reuse and Recycling Plan
U.A.E	United Arab Emirates
U.K	United Kingdom
U.S	United States
WMP	Waste Management Plan

ABSTRACT

Solid waste is made up of hazardous materials that are mostly non-biodegradable, construction solid waste mostly in the form of; broken tiles, steel, Polyvinyl Chloride (PVC) and metal pipes, concrete debris, metal, glass, plastic and gypsum presents huge sustainable management challenges. This is particularly so in construction projects sites that lack low-waste and recycling technology, disposal equipment and in which construction workers are equipped with low levels of education and training. The current study specifically investigated factors that influence the sustainable management of construction solid waste in project sites. Research focused on the influence of design approaches and management, education and training programs, industry targeted programs and low waste technology and recycling equipment. The research was pivoted on two theories; Balance Theory of Recycling Construction and Demolition Waste and Task-contextual Theory. The study was guided by a descriptive survey research design. Target population 3,055 respondents. Study's sample size was of 16, Consultants (Architects, Contractors and Quantity Surveyors), 287 Clients (Landlords that are members of Imenti North Meru Landlords association) and 39 Meru County Government's Department of water, environment and sanitation staff that was selected to participate in the study. Stratified sampling and Simple random sampling was employed to select the respondents. Questionnaires were used to collect data in the study locale. Data was analyzed qualitatively and quantitatively using SPSS version 22.0, this was presented in frequency and percentage tables and Pearson-Product Correlation was applied. The study found that design approaches and management, education and training program, industry targeted programs and low waste technology and recycling equipment had an influence on the sustainable management of construction projects solid waste in Imenti North. The study concluded that design approaches and management had the greatest influence on sustainable management of residential construction solid waste followed by education and training programs then low waste technology and recycling equipment while the industry targeted programs had the least effect on the sustainable management of residential construction solid waste. The study recommends that awareness of the benefits of solid waste management should be created and the general population mobilized, that project managers in Meru County should diversify the form of waste disposal used, that the county government can formulate programs and education/training packages to empower the residents in solid waste reduction and segregation and that government should design better approaches on waste management and help create markets for waste materials through policy making, economic incentives, regulations, enforcement of regulations, and campaigns/promotions.

CHAPTER ONE
INTRODUCTION

1.1 Background to the Study

Hazardous to the environment, construction waste is mostly made of non-biodegradable materials; broken tiles, steel, timber, Polyvinyl Chloride (PVC) pipes and metal, concrete debris, metal, glass, plastic and gypsum (Cha, Kim & Han, 2009). Studies show that this is not a less developed countries challenge only but an environmental issue in developed counties as well (Tam & Lu, 2016; Giwa & Peng, 2013; Li & Zhang, 2012). In the United States (U.S) reports show construction sites waste in particular wood and gypsum contributing to 42% and 27% of Municipal Solid Waste (MSW) respectively (United States Environmental Protection Agency, 2009). Further, countries such as Spain and Poland are reported to recycle 20% of their construction sites solid waste while in Australia, Japan, Hong Kong and Italy construction waste is reported to be at 44%, 36%, 38% and 30% respectively (BIO Intelligence Service, 2011). Construction projects' solid waste contributes to 30%-40% of MSW in China (Qiu, 2010).

In the United States (U.S), Laquatra and Pierce (2011) reported that Industry targeted programs in the form of charge schemes and high levels of education positively influenced endeavors to sustainably manage construction projects solid waste management (CSWM) leading to 75% of this type of waste recycled in local towns in the city of Portland. Reduction in design variations on residential and commercial buildings through contractual obligation that enhanced design management reduced construction solid waste by 30% in Canada (Mendis, Hewage & Wrzesniewski, 2015).

In Spain, Calvo, Varela-Candamio and Novo-Corti, (2014) reported that industry intervention in particular charge schemes anchored on legislation positively influenced efforts on the sustainable management of construction projects solid waste leading to 30% decrease in its production. The unavailability of recycling technology and lack of awareness was reported to adversely influence the sustainable management of construction projects solid waste resulting to a 37% increase in its unsustainable disposal in towns of Northern Cyprus (Najafy, 2014). In the Netherlands, Mulders (2013) reported that the availability of recycling technology and low-waste equipment and Industry targeted

programs in the form of high charge schemes on disposal of construction waste (CW) in landfills positively influenced the sustainable management of construction solid waste resulted to over 85% of C.W recycled.

In Malaysia, Saadi, Ismail and Alias (2016) established lack of Industry targeted programs in particular failure to create of awareness campaigns on reduction, reuse and recycling of construction waste and to provide landfills negatively influenced sustainable management of construction solid waste. Thomas and Wilson, (2013) reported that poor design approaches and management negatively influenced the sustainable management of construction solid waste in construction sites in India. Inadequate training and low levels of education among construction workers was reported to contribute to the unsustainable management of construction solid waste material which amounted closely to 30%-40% of Municipal Solid Waste (MSW) in mainland China (Yuan,Sheng & Wang 2011). The lack of low-waste technology and equipment and inadequate design management characterized by numerous variations in design were responsible for 57% of construction projects solid waste negatively influencing its sustainable management in Thailand (Manowong, 2012).

In Saudi Arabia, Kabir, Al-Ismaeel, Bu Aeshah and Al-Sadun (2015) established that the non-existence of In

Pdustry targeted programs such as regulations that establish charge schemes for construction material waste was responsible for 53% of non-recycled and non-reused solid material waste in residential construction sites. The adoption of a reliable design approaches and management and the existence of reducing, reusing and recycling technologies resultend to the sustainable management of 80% of construction project waste in the United Arab Emirates (U.A.E) (Rogers, 2011). In Turkey, Altuncu and Kasapseçkin (2011) established low levels of training leading to poor workmanship coupled with unavailability of low-waste technology adversely influenced the sustainable management of construction solid waste contributing to 79% of MSW.

In Nigeria, Wahab and Lawal (2011) reported that issues related to design approaches and management causing design changes adversely influenced the sustainable management of construction projects sites solid waste. In Ghana, Agyekum, Ayarkwa and Adinyira (2012) reported lack of low-waste technology and recycling equipment adversely influenced the

sustainable management of construction solid waste in 65% of construction project sites under study. Un-reliable Industry targeted programs characterized by failure to provide landfills and unclear legislation on charge schemes adversely influenced the sustainable management of construction solid waste resulting to its 53% increase in construction projects sites in Cape Verde (Vaz, Pontual, Mainier & da Motta, 2016).

Merid, Abera and Belachew (2010) observed there was need to integrate training programmes for building construction workers on reduction, sorting, reuse and recycling of construction solid waste to enhance its sustainable management in project sites in Ethiopia. In Uganda, Muhwezi, Chamuriho and Lema (2012) reported that substandard design approaches and management leading to poor communication on design resulting to poor site coordination, numerous reworks and variations in design by clients adversely influenced the sustainable management of construction solid waste in project sites. In Tanzania, Sabai (2013) reported that the non-existence of education and training programmes on reuse and recycling of building construction waste exhibited a significant adverse influence on the sustainable management of construction solid waste in project sites.

1.2 Statement of the Problem

Forming a significant percentage of Municipal Solid Waste (MSW), construction solid waste constituting; broken tiles, concrete debris, steel, timber, metal, glass, packaging, plastic and gypsum continues to litter construction project sites in major administrative constituencies and accumulate in landfills around the world. Thought to be an important preventive infectious diseases strategy and an environmental protection measure, the degree of sustainable management of construction solid waste through practices such as reduction, re-use and recycling in Imenti North continues to be low. This emanating from lack of low-waste and recycling technology, disposal equipment and low levels of education and training among construction workers and inconsistency in design approaches and management during construction.

Further, the unsustainable disposal of residential construction solid waste by contractors and clients in the town continues unabated. This party attributed to failure by those charged with the responsibility of ensuring the environment in Meru County is protected and

conserved. In particular, Meru County government's department of Water, Environment and Natural resources has failed to both enforce county laws on management of construction solid waste and implement initiatives that would enhance its sustainable management. Substandard policy measures have also been identified as contributors to the unsustainable management of this type of waste. This has been found to lead to; blocked roads, air pollution, clogged drainage systems contributing to water borne diseases and litter in construction sites' neighboring areas in Imenti North. This study therefore sought to unpack the influence of; design approaches and management, education and training programs, industry targeted programs and low waste technologies and recycling equipment in the sustainable management of residential construction solid waste.

1.3 Purpose of the Study

The purpose of the study was to investigate determinants of sustainable management of solid waste management with specific reference to construction projects in Imenti North Meru County, Kenya.

1.4 Objectives of the Study

The study was guided by the following research objectives;

i. To establish the influence of design approaches and management on the sustainable management of construction projects solid waste in Imenti North.
ii. To assess the influence of education and training programs on the sustainable management of construction projects solid waste in Imenti North.
iii. To determine the influence of industry targeted programs on the sustainable management of construction projects solid waste in Imenti North.
iv. To examine the influence of low waste technology and recycling equipment on the sustainable management of construction projects solid waste in Imenti North.

1.5 Research Questions

The study sought to answer the following research questions;

i. How does design approaches and management influence the sustainable management of construction projects solid waste in Imenti North?

ii. How does education and training programs influence the sustainable management of construction projects solid waste in Imenti North?
iii. To what extent do industry targeted programs influence the sustainable management of construction projects solid waste in Imenti North?
iv. What is the influence of low waste technology and recycling equipment on the sustainable management of construction projects solid waste in Imenti North?

1.6 Significance of the Study

It is hoped that the findings of this scholarly investigation would be of great importance to policy makers in the Ministry of Environment and Natural Resources in coming up with policy measures that the National Construction Authority (NCA) and National Environmental Management Authority (NEMA) can use to enforce the sustainable management of construction projects solid waste. It is also anticipated that Meru County Government's Departments of Water, Environment and Natural Resources would use study findings to facilitate the coordination of the county's interdepartmental development plan on issues related to sustainable management of construction projects solid waste. The study also contributes to the body of knowledge on the sustainable management of residential construction waste specifically on how; design approaches and management, education and training, Industry targeted programs and lack of equipment and technology. The study also provides suggestions that can be adopted which can be used to petition the County Assembly of Meru to enact legislation that facilitates sustainable management of construction projects solid waste.

1.7 Limitations of the Study

The main limitation of the study was that respondents may consider some information confidential and not reveal adequate data. To address this, research instruments used ensured confidentiality and anonymity by requesting the respondents not to indicate their names and contact on them. The study was limited to four key variables: design approaches and management, education and training programs, Industry targeted programs, low waste technology and recycling equipment. The sustainable management of residential construction solid waste in construction sites might also result from a multiplicity of other factors not covered by the study.

1.8 Delimitations of the Study

The scope of the study was confined to construction projects sites in Imenti North and therefore study findings cannot be hypothesized to construction sites in other major sub-counties in Meru County. The study's respondents are; consultants, clients (Landlords or private developers) and staff from County government of Meru department of water, environment and sanitation.

1.9 Basic Assumptions of the Study

The study strongly assumes design approaches and management; education and training programs, Industry targeted programs, low waste technology and recycling equipment have significance influence on the sustainable management of construction projects solid waste. It assumes that the sample population was a representative of the general population that relates to the topic under study. The study also assumes that respondents are aware of how factors covered in the study influence the sustainable management of construction projects solid waste.

1.10 Definitions of Significant Terms Used in the Study

Design Approaches and Management

This refers to the measures taken by construction consultants and clients to minimize the generation of construction solid waste in project sites. These measures include; effective site coordination, the reduction of design variations causing design defects and reworks resulting to an increase in the volumes of solid construction materials.

Education and Training Programmes

This refers to the different levels of knowledge and acquired skills among construction workers and contractors on the management of building design and the sustainable management and disposal of construction solid waste.

Industry Targeted programs

This refers to policy measures implemented in the building construction industry to curb the unsustainable disposal of construction projects solid waste. This takes the form of the number of charge schemes, economic incentives and awareness raising campaigns that

both cultivate a culture of and the adoption of sustainable management approaches for this type of waste.

Low Waste Technology and Recycling Equipment

This refers to both the use technologies such as prefabricated components, large panel steel formworks that facilitate minimal waste during construction and use of apparatus and automated machinery used for recycling of construction solid waste. The recycling equipment includes; concrete jaw and cone crusher, iron ore crusher, brick crusher, glass breaker screen, and cleaner wood screens and crushers, and plastic grinders and granulators.

Residential Construction Solid Waste

This refers to waste; asphalt, ferrous and non-ferrous metal, broken tiles, glass, bricks, plastic and concrete debris that is in most cases non-biodegradable and generated from building activities in residential areas. This type of waste degrades the environment as it litters streets, blocks roads and drainage systems in towns.

Sustainable Management

This refers to practices such as; reduction, reuse and recycling used to better handle construction solid waste; steel, broken tiles, glass, concrete debris and timber with the view of preventing diseases emanating from the unsustainable disposal of this waste and protecting the environment in these construction project sites.

1.11 Organization of the Study

This study is organized into five chapters. Chapter One was introduction covering; background to the study, statement of the problem, purpose of the study which explained what the study intended to accomplish, research objectives and research question, significance of the study. The significance of the study justifies the reason for my study. This chapter also highlights delimitation and limitation of the study and basic assumptions of the study.

Chapter Two reviews literature of the study. This chapter brings out what previous researchers have found out in the area of study. This chapter covers how various

independent variables: design approaches and management, education and training, industry targeted programs and lack of equipment and technology from a global point of view narrowing down to the local level. It also covered theoretical and conceptual frameworks.

Chapter Three is research methodology and covers; research design, target population, sampling procedure which discussed in detail how the sample for this study was selected. It also covered methods of data collection, pilot study, validity and reliability of data collection instruments, data collection procedures, data analysis techniques and ethical considerations.

Chapter four covers data analysis, presentation and interpretation of findings, based on background information and on four variables under study which include; design approaches and management, education and training, industry targeted programs and lack of equipment and technology.

Chapter five covers summary of findings, discussions of the findings, conclusions and recommendations. It also provides suggestions for further studies.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction to Literature Review

This chapter delves into past studies on the factors influencing the sustainable management of residential construction solid waste from a global perspective narrowing down to the continental and regional levels, national level and eventually the study locale.

2.2 Sustainable Management of Construction Projects Solid Waste

In a study, Oyedele and Ajayi (2014) found evidence that inadequate information on market availability of recycled construction materials adversely influenced sustainable management of construction solid waste in project sites in United Kingdom (U.K). This they argued resulted to high costs of recycled construction materials despite reservations by consultants on their quality negatively influencing the sustainable management of construction solid waste (Oyedele & Ajayi, 2014). However, in their study Ferek, Harasymiuk and Tyburski, (2016) observed that the reuse and recycling of building construction materials had a significant positive influence on the sustainable management of construction projects solid waste in Poland. They identified the reuse and recycling of; plastic, steel, concrete debris and insulation materials significantly played a key role in the sustainable management of construction projects solid waste (Ferek, et al., 2016).

In their study, Wang, Yuan, Kang and Lu (2010) observed that the non-existence of a well-developed construction waste recycling market adversely influenced the sustainable management of construction projects solid waste in China. Further, they note even with the availability of recycling equipment the lack of market for recycled building materials contributed to minimal tones of recycled building solid waste in construction sites negatively influencing the sustainable management of residential construction solid waste (Wang, et al., 2010). Similarly, Chinda (2016) found evidence revealing market availability and on-site activities such as reuse of building materials significantly influenced the sustainable management of construction projects solid waste in Thailand. He notes that lack of a well-developed recycled building materials market and the existence of subsidized recycling equipment significantly influenced decisions to recycle construction solid waste

on-site leading to a negative influence of sustainable management of construction projects' solid waste (Chinda, 2016).

Powmya and Abidin, (2014) also observed that the non-existence of a recycled building products market had a significant negative influence on the sustainable management of construction projects solid waste in Oman. They argued that low demand for recycled building waste materials such as; recycled concrete aggregates and debris, wood and recycled glass contributed to mass disposal of these construction wastes in landfills adversely influencing the sustainable management of residential construction solid waste (Powmya & Abidin, 2014). Further, Saghafi and Teshnizi, (2011) reported that minimal; on-site reduce, reusing and recycling activities had a significant negative influence on the sustainable management of construction projects solid waste in Iran. They also contend that this emanated from the unavailability or limited access to recycling equipment leading to both mass production of building materials waste and their disposal in nearby landfills in the country (Saghafi & Teshnizi, 2011).

Further, in their study Atombo, Dzantor and Agbo, (2015) observed that minimal onsite reuse and recycling activities of construction waste adversely influenced the sustainable management of construction projects solid waste in Ghana. They also contend that this emanated from the non-existence of subsidized recycling equipment and market for both recycled building materials and low demand for sustainable buildings which had a significant negative influence on the sustainable management of construction projects solid waste (Atombo, et al., 2015).Similarly, Owolabi et al., (2014) found evidence implying the unavailability of subsidized recycling equipment negatively influenced the recycling of building waste materials in Nigeria. This they argued hindered both reuse and recycling activities on-site contributing a significant adverse influence on the sustainable management of construction project sites solid waste (Owolabi et al., 2014). In a study, Fombe and Ntani (2012) also found the inaccessibility of subsidized recycling equipment and minimal reuse of construction materials had a significant adverse influence on the sustainable management of construction projects solid waste in Cameroon. They also observed that this additionally led to both minimal recycling activities and the increased

number of landfills with construction solid waste negatively influencing its sustainable management (Fombe & Ntani, 2012).

In a study, van Wyk (2014) asserted that failure to adopt a waste management plan (WMP) onsite led to low levels of reuse and recycling activities negatively influencing the sustainable management of construction projects solid waste in South Africa. He further argued that this resulted to a high number of landfills with construction solid waste which presented a significant negative influence to its sustainable management (van Wyk, 2014). Similarly, Urio and Brent, (2006) that minimal levels of reuse and recycling of construction solid waste adversely influenced its sustainable management in Botswana. Specifically, they contend that this resulted to mass production of this type of waste increasing the number of landfills with construction solid waste materials (Urio & Brent, 2006).

Sabai, Lichtenberg, Cox, Mato and Egmond, (2014) assert insignificant levels of recycling of construction solid waste adversely influenced the sustainable management of construction projects solid waste in Tanzania. Additionally, they observed this mainly emanated from lack of subsidized recycling equipment which was found to also result to increased numbers of landfills with construction solid waste (Sabai, et al., 2014). In a study, Madinah, Boerhannoeddin and Ariffin, (2014) also assert low levels of reuse activities onsite and lack of subsidized recycling equipment negatively influenced the sustainable management of construction projects solid waste in Uganda. They also observed that this led to increased number of landfills with construction solid waste in the city under study (Madinah, et al., 2014). Further, in a study Monyoncho (2013) observed lack of subsidized recycling equipment adversely influenced the sustainable management of construction projects solid waste in Kenya. In particular, he argued that the non-existence of such equipment resulted to the mass production of construction waste onsite which in most cases found its way to landfills in urban areas (Monyoncho, 2013).

2.3 Determinants of Sustainable Solid Waste Management

This section reviews empirical literature on sustainable solid waste management based on the stated study objectives:

2.3.1 Design Approaches and Management and Sustainable Management of Construction Projects Solid Waste

Abarca Guerrero, Maas and Lambert, (2012) observed that the design stage in construction is the most important determinant of enhancing sustainable management of construction projects solid waste. They contend that it is at this stage where variations in design are minimized, design errors are eradicated and communication on design specifications are properly handled when effective and efficient design approaches are adopted ensuring construction waste is sustainably managed (Abarca Guerrero, et al., 2012). Approaches to construction design and management were found to have played an essential role in the sustainable management of construction projects solid waste in the United Kingdom (U.K) (Ajayi, 2017). He further notes the minimization of design errors that in most cases lead to numerous rework emanating from design changes contributed to re-use of some construction materials like wood resulting to the sustainable management of construction projects solid waste (Ajayi, 2017). In their study, Kozlovská and Spišáková, (2013) established the design stage and subsequent management was pivotal in the realization of sustainable management of construction projects solid waste in Slovakia. They note proper management of errors in design, efficient design communication at construction sites and minimal variations in design were pivotal in ensuring that sustainable management of construction projects waste was realized (Kozlovská & Spišáková, 2013).

In their study, Lu and Yuan (2010) found evidence that substandard design approaches and management adversely influenced the sustainable management of construction projects solid waste in China. They also observed that this took the form of; numerous variations in design, numerous reworks and weak site coordination all leading to mass production of construction solid waste and subsequently unsustainable disposal in the residential construction sites (Lu & Yuan, 2010). Further, Priyadarshi and Sameersinh (2013) observed the non-existence of sustainable management practices such as reduction, recycling and reuse of construction waste in project sites in India. This they note emanated from poor design approaches and management characterized by; substandard site coordination, variations in design and numerous re-works whose root cause was poor design communication (Priyadarshi & Sameersinh, 2013).

In a study, Al-Hajj and Hamani (2011) observed substandard design approaches and management adversely influenced the sustainable management of construction projects solid waste in construction sites in the United Arab Emirates (U.A.E). They note that these took the form of numerous design changes and reworks leading to the massive production of wood, piping and sanitary fittings, roof tiles and concrete in construction sites. Further, they contend coupled with the non-existence of sustainable management practices like; reduction, re-use and recycling it led to colossal disposal of these waste in these construction sites (Al-Hajj & Hamani, 2011). In his study, Bekr (2014) also established substandard design approaches and management had resulted to a significant negative influence on the sustainable management of construction project sites solid waste in construction sites in Jordan. He also notes that these were exhibited in the form of; recurrent variations in design and inconsistency in site coordination leading to periodic reworks and the frequent colossal production of wood, piping, sanitary fittings and tiles waste in these construction sites that was neither re-used nor recycled (Berk, 2014).

Similarly, Eze, Seghosime, Eyong and Loya (2017) also found that substandard design approaches and management had a negative influence on the sustainable management of construction projects' sites solid waste in Nigeria. They also point out that these led to numerous reworks emanating from poor site coordination which led to massive production of cement packing, wood, Polyvinyl Chloride (PVC) pipes and metal pipes, floor tiles and sanitary fittings waste in construction sites that was in most cases not re-used or recycled (Eze, et al., 2017). Further, Agyekum, Ayarkwa and Adjei-Kumi (2013) observed that substandard design approaches and management negatively influenced the sustainable management of residential construction solid waste in construction sites in Ghana. This they note was characterized by variations in design and numerous reworks which they argued led to massive production of solid construction materials waste in these construction sites as minimal or no sustainable practices such as recycling were adopted (Agyekum, et al., 2013).

Effective approaches and efficient management of design was found to positively influence the sustainable management of construction projects solid waste in Zambia (Muleya & Muyoba, 2010). Further, they note the minimization of design errors and variations in

design significantly contributed to adoption of re-use strategies of construction materials during construction which led to reduced disposal resulting to sustainable management of wood waste in construction sites (Muleya & Muyoba, 2010). Similarly, in their study Ndihokubwayo and Haupt (2010) established that failure to employ effective design approaches and management had a significant adverse influence on the sustainable management of construction project solid waste in South Africa. They also contend that poor site coordination emanating from substandard communication on design and variations in design significantly contributed to increased wastage of construction materials which were not managed in sustainable ways (Ndihokubwayo & Haupt, 2010).

2.3.2 Education and Training Programmes and Sustainable Management of Construction Projects Solid Waste

In a study, Villoria Sáez, del Río Merino and Porras-Amores, (2012) observed the existence of professional construction and waste reduction and reuse training programmes for workers positively influenced the sustainable management of construction projects solid waste in Spain. These they further note did significantly lead to increased on-site waste reduce and reuse activities which significantly led to the decreased disposal of construction sites solid waste in landfills (Villoria Sáez, et al., 2012). However, Couto and Couto, (2009) found evidence that the non-existence of training programmes for construction workers adversely influenced the sustainable management of construction projects solid waste in Portugal. They therefore note that there was need to create training programmes for construction workers in; reduce, reuse and recycling of construction waste for its sustainable management (Couto & Couto, 2009).

Further, Manewa, Rameezdeen, Amaratunga and Ginige (2007) established high levels of illiteracy on professional construction and the non-existence of training programmes adversely influenced the sustainable management of construction projects solid waste in Sri Lanka. They contend that failure by contractors to train their workers on sustainable waste management and the use of unskilled workers by some resulted to mass production of waste which negatively influenced the sustainable management of construction solid waste (Manewa, et al., 2007). Similarly, low levels of education in construction and training in sustainable waste management were found to have had negative significant

influence on the sustainable management of construction projects solid waste in Malaysia (Ya'cob, Zawawi, Isa & Othman, 2013). They argued that these resulted to low levels of professional construction knowledge and also lack of skills in reuse, reduce and recycling among workers leading to mass generation of construction solid waste such as wood chippings, bricks and piping (Ya'cob, et al., 2013).

In their study, Nikmehr, Hosseini, Oraee and Chileshe, (2015) established that the non-existence of education and training programmes did negatively influence the sustainable management of construction projects solid waste in Iran. They observe the non-existence of dependable education programs in construction and training in sustainable waste management practices resulted to lack of skills among construction workers contributing to numerous reworks significantly resulting to the generation of construction solid waste which in most cases was not reused or recycled (Nikmehr, et al., 2015). Lack of training programmes and those on education for professional construction adversely influenced the sustainable management of construction projects solid waste in Jordan (Al-Rifai & Amoudi, 2016). These they observed resulted to a high number of unskilled construction workers who also lacked knowledge and skills on waste reduction, reuse and recycling leading to the unsustainable management of construction solid waste (Al-Rifai & Amoudi, 2016).

Contractors' failure to adopt the use of sustainable waste management trainings for their workers adversely influenced the sustainable management of construction projects solid waste in Nigeria (Garba, Olaleye & Jibrin, 2016). Further, they note that lack of training on sustainable waste management practices contributed to insufficient knowledge on reduce, reuse and recycling negatively influencing the sustainable management of construction solid waste (Garba, et al., 2016).

In their study, Chikezirim and Mwanaumo (2013) also found evidence indicating the non-existence of training in sustainable waste management practices had adverse influence on sustainable management of construction projects solid waste in South Africa. He notes that this contributed to inadequate knowledge among construction workers in sustainable waste management practices such as; reduce, reuse and recycle leading to unsustainable management of construction residential solid waste (Chikezirim & Mwanaumo, 2013).

Similarly, Ntshwene, Essah and Dixon, (2014) reported that failure to undertake trainings in sustainable waste management for construction workers adversely influenced the sustainable management of construction projects solid waste in Bostwana. They contend that most construction workers and their managers lacked knowledge on construction evaluation tools and in particular those related to the sustainable management of construction waste on site leading to unsustainable management of construction projects solid waste (Ntshwene, et al. 2014).

2.3.3 Industry Targeted Programs and Sustainable Management of Construction Projects Solid Waste

Gangolells, Casals, Forcada and Macarulla (2014) observed that the non-existence of sound industry targeted programs negatively influenced the sustainable management of construction projects solid waste in Spain. In particular, they note that the lack of awareness campaigns on sustainable practices such as reuse, reduce and recycling and the failure to create economic incentives such as jobs creation in recycling and proDesign approaches and management of bonuses in charge schemes adversely influenced the sustainable management of construction solid waste in project sites (Gangolells, et al., 2014). However, Oyenuga and Bhamidiarri (2015) found evidence on the effective implementation of industry targeted programs that positively influenced the sustainable management of construction projects solid waste in the United Kingdom (U.K). Specifically, they observed that both the use of awareness campaigns which had improved information levels on the Life Cycle Assessment Model (LCAM) that advocates on the need to reduce, reuse and recycle construction solid waste and the introduction of economic incentives in the form of job creation in the recycling industry resulted to a more sustainable way of managing construction solid waste on project sites (Oyenuga & Bhamidiarri, 2015).

In their study, Yean Yng Ling and Song Anh Nguyen (2013) found evidence that lack of industry targeted programs in particular failure to create of awareness campaigns adversely influenced the sustainable management of construction projects solid waste in Vietnam. They specifically observed that failure by the construction industry to create awareness on reduction, reuse and recycling of construction waste resulted to mass production and

unsustainable disposal of construction solid waste in project sites (Yean Yng Ling & Song Anh Nguyen, 2013). Similarly, in a study, Nagapan, Abdul Rahman and Asmi (2012) established that lack of industry targeted programs in the form of both charge schemes and awareness campaigns negatively influenced the sustainable management of construction project solid waste in Malaysia. Further, they note that this has continually created negative attitudes among construction consultants and their clients on the need to adopt sustainable practices such as; reuse and recycling of construction solid waste (Nagapan, et al., 2012).

The non-existence of industry targeted programs and in particular lack of awareness campaigns adversely influenced the sustainable management of construction projects solid waste in the United Arab Emirates (U.A.E) (Al-Hajj & Iskandarani, 2012). Al-Hajj and Iskandarani, (2012) also observed that this coupled with lack of economic incentives resulted to the existence of a negative attitude among contractors and clients on the need to implement a site waste management plan (SWMP) that integrates onsite sustainable approaches such as reduce and reuse of construction solid waste. Similarly, Reid, Hassan and Al-Kuwari (2015) established that the non-existence of awareness campaigns had a negative influence on the sustainable management of construction solid waste in Qatar. Further, they note low information levels on the need to adopt a SWMP emanating from lack of awareness campaigns on the same resulted to inadequate degrees of reuse, reduction and recycling of construction solid waste in residential building projects in the city of Doha (Reid, et al., 2015).

In their study, Djokoto, Dadzie and Ohemeng-Ababio (2014) observed that lack of sound industry targeted programs adversely influenced the sustainable management of construction projects solid waste in Ghana. In particular, they argued that the non-existence of favorable charge schemes, awareness campaigns on reduce, reuse and recycle and other economic incentives negatively influenced the sustainable management of construction project sites solid waste (Djokoto, et al., 2014). Similarly, Dania, Kehinde and Bala (2007) found lack of effective implementation structures and measures of industry targeted programs negatively influenced the sustainable management of construction projects solid waste in Nigeria. Additionally, they contend that the use ineffective approaches on charge schemes and on creation of awareness on the need for reuse, reduction and recycling

perpetuated the unsustainable disposal of construction solid waste to landfills (Dania, et al., 2007).

In a study, Mohamed and Mohamed (2016) also observed that inconsistencies in industry targeted programs especially low levels of awareness creation campaigns on construction solid waste management adversely influenced its sustainable management in construction project sites in Khartoum, Sudan. These they argued resulted to both minimal levels of waste sorting and the uncontrolled disposal of construction solid waste in landfills by contractors in the city (Mohamed & Mohamed, 2016). Further, Abdelhamid (2014) found evidence exhibiting that the ineffective implementation of industry targeted programs negatively influenced the sustainable management of construction projects solid waste in Egypt. Specifically, he contends that failure to develop awareness creation campaigns on sustainable approaches to construction waste management coupled with the non-existence of economic incentives contributed to the negative attitude among consultants, contractors and their clients on the need to create a site waste reuse and recycling plan (SWR&RP) adversely influencing the sustainable management of construction solid waste (Abdelhamid, 2014).

Muleya and Kamalondo, (2017) found evidence on the adverse influence of the ineffective implementation of industry targeted programs on the sustainable management of construction projects solid waste in Zambia. In particular, they argued the non-existence of awareness creation campaigns and failure to provide economic incentives that would encourage the adoption of a SWMP resulted to low degrees of; reduce, reuse and recycling of construction sites solid waste (Muleya & Kamalondo, 2017). Further, Sabai (2015) observed that the non-existence of industry targeted programs that would have encouraged sustainable approaches to the management of construction solid waste had a negative influence on its sustainable management in Tanzania. Additionally, he notes failure to specifically implement effectively economic incentives that would encourage contractors to develop on site Cradle to Cradle (CTC) systems adversely influenced the reuse and recycling of construction solid waste in residential construction sites (Sabai, 2015).

2.3.4 Low Waste Technology and Recycling Equipment and Sustainable Management of Construction Projects Solid Waste

Ortiz, Pasqualino, and Castells (2010) observed the availability of recycling equipment positively influenced the sustainable management of construction projects solid waste in Spain. Further, they note the availability of concrete debris crushers, wood waste grinders and shredders and plastic granulators led to reduced production of construction solid waste in residential sites that were in most cases recycled or reused (Ortiz, et al., 2010). However, in their study Bohne and Waerner, (2014) found evidence that limited access to recycling equipment worked as a major barrier to the sustainable management of construction projects solid waste in Norway. They specifically contend that limited access to concrete debris crushers and plastic granulators had a significant adverse influence on the sustainable management of construction solid waste in residential sites (Bohne & Wærner, 2014).

In their study, Zhang, Wu and Shen, (2012) found evidence indicating that access to recycling equipment and the utilization of low-waste technology on site positively influenced the sustainable management of construction projects solid waste in Hong Kong. They note that the use of prefabricated products and materials, large panel steel formwork and access to recycling equipment such as; concrete debris crushers and plastic granulators had a positive significant influence on the sustainable management of construction projects solid waste (Zhang, et al., 2012). Minimal utilization of low-waste technologies had an adverse significant influence on sustainable management of construction projects solid waste in Malaysia (Wee, Shan, Wai & Chen, 2015). They contend the non-existence of use of prefabrication products on site resulted to the mass production of construction materials that was neither reused nor recycled leading to the unsustainable management of construction projects' site solid waste (Wee et al., 2015).

Further in a study Al Zarouni, (2015) observed that the unavailability of recycling equipment had an adverse significant influence on the sustainable management of construction projects solid waste in the United Arab Emirates (UAE). He notes that the unavailability of plastic granulators and shredders led to the massive production of plastic waste on site negatively influencing the sustainable management of construction solid

waste (Al Zarouni, 2015). However, in a study Hashemi, Noguchi and Altan, (2015) reported the slow but efficient adoption of low waste technologies had a significant positive influence on the sustainable management of construction projects solid waste in Iran. In particular, they note that the utilization of prefabricated products in the construction of residential buildings had significantly contributed to the sustainable management of construction solid waste in residential project sites (Hashemi, et al., 2015).

In their study, Ayarkwa, Agyekum and Adinyira (2011) observed failure to use low waste technologies and the unavailability of recycling equipment as having presented adverse influence on the sustainable management of construction project solid waste in Ghana. Further, they also note that failure to utilize prefabricated construction materials and the use of large panel steel formwork, the non-existence of plastic granulators and concrete debris crushers negatively influenced the sustainable management of construction solid waste on-site in residential projects (Ayarkwa, et al., 2011). In her study, Wokekoro (2007) found evidence indicating that the unavailability of recycling equipment in the construction in Nigeria adversely influenced the sustainable management of construction projects solid waste. Specifically, she observed that the unavailability of equipment such as; concrete debris crushers, plastic granulators and wood waste grinders, shredders and crushers resulted to massive disposal of construction solid waste (Wokekoro, 2007).

2.4 Theoretical Framework

The current scholarly investigation was pivoted on two theories; Balance Theory of Recycling Construction and Demolition Waste and Task-contextual Theory.

2.4.1 Balance Theory of Recycling of Construction and Demolition (C&D) Waste

Developed by Wong and Yip, (2002) the Balance Theory of Recycling Construction and Demolition (C&D) Waste is based on the premise that construction waste from construction sites can be reduced through waste sorting and recycling. Additionally, they argued that this could best be realized through both the establishment of recycling facilities and the training of construction workers on better on site construction waste sorting techniques (Wong & Yip, 2002). Further, Park and Tucker (2016) proponents of the theory argued that the sustainable management of construction waste materials through reuse is highly reliant on the training of construction workers on the importance of construction

waste reuse. This it is argued creates a culture of waste sorting, reuse and sustainable disposal for recycling (Park & Tucker, 2016). However, sustainable management of construction solid waste through recycling can only be achieved when the amount of waste generated on site and delivered for recycling process is proportional to the amount of the recycled C&D products imported and utilized as building materials for that particular residential project (Wong & Yip, 2002).

The Balance Theory of Recycling Construction and Demolition (C&D) Waste is employed to address issues raised by research study variables; education and training programmes and low waste technology and recycling equipment. It assists the researcher to make the argument that sustainable management of construction projects solid waste is influenced by; training of construction workers in sorting of waste, reduction, reuse and technical recycling skills and it is also influenced by the use prefabricated components and large panel steel formwork in construction projects.

2.4.2 Task-contextual Theory

Developed by Motowidlo, Borman and Schmit (1997) the Task-Contextual theory is based on the premise that the best technique to establish competencies that are essential for a job is to appreciate both the task and contextual demands of the job. Further, they observed that there exist variations in individual personality and cognitive capability, coupled with learning experiences leading to the divergent levels in knowledge, skills and occupational customs that moderate effects of personality and cognitive capability on job performance (Motowildo et al., 1997). Additionally, Motowildo et al., (1997) posit that the technical core determines task performance which is done by undertaking the technical demands of the job while the contextual competencies are associated to the personality, behavior and motivation and it is to a greater extent optional or supportive by design.

Ajayi et al., (2016) proponents of the theory note that the sustainable management of construction solid waste materials is heavily reliant on design task proficiency, low waste design skills and construction linked knowledge that are indispensable task competencies on the other hand they observe that behavioural competence and inter-professional collaborative capabilities are essential contextual competencies for designing out waste. Further, they contend that there is therefore need to improve designers' competencies by

addressing their training needs and also enhancing the attitudes of construction workers on sustainable management of construction solid waste making use of awareness campaigns that appeal to their self-conviction and inclination to waste mitigation (Ajayi et al., 2016).

The Task-Contextual theory is employed to address issues raised by research study variables; design approaches and management, education and training programmes and industry targeted programmes. It assists the researcher to make the argument that sustainable management of construction projects solid waste is influenced by; kinds of knowledge, skills, work habits, and traits of consultants, construction workers and their clients. Additionally, it is influenced by training of construction workers in sorting of waste, reduction, reuse and technical recycling skills and it is also influenced by the use industry targeted programs that entail awareness campaigns and economic incentives for the sustainable management of construction projects solid waste.

2.5 Conceptual Framework

Determinants of sustainable management of construction solid waste in construction project sites in the study locale is as represented in Figure 1 Conceptual Framework which illustrates relationships between independent variables and dependent variables of the study.

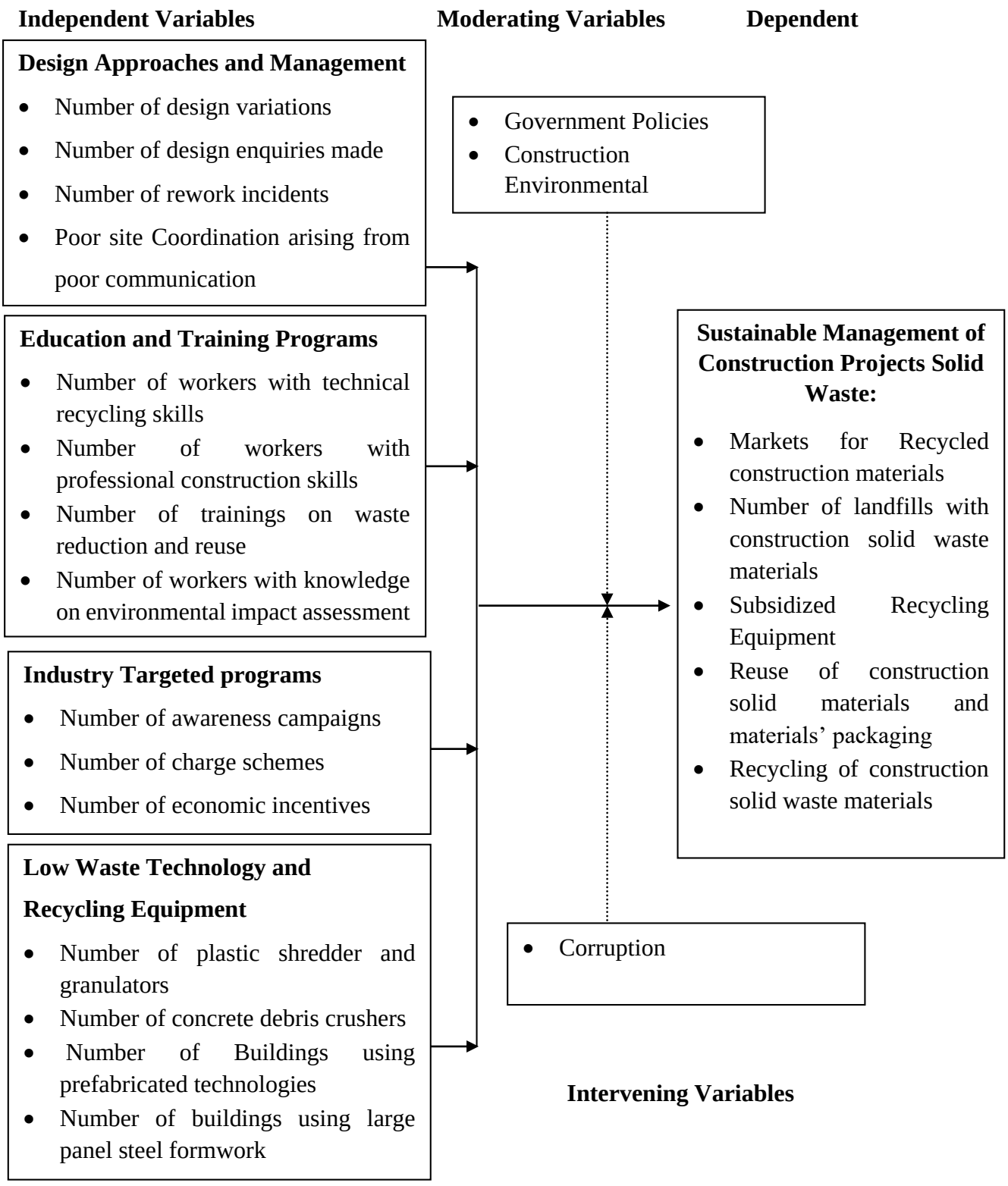

Figure 1: Conceptual Framework

2.6 Explanation of Conceptual Framework

Determinants of sustainable management of construction solid waste in construction project sites in the study locale are: design approaches and management, education and training programs, industry targeted programs and low waste technology and recycling equipment. The determinants work as the research study's independent variables and their relationship with the study's dependent variable (sustainable management of construction solid wastes in construction projects). The independent variables have indicators that depict the variables and develop the rationale that guided their measurement. Government policy and environmental activism are moderating variables which have minimal influences on sustainable management of construction projects solid waste while corruption and construction environmental regulations were either positively or negatively contribute to sustainable management of construction projects solid waste.

2.7 Research Gaps

The Ajayi, (2017) did not find out whether and how number of design enquiries and poor site coordination emanating from poor communication influenced sustainable management of construction projects solid waste in United Kingdom. The Al-Hajj and Hamani (2011) study doesn't also address how substandard site coordination emanating from poor communication as well as number of design enquiries influenced sustainable management of construction projects solid waste in United Arab Emirates (U.A.E). The Eze, Seghosime, Eyong and Loya (2017) study did not find out how design variations and number of design enquiries influenced sustainable management of construction projects solid waste in Nigeria. This investigation seeks to fill these gaps.

The Villoria Sáez, del Río Merino and Porras-Amores, (2012) study in Spain only looks at how existence of professional construction and waste reduction and reuse training programmes positively influenced sustainable management of construction projects solid waste it does not look at how workers' knowledge on environmental impact assessment influence the same. The Nikmehr, Hosseini, Oraee and Chileshe, (2015) study also looks at the influence of professional construction skills but doesn't detail on the influence of other types of trainings such as recycling skills, waste reduction and reuse on the same. This investigation seeks to fill these gaps.

This investigation also sought to fill a research gap on whether similar findings by Bohne and Wærner, (2014) in Norway; Djokoto, Dadzie and Ohemeng-Ababio (2014) in Ghana and Chikezirim and Mwanaumo (2013) in South Africa could be replicated in Imenti North Sub-County.

Most of these studies have been done in far off countries and regions; through this investigation the researcher seeks to fill a research study gap on determinants of sustainable solid waste management with specific reference to construction project sites in rural centers in Imenti North Sub-County, Meru County, Kenya.

2.8 Summary of Literature Review

Kozlovská and Spišáková, (2013) found evidence indicating that proper management of errors in design, efficient design communication at construction sites and minimal variations in design were pivotal in ensuring that sustainable management of construction projects solid waste was realized. Lu and Yuan (2010) observed different evidence of substandard design approaches and management in the form of numerous variations in design, numerous reworks and weak site coordination as having negatively influenced sustainable management of construction projects solid waste in China.

Couto and Couto, (2009) assert the non-existence of training programmes for construction workers adversely influenced the sustainable management of construction projects solid waste in Portugal. Ntshwene, Essah and Dixon, (2014) had reported similar findings in Bostwana. Oyenuga and Bhamidiarri (2015) found evidence on the effective implementation of industry targeted programs that positively influenced the sustainable management of construction projects solid waste in the United Kingdom. This was however the no the case in the findings Dania, Kehinde and Bala (2007) who established lack of effective implementation structures and measures of industry targeted programs negatively influenced the sustainable management of construction projects solid waste in Nigeria.

Ortiz, Pasqualino, and Castells (2010) found the availability of recycling equipment positively influenced the sustainable management of construction projects solid waste in Spain. Zhang, Wu and Shen, (2012) had asserted similar findings in Hong Kong. Wokekoro

(2007) had however observed that the unavailability of recycling equipment in the construction in Nigeria adversely influenced the sustainable management of construction projects solid waste.

This chapter has reviewed literature on how design approaches and management, education and training programs, industry targeted programs and low waste technology and recycling equipment influence sustainable solid waste management with specific reference to construction project sites. Accordingly, the chapter also comes up with a theoretical framework and a conceptual framework.

CHAPTER THREE
RESEARCH METHODOLOGY

3.1 Introduction

This chapter includes: the research design applied in the study, the target population, sampling procedure and sample size and methods of data collection, pilot test, validity and reliability of research instruments which was utilized for the gathering of data required for the study. Additionally, it incorporates data analysis techniques and the operationalization table of variables under investigation plus ethical considerations.

3.2 Research Design

Leedy and Ormrod, (2010) defined research design as the plan adopted in research studies which facilitate researchers to undertake various research operations, hence creating a favorable environment to access adequate information with very little expenditure on effort, time and financial resources. It establishes the framework for gathering, measurement and analysis of data. The current research made use of a descriptive survey research design to undertake an into determinants of solid waste management with specific references to construction projects solid waste in Imenti North, Meru County, Kenya. The choice of survey research design was informed by its inherent features that aided the gathering of information on the prevailing state of affairs and also comprehensively portrays characteristics of the population of study (Salaria, 2012). Additionally, the choice of descriptive survey research design is informed by its capability for to facilitate the gathering of qualitative as well as quantitative data on the relationship between variables under research establishing the link between study variables and problem under investigation (Vogt, Gradner & Haeffele, 2012).

3.3 Target Population

Orodho, (2009) described population as the total of all the individuals or items sharing certain traits or features that researchers have expressed attentiveness for consideration in any field of investigation. According to the National Construction Authority (NCA) there are 53 duly registered consultants; Architects, Contractors and Quantity Surveyors in Imenti North while the Landlords Association-Meru branch has 2,876 duly registered

members and County government of Meru has 126 staff at the Department of water, environment and sanitation. The current study's target population was therefore 3,055 respondents in the researcher's study locale. These respondents are ideal for the gathering of the current study's required data because the variables under investigation as well as their existing correlation with respect to the topic under investigation are well known to them. This was summarized in Table 3.1 on target population

Table 3. 1: Target Population

Respondents	**Target Population**
Consultants (Architects, Contractors and Quantity Surveyors)	53
Clients (Registered members of Landlords' Association-Meru)	2,876
Department of water, environment and sanitation (Staff)	126
Total	**3,055**

3.4 Sample Size and Sampling Procedure

Sampling is the procedure employed to select units of a population to work as representation of the total population. For the current research study, Stratified and Simple Random sampling was used (Emmel, 2013).

3.4.1 Sample Size

This sample size was obtained by applying the formula:

$$Ns = (Np\ )(\ p)(1-\ p)$$

$$(Np\ -1)(B/C)\ 2 + (\ p)(1-\ p)$$

n=(Z^2 **.**PQ/ α^2) by Dillman, (2007) as shown in 3.4.2 sampling procedure.

342 respondents drawn from a targeted population of 3,055 formed the sample size for the study.

3.4.2 Sampling Procedure

The sample size was computed as follows:

At 95% confidence level or probability of 0.05, sample size n can be calculated as:

Desired sample n=(Z^2 **.**PQ/ α^2)

Where Z= Critical **value** of Z at 0.05 which is equal to 1.96

P=Accessible proportion of the target population= 50%

Q= In accessible proportion of the target population=50%

The acceptance error estimate = α.

Using the above formula, the maximum sample size (n_o) required from a large population of 10,000 or more units would be 384 units. The sample size can be adjusted with respect to target population as:

The adjusted sample size $n_1=n_o/ (1+n_o/N)$. Where N is the size of the target population in the area of study

The adjusted sample size $n_1=1+384/ (1+384/3,055) =342$

384/3055 =0.126, 0.126+1= 1.126, 1+384 =385,

385/1.126 = 342

$n_1=342$

The sample size is as shown in Table 3.2. On Sampling Frame

Table 3. 2: Sampling Frame

Respondents	**Target Population**	**Sample Size**
Consultants (Architects, Contractors and Quantity Surveyors)	53	16
Clients (Registered members of Landlords' Association-Meru)	2,876	287
Department of water, environment and sanitation (Staff)	126	39
Total	**3,055**	**342**

For the current study, stratified sampling was employed to ensure proper representation of the different study respondents from each stratum to enhance representation of variables related to them. Simple random sampling was then used as the unit of analysis to distribute final sampled study subjects from dissimilar strata represented by each of them (Steven, 2012).

3.5 Research Instruments

The current study's primary data was collected through the use of questionnaires. Defined as a properly designed investigation tool a questionnaire facilitates researchers to gather information from final study sampled subjects on their traits, current and past behavior, viewpoints or code of conduct and their beliefs and or their rationale for action with respect to the problem under research (Bell, 2010). The choice of this research instrument was guided by its inbuilt advantages including; it's been free from the interviewee prejudicial tendencies and granting respondents sufficient time to provide well thought out responses. Additionally, questionnaires provide a coherent flow of information as well as an opportunity for the researcher to analyze data more objectively that any other forms of research instruments (Saris & Gallhofer, 2014). The current study's questionnaire incorporated closed as well as open ended questions. Its closed questions were made up of a fixed set of questions whose target respondents are; consultants, clients and staff at county government's department of water, environment and sanitation in an itemized pattern and with classified response options. On the other hand, respondents did not experience restrictions in answering the questionnaires' open-ended questions but they freely revealed required information. The questionnaire was divided in 6 sections. Section one requested the final study's sampled subject to fill in his or her background information, whereas the remaining 5 sections incorporated variables under investigation in the current research study. The sections were; Design Approaches and Management, Education and Training Programs, Industry Targeted programs, Low Waste Technology and Recycling Equipment and sustainable management of construction projects solid waste.

3.5.1 Pilot Testing of Instruments

A pilot study is defined as a pre-test that a researcher conducts prior to the larger study whose unique objective is that of establishing whether the methodology of choice is feasible, requisite sample has been met and research tool of choice are non-ambiguous (De Vos, Strydom, Fouché & Delport, 2011). A pilot study was therefore conducted to tackle matters related to; items ambiguity in research questionnaires, sample size sufficiency, questionnaire design imperfections and possible obstruction that may result from suggested data analysis techniques (De Vos, et al., 2011). The correctness of data to be gathered is predominantly dependent on the choice data collection research tools with respect to

validity and reliability which are mainly established through a pilot test (Polit & Beck, 2012). The current research study's pilot was conducted using Neuman (2011) recommendations on the use of 10–20% of the main sample size for conducting pilot study. Specifically 15% of the main sample size was used which translates to a total of 51 sampled respondents.

3.5.2 Validity of the instruments

Validity is defined as the degree to which the measures in a selected research tool yields error-free evidence of concepts it is designed to examine and tests measure what they posit to measure (Kothari, 2012). The current research study's questionnaire validity was established making use of; face, content and construct validity. Face validity involved the researcher's supervisor undertaking a quick scan on the questionnaire and providing an abstract overview of it. The researcher's supervisor and raters from University of Nairobi guided the determination of content validity with regard to; legibility, coherence and comprehensiveness by employing continuous discussions. From these consultations the researcher was able to examine the design of items in the questionnaire determining whether they reflect themes under inquiry and also make recommended redesign approaches and managements. Construct validity was established by checking on quality of instructions integrated in study instruments, reviewing clarity and ambiguity.

3.5.2.1 Validity Analysis

With factor analysis, the construct validity of a questionnaire can be tested (Kothari, 2012). It is always ideal to conduct a factor analysis on the scale data to see if the scale really is one-dimensional. Responses to the individual scale items are the variables in such a factor analysis. If a questionnaire is a construct valid, all items together represent the underlying construct well. Exploratory factor analysis detects the constructs - i.e. factors – that underlie a dataset based on the correlations between variables (in this case, questionnaire items) (Kothari, 2012). The factors that explain the highest proportion of variance the variables share is expected to represent the underlying constructs. Table 3.3 shows the validity analysis results.

Table 3. 3: Component Matrix

	Component			
	1	**2**	**3**	**4**
The number of design variations has influence on the sustainable management of residential construction solid waste.	.155	**.461**	.206	.010
The number of design enquiries does not influence the sustainable management of residential construction solid waste.	.027	**.524**	.359	.091
The number of rework incidents influences sustainable management of residential construction solid waste.	.478	.058	**.730**	.310
Poor site coordination arising from poor communication on design does not influence sustainable management of residential construction solid waste.	**.666**	.558	.266	.178
The number of workers with technical recycling skills has influence on the sustainable management of residential construction solid waste.	.326	**.703**	.513	.125
The number of number of workers with professional construction skills does not influence the sustainable management of residential construction solid waste.	.199	**.580**	.387	.143
The number of trainings on construction waste reduction has influence on sustainable management of residential construction solid waste.	**.576**	.462	.420	.243
The number of trainings on construction waste reuse does not influence on sustainable management of residential construction solid waste.	.191	.197	.167	**.722**
The number of charge schemes has influence on the sustainable management of residential construction solid waste.	**.666**	.558	.266	.178
The number of number of awareness campaigns does not influence the sustainable management of residential construction solid waste.	.192	**.626**	.169	.504
The number of recycling incentives has influence on sustainable management of residential construction solid waste.	**.506**	.034	.077	.185
Existence of plastic shredders and granulators on site has influence on the sustainable management of residential construction solid waste.	**.755**	.274	.061	.214
The number of concrete debris crushers on site does not influence the sustainable management of residential construction solid waste.	**.731**	.123	.041	.091
The number of buildings using prefabricated technologies has influence on the sustainable management of residential construction solid waste.	.478	.058	**.730**	.310
Existence of buildings using large panel steel formwork does not influence on sustainable management of residential construction solid waste.	**.666**	.558	.266	.178

The results in Table 3.3, allowed for the identification of variables that fall under each of the 4 major extracted factors. Each of the 15 parameters was looked at and placed to one of the 4 factors depending on the percentage of variability it explained the total variability of each factor. From the factor analysis, all the variables indicators high construct validity since all exceeded the prescribed threshold of 0.40 (Saunders, Lewis & Thornhill, 2012).

3.5.3 Instrument Reliability

Reliability is defined as the degree to which scores obtained after the distribution of a research tool and the utilization of a technique are reliable and can be regenerated employing the same units of measurement (Drost, 2011). The research study employed Ritter (2010) recommendations on internal consistency technique utilization as well as the application of Cronbach Alpha to determine its questionnaire reliability. According to Ritter (2010) recommendations, Alpha values range from 0 to 1 and placing a co-efficient of 0.7 as acceptable that of 0.8 and or higher demonstrating good reliability of the research tools were employed to guide the reliability determination process. To check reliability, research study questionnaire was also administered to a pilot study on a total of 51 respondents from different strata in main sample size. Pilot study results was then discussed with researcher's supervisors and raters from University of Nairobi to reach a conclusion on the reliability of the choice research tools.

3.5.3.1 Reliability Analysis

Reliability analysis was subsequently done using Cronbach's Alpha which measures the internal consistency by establishing if certain items within a scale measure the same construct. The findings were as shown in Table 3.4.

Table 3. 4: Reliability Analysis

	Alpha value	No of items	Comments
Design approaches and management	0.722	4	Reliable
Education and training programs	0.834	4	Reliable
Industry targeted programs	0.713	3	Reliable
Low waste technology and recycling equipment	0.701	4	Reliable

From the results in Table 3.4, all the variables were reliable since their Cronbach Alpha value were greater than 0.7 in which the education and training programs had the highest

Cronbach Alpha value of 0.834 and Low waste technology and recycling equipment had the lowest Cronbach Alpha value of 0.701. As per Malhotra (2015), if all the variables are reliable then the research instrument is reliable and therefore no amendments required.

3.6 Data Collection Procedures

Primary data was collected through the use of self-administered questionnaires and the drop and pick later technique to the final sampled study's subjects was applied. Additionally, the current research study employed the use structured questionnaires and this choice is anchored on design nature of these research tools which presents each item with a set of choice answers and is also economical in terms of time and money (Saris & Gallhofer, 2014). The desired response rated was achieved by developing a register record of administered questionnaires which facilitated their tracking.

3.7 Data Analysis

Data analysis is the procedure that entails the packaging of gathered data, its articulation and the arranging of its main elements to such an extent that it can be skillfully and effectively conveyed (Steven, Brady & Patricia, 2010). Collected primary data was sorted, edited, coded and analyzed to ensure that comprehensibility and reliability of research tools are upheld. For purposes of creating a detailed abstraction of how the data looked like and to facilitate the identification of pattern, quantitative data from individual research questions were also tabulated. Additionally, to achieve dependable analysis, SPSS version 22.0 was used to analyze gathered primary data from which findings were presented making use of descriptive statistic guided by; frequencies, mean, variance and standard deviation. The researcher made use of results of the analysis to arrive at justifiable conclusions on the subject under investigation.

Data from open ended questions were analyzed making use of content analysis and results from this analysis presented in themes guided by the objectives of the current study. Information from this was summarized by employing frequencies and percentages.

To ascertain the existence of a significant or insignificant relationship between any two of the study's variables and the distinct unique significance of each of the study's four variables with respect to the sustainable management of construction projects solid waste

in building construction sites in the locale of the current study, Pearson Product-Moment correlation (Pearson *r*) was employed (O'Brien & Scott, 2012). In particular, a linear correlation between any two of the research study's predictor variables were determined and their unique influence on the dependent variable established.

3.8 Ethical Considerations

A permit from the National Commission for Science, Technology and Innovation (NACOSTI) was sought to conduct the current study. Secondary data from all literatures utilized for the purpose of this study was acknowledged in the reference list. Additionally, final sampled study subjects were both requested to grant the researcher permission and also to indicate their willingness to participate in the research. Anonymity in answering of the current study's questionnaire was upheld while data collected in the course of the study was used for research purposes only (Macfarlane, 2009).

3.9 Operationalization of Variables

The study's variables were defined as shown on Table 3.5

Table 3. 5: Operationalization of Variables

Objectives	Variables	Indicators	Measurement	Measurement Scale	Data Analysis	Tools of Analysis
To establish the influence design approaches and management on the sustainable management of residential construction solid waste in Meru Town.	Independent Variable Design Approaches and Management	Number of design variations	Number of consultants, clients and staff at county government's department of water, environment and sanitation reporting on the influence of numerous design variations on sustainable management of construction projects solid waste.	Interval Scale	Descriptive and Inferential Statistics	Correlation
		Number of design enquiries	Consultants, clients and staff at county government's department of water, environment and sanitation reporting on the influence of numerous design enquiries on sustainable management of construction projects solid waste.	Ordinal Scale	Descriptive and Inferential Statistics	Regression
		Number of rework incidents	Consultants, clients and staff at county government's department of water, environment and sanitation reporting on the influence of numerous rework incidents on sustainable management of construction projects solid waste.	Ordinal Scale	Descriptive and Inferential Statistics	Regression
		Poor site coordination arising from poor communication on design	Consultants and clients reporting on the influence of poor site coordination on sustainable management of construction projects solid waste.	Ordinal Scale	Descriptive and Inferential Statistics	Regression
To assess the influence of education and training programs on the sustainable management of residential construction solid waste in Meru Town	Independent Variable Education and Training programs	Number of workers with technical recycling skills	Consultants and clients reporting on the influence of workers' technical recycling skills on sustainable management of construction projects solid waste.	Ordinal Scale	Descriptive and Inferential Statistics	Regression
		Number of workers with professional construction skills	Number of consultants, clients and staff at county government's department of water, environment and sanitation reporting on the influence of workers' professional construction skills on sustainable management of construction projects solid waste.	Interval Scale	Descriptive and Inferential Statistics	Correlation
				Interval Scale		Correlation

		Number of trainings on construction waste reduction and reuse Number of trainings on construction waste reuse	Number of consultants, clients and staff at county government's department of water, environment and sanitation reporting on the influence of number of trainings on construction waste reduction and reuse on sustainable management of construction projects solid waste. Consultants, clients and staff at county government's department of water, environment and sanitation reporting on the influence of training on construction waste reuse on sustainable management of construction projects solid waste.		Descriptive and Inferential Statistics	
To determine the influence of Industry targeted programs on the sustainable management of residential construction solid waste in Meru Town	Independent Variable Industry Targeted programs	Number of Charge Schemes Number of awareness campaigns	Consultants, clients and staff at county government's department of water, environment and sanitation reporting on the influence of number of charge schemes on sustainable management of construction projects solid waste. Number of consultants, clients and staff at county government's department of water, environment and sanitation reporting on the influence of number of awareness campaigns on sustainable management of construction projects solid waste.	Ordinal Scale Interval Scale	Descriptive and Inferential Statistics Descriptive and Inferential Statistics	Regression Correlation
To examine the influence of low waste technology and recycling equipment on the sustainable management of residential construction solid waste in Meru Town	Independent Variable Low waste technology and recycling equipment	Plastic shredders and granulators on site Number of concrete debris crushers on site Number of buildings using	Consultants and clients reporting on the influence of plastic shredders and granulators on site on sustainable management of construction projects solid waste. Number of consultants and clients reporting on the influence of number of concrete debris crushers on site on sustainable management of construction projects solid waste. Number of consultants, clients and staff at county government's department of water, environment and sanitation reporting on the influence of number of buildings using	Ordinal Scale Interval Scale Interval Scale	Descriptive and Inferential Statistics Descriptive and Inferential Statistics Descriptive and Inferential Statistics	Regression Correlation Correlation

		prefabricated technologies	prefabricated technologies on sustainable management of construction projects solid waste.	Ordinal Scale	Descriptive and Inferential Statistics	Regression
		Existence of buildings using large panel steel formwork	Consultants, clients and staff at county government's department of water, environment and sanitation reporting on the influence of buildings using large panel steel formwork on sustainable management of construction projects solid waste.			
Sustainable Management of residential construction solid waste	Dependent Variable	Markets for recycled construction materials	Consultants, clients and staff at county government's department of water, environment and sanitation reporting on the influence of markets for recycled construction materials on sustainable management of construction projects solid waste.	Ordinal Scale	Descriptive and Inferential Statistics	Regression
		Number of landfills with construction solid waste materials	Staff at county government's department of water, environment and sanitation reporting on the influence of landfills with construction solid waste on sustainable management of construction projects solid waste.	Interval Scale	Descriptive and Inferential Statistics	Correlation
		Subsidized recycling equipment	Consultants, clients and staff at county government's department of water, environment and sanitation reporting on the influence of subsidized recycling equipment on sustainable management of construction projects solid waste.	Ordinal Scale	Descriptive and Inferential Statistics	Regression
		Reuse of construction materials and material's packaging	Consultants and clients reporting on the influence of reuse of materials' packaging and construction materials on site on sustainable management of construction projects solid waste.	Ordinal Scale	Descriptive and Inferential Statistics	Regression
		Recycling of construction solid materials	Consultants and clients reporting on the influence of recycling of construction solid waste materials on site on sustainable management of construction projects solid waste.	Ordinal Scale	Descriptive and Inferential Statistics	Regression

CHAPTER FOUR

DATA ANALYSIS, PRESENTATION AND INTERPRETATION OF FINDINGS

4.1 Introduction

The findings obtained from the questionnaires is presented in this study. The chapter starts by giving the responses rate, reliability analysis and the validity interpretation. The demographic data for the respondents is presented and thereafter the findings for the determinants of sustainable solid waste management. Finally, regression and Pearson moment correlation were conducted. The findings were presented in tables.

4.2 Response Rate

As shown in Table 4.1, the questionnaires that the researcher administered were 342 out of which only 248 fully filled questionnaires were returned. This gave a response rate of 72.51% which was within what Sekaran (2003) prescribed as a significant response rate for statistical analysis and established it at a minimum value of 50%.

Table 4. 1: Response Rate

		Response Rate
Response	248	75.21%
Non-response	94	24.69%
Total	**342**	**100.00**

4.3 Demographic Information

This section required the respondents to indicate their general information including age bracket, gender and their highest level of education and age bracket. This general information is presented in form tables and sections 4.3.1, 4.3.2 and 4.3.3.

4.3.1 Age of the Respondent

The researcher asked the respondents to indicate the how old they are by selecting the age group they belong to. Their responses were as shown in Table 4.2.

Table 4. 2: Age of the Respondent

	Frequency	Percent
20-29 years	20	8.1
30-39 years	90	36.3
40-49 years	89	35.9
50 years and above	49	19.8
Total	**248**	**100.0**

As per the findings in Table 4.4, 36.3% of the respondents were aged between 30 and 39 years, 35.9% were aged between 40 and 49 years, 19.8% of them were aged above 50 years while those aged between 20 and 29 years were only 8.1%. This is an implication that researcher obtained data across all the required age groups with most of the information coming from 30 to 39 years' age group. Therefore, the information obtained was more reliable for the study.

4.5.2 Gender of the Respondent

The researcher requested the respondents to indicate their gender. Their responses were as shown in Table 4.3.

Table 4. 3: Respondents Gender

	Frequency	Percent
Male	149	60.1
Female	99	39.9
Total	**248**	**100.0**

On respondents' gender analysis, 60.1% of the respondents were male with 39.9% being female. This shows that the researcher was not gender biased in collection of data since all the respondents were considered irrespective of their gender and the information collected was reliable

4.5.3 Highest level of Education

The respondents were required by the researcher to indicate their highest level of education. Their responses were presented in Table 4.4.

Table 4. 4: Highest level of Education

	Frequency	Percent
Certificate	24	9.7
Diploma	48	19.4
Bachelors' Degree	108	43.5
Masters' Degree	53	21.4
PhD	15	6.0
Total	**248**	**100.0**

On analysis of the highest level of education of the respondents, 43.5% of the respondents had a bachelor's degree, 21.4% of the respondents had master's degree, 19.4% had diploma and 9.7% had certificate while 6% had a PhD. This shows that most of the respondents had basic education to be able to respond to the questionnaires effectively and hence the information they gave could be relied upon.

4.6 Determinants of Sustainable Solid Waste Management

The determinants of sustainable solid waste management considered in this study include design approaches and management, education and training programs, industry targeted programs and low waste technology and recycling equipment. Their findings were as presented in the following subsections.

4.6.1 Design Approaches and Management

On analysis of design approaches and management, the researcher asked to use a Likert scale of 1-5 where 1=strongly disagree, 2=disagree, 3=neutral, 4=agree and 5=strongly agree and indicate their level of agreement with various statements. Their replies were as shown in Table 4.5.

Table 4. 5: Level of Agreement with Various Statements on Design Approaches and Management

	Mean	Std. Dev.	CV
The number of design variations has influence on the sustainable management of residential construction solid waste.	3.9194	.6563	0.1674
The number of design enquiries does not influence the sustainable management of residential construction solid waste.	2.2056	.9406	0.4265
The number of rework incidents influences sustainable management of residential construction solid waste.	3.9879	.8022	0.2012
Poor site coordination arising from poor communication on design does not influence sustainable management of residential construction solid waste.	4.3347	.6710	0.1548

The findings on the design approaches and management reveal that the respondents agreed that poor site coordination arising from poor communication on design does not influence sustainable management of residential construction solid waste (Mean=4.3347), that the number of rework incidents influences sustainable management of residential construction solid waste (Mean=3.9879) and that the number of design variations has influence on the sustainable management of residential construction solid waste (Mean=3.9194). However, the respondents disagreed that the number of design enquiries does not influence the sustainable management of residential construction solid waste (Mean=2.2056).

4.6.2 Education and Training Programs

Further education and training programs, the respondents were asked to indicate their level of agreement with various statements using a Likert scale of 1-5 where 1=strongly disagree, 2=disagree, 3=neutral, 4=agree and 5=strongly agree. Their responses were illustrated in Table 4.6.

Table 4. 6: Agreement with Various Statements on Education and Training Programs

	Mean	Std. Dev.	CV
The number of workers with technical recycling skills has influence on the sustainable management of residential construction solid waste.	4.3024	.6047	0.1405
The number of number of workers with professional construction skills does not influence the sustainable management of residential construction solid waste.	2.1290	.7685	0.3610
The number of trainings on construction waste reduction has influence on sustainable management of residential construction solid waste.	4.0766	.6537	0.1604
The number of trainings on construction waste reuse does not influence on sustainable management of residential construction solid waste.	3.3145	.9597	0.2895

From the results on the education and training programs, the respondents agreed that the number of workers with technical recycling skills has influence on the sustainable management of residential construction solid waste as shown by a mean of 4.3024 and that the number of trainings on construction waste reduction has influence on sustainable management of residential construction solid waste as indicated by a mean of 4.0766. However, the respondents were neutral that the number of trainings on construction waste reuse does not influence on sustainable management of residential construction solid waste as illustrated by a mean of 3.3145 and disagreed that the number of number of workers with professional construction skills does not influence the sustainable management of residential construction solid waste as shown by a mean of 2.1290.

4.6.3 Industry Targeted Programs

The respondents were further asked to use a Likert scale of 1-5 where 1=strongly disagree, 2=disagree, 3=neutral, 4=agree and 5=strongly agree and show their level of agreement with various statements on industry targeted programs. Their responses were as shown in Table 4.7.

Table 4. 7: Agreement with Various Statements on Industry Targeted Programs

	Mean	Std. Dev.	CV
The number of charge schemes has influence on the sustainable management of residential construction solid waste.	4.3831	.7652	0.1746
The number of number of awareness campaigns does not influence the sustainable management of residential construction solid waste.	3.0242	1.0452	0.3456
The number of recycling incentives has influence on sustainable management of residential construction solid waste.	3.7298	.8220	0.2204

As shown in Table 4.7, the respondents agreed that the number of charge schemes has influence on the sustainable management of residential construction solid waste (Mean=4.3831) and that the number of recycling incentives has influence on sustainable management of residential construction solid waste (Mean=3.7298) while they neutral that the number of number of awareness campaigns does not influence the sustainable management of residential construction solid waste (Mean=3.0242).

4.6.4 Low Waste Technology and Recycling Equipment

The respondents were further requested to show their level of agreement with various statements on Low Waste Technology and Recycling Equipment using a Likert scale of 1-5 where 1=strongly disagree, 2=disagree, 3=neutral, 4=agree and 5=strongly agree. Their responses were as shown in Table 4.8.

Table 4. 8: Level of Agreement with Various Statements on Low Waste Technology and Recycling Equipment

	Mean	Std. Dev.	CV
Existence of plastic shredders and granulators on site has influence on the sustainable management of residential construction solid waste.	2.8427	.7658	0.2694
The number of concrete debris crushers on site does not influence the sustainable management of residential construction solid waste.	3.0000	.9043	0.3014
The number of buildings using prefabricated technologies has influence on the sustainable management of residential construction solid waste.	4.3831	.7652	0.1746
Existence of buildings using large panel steel formwork does not influence on sustainable management of residential construction solid waste.	3.9879	.8022	0.2012

From the findings, the respondents agreed that the number of buildings using prefabricated technologies has influence on the sustainable management of residential construction solid waste as expressed by a mean of 4.3831 and that the existence of buildings using large panel steel formwork does not influence on sustainable management of residential construction solid waste as illustrated by a mean score of 3.9879. The respondents were also neutral that the number of concrete debris crushers on site does not influence the sustainable management of residential construction solid waste as shown by a mean of 3.0000 and that existence of plastic shredders and granulators on site has influence on the sustainable management of residential construction solid waste as illustrated by a mean of 2.8427.

4.6.5 Sustainable Management of Residential Construction Solid Waste

The respondents were also asked to indicate the extent of trend of various measures of sustainable management of residential construction solid waste in Meru County using a Likert scale of 1-5 where 5=very great extent, 4=great extent, 3=moderate extent, 2=little extent and 1=not at all. The replies were as shown in Table 4.9.

Table 4. 9: Trend of Various Measures of Sustainable Management of Residential Construction Solid Waste

	Mean	Std. Dev.	CV
Markets for recycled construction materials.	3.8831	.6662	0.1716
Number of landfills with construction solid waste materials.	3.2460	1.0532	0.3244
Subsidized Recycling Equipment.	3.7097	.8657	0.2334
Reuse of construction materials and materials' packaging.	4.1653	.6369	0.1529
Recycling of construction solid materials.	2.7137	1.0885	0.4011

The respondents indicated that reuse of construction materials and materials' packaging (Mean=4.1653), that markets for recycled construction materials (Mean=3.8831) and subsidized Recycling Equipment (Mean=3.7097) greatly influence sustainable management of residential construction solid waste in Meru County. However, the respondents indicated that number of landfills with construction solid waste materials (Mean=3.2460) and recycling of construction solid materials (Mean=2.7137) moderately influence sustainable management of residential construction solid waste in Meru County.

4.8 Inferential Statistics

The researcher conducted both the Pearson correlation analysis and the regression analysis. The regression analysis was used to establish the relations between the independent and dependent variables while correlation was conducted to assess the degrees of association between the variables.

4.8.1 Pearson Moment Correlation Results

This was conducted to assess the degrees of association between the variables. A Pearson moment correlation is a number between -1 and +1 that measures the degree of association between two variables. A positive value for the correlation implies a positive association while a negative value for the correlation implies a negative or inverse association. Table 4.10 shows the results for the Pearson moment correlation.

Table 4. 10: Correlation Coefficients

		Sustainable Management of	Design approaches and management	Education and training programs	Industry targeted programs	Low waste technology and recycling
Sustainable Management of Residential Construction Solid Waste	Pearson Correlation	1				
	Sig. (2-tailed)	.				
Design approaches and management	Pearson Correlation	.817	1			
	Sig. (2-tailed)	.012	.			
Education and training programs	Pearson Correlation	.761	.223	1		
	Sig. (2-tailed)	.001	.006	.		
Industry targeted programs	Pearson Correlation	.618	.243	.497	1	
	Sig. (2-tailed)	.002	.002	.000	.	
Low waste technology and recycling equipment	Pearson Correlation	.729	.333	.420	.531	1
	Sig. (2-tailed)	.017	.000	.000	.000	.

The analysis of correlation results between the Sustainable Management of Residential Construction Solid Waste and Design approaches and management shows a positive coefficient 0.817, with p-value of 0.012. It indicates that the result is significant at α =5% and that if the design approaches and management increase it will have a positive impact on the sustainable management of residential construction solid waste. The correlation results between education and training programs and sustainable management of residential construction solid waste also indicates the same type of result where the correlation coefficient is 0.761 and a p-value of 0.001 which significant at α = 5%.

The results also show that there is a positive association between industry targeted programs and sustainable management of residential construction solid waste where the correlation coefficient is 0.618, with a p-value of 0.002. Further, the result shows that there is a positive association between low waste technology and recycling equipment and

sustainable management of residential construction solid waste where the correlation coefficient is 0.729, with a p-value of 0.017. Nevertheless, the positive relationship indicates that when the practice of the afore-mentioned factors is in place the levels of sustainable management of residential construction solid waste increases.

Overall, design approaches and management had the greatest effect on sustainable management of residential construction solid waste followed by industry targeted programs then education and training programs while low waste technology and recycling equipment had the least effect on the sustainable management of residential construction solid waste.

4.8.2 Regression Analysis

In this study, a multiple regression analysis was conducted to test the influence among predictor variables. The research used statistical package for social sciences (SPSS V 21.0) to code, enter and compute the measurements of the multiple regressions. The model summary are presented in the Table 4.11.

Table 4. 11: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.837	0.701	0.696	0.990

The study used coefficient of determination to evaluate the model fit. The adjusted R^2, also called the coefficient of multiple determinations, is the percent of the variance in the dependent explained uniquely or jointly by the independent variables. The model had an average adjusted coefficient of determination (R^2) of 0.696 and which implied that 69.6% of the variations in sustainable management of residential construction solid waste are explained by changes in design approaches and management, education and training programs, industry targeted programs and low waste technology and recycling equipment.

The study further tested the significance of the model by use of ANOVA technique. The findings are tabulated in Table 4.12.

Table 4. 12: Analysis of Variance (ANOVA)

Model		Sum of Squares	Df	Mean Square	F	Sign.
1	Regression	566.126	4	141.532	142.607	.000
	Residual	241.168	243	0.992		
	Total	**807.294**	**247**			

From the ANOVA statics, the study established the regression model had a significance level of 0.00% which is an indication that the data was ideal for making a conclusion on the population parameters as the value of significance (p-value) was less than 5%. The calculated value was greater than the critical value (142.607>2.4088) an indication that design approaches and management, education and training programs, industry targeted programs and low waste technology and recycling equipment all have a significant effect on sustainable management of residential construction solid waste. The significance value was less than 0.05 indicating that the model was significant.

In addition, the study used the coefficient table to determine the study model. The findings are presented in the Table 4.13.

Table 4. 13: Regression Coefficients

	Un standardized Coefficients		Standardized Coefficients	t	Sig
	B	Std. Error	Beta		
(Constant)	0.912	0.112		8.143	.000
Design approaches and management	0.801	0.393	0.817	2.038	.048
Education and training programs	0.711	0.244	0.761	2.914	.006
Industry targeted programs	0.587	0.239	0.618	2.456	.018
Low waste technology and recycling equipment	0.719	0.178	0.729	4.039	.000

The regression equation obtained from this outcome was: -

$$\mathbf{Y = 0.912+0.801X_1 + 0.711X_2 +0.587X_3 + 0.719X_4}$$

As per the study results, it was revealed that if all independent variables were held constant at zero, then the Sustainable management of residential construction solid waste will be 0.912. From the findings the study revealed that if design approaches and management increases by one unit, then sustainable management of residential construction solid waste would increase by 0.801. This variable was significant since p=0.048 is less than 0.05.

The study further revealed that if education and training programs changes it would lead to 0.711 change in sustainable management of residential construction solid waste. The variable was significant since p-value=0.006<0.05. Moreover, the study showed that if all other variables are held constant, variation in industry targeted programs variates sustainable management of residential construction solid waste by 0.587. This variable was significant since p=0.018 was less than 0.05. Finally, the study revealed that variation in low waste technology and recycling equipment would change the sustainable management of residential construction solid waste by 0.719. This variable was significant since p-value=0.000 was less than 0.05.

Generally, design approaches and management had the greatest influence on sustainable management of residential construction solid waste followed by education and training programs then low waste technology and recycling equipment while had the industry targeted programs then least effect on the sustainable management of residential construction solid waste. All the variables were significant since p-values were less than 0.05.

CHAPTER FIVE
SUMMARY OF FINDINGS, DISCUSSIONS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presents summary of the data findings, discussion of the data findings, conclusion drawn from the findings highlighted and recommendation made. The conclusions and recommendations drawn are focused on addressing the objective of the study.

5.2 Summary of the Findings

The study sought to establish the influence of design approaches and management on the sustainable management of construction projects solid waste in Imenti North. The study found that poor site coordination arising from poor communication on design does not influence sustainable management of residential construction solid waste, that the number of rework incidents influences sustainable management of residential construction solid waste and that the number of design variations has influence on the sustainable management of residential construction solid waste. Moreover, the study revealed that number of design enquiries influence the sustainable management of residential construction solid waste.

The study further sought to assess the influence of education and training programs on the sustainable management of construction projects solid waste in Imenti North. The study revealed that number of workers with technical recycling skills has influence on the sustainable management of residential construction solid waste and that the number of trainings on construction waste reduction has influence on sustainable management of residential construction solid waste. The study further found that the number of trainings on construction waste reuse does not influence on sustainable management of residential construction solid waste and that the number of number of workers with professional construction skills influence the sustainable management of residential construction solid waste.

The study also sought to determine the influence of industry targeted programs on the sustainable management of construction projects solid waste in Imenti North. It was clear that the number of charge schemes has influence on the sustainable management of residential construction solid waste and that the number of recycling incentives has influence on sustainable management of residential construction solid waste and that the number of number of awareness campaigns does not influence the sustainable management of residential construction solid waste.

Further the study sought to examine the influence of low waste technology and recycling equipment on the sustainable management of construction projects solid waste in Imenti North. The study revealed that the number of buildings using prefabricated technologies has influence on the sustainable management of residential construction solid waste and that the existence of buildings using large panel steel formwork does not influence on sustainable management of residential construction solid waste. The study found that the number of concrete debris crushers on site does not influence the sustainable management of residential construction solid waste and that existence of plastic shredders and granulators on site has influence on the sustainable management of residential construction solid waste.

5.3 Discussion of the Findings

5.3.1 Design Approaches and Management

It was clear that poor site coordination arising from poor communication on design does not influence sustainable management of residential construction solid waste, that the number of rework incidents influences sustainable management of residential construction solid waste and that the number of design variations has influence on the sustainable management of residential construction solid waste. Moreover, the study revealed that number of design enquiries influence the sustainable management of residential construction solid waste. These findings are in line with Abarca Guerrero, Maas and Lambert (2012) observed that the design stage in construction is the most important determinant of enhancing sustainable management of construction projects solid waste. They contend that it is at this stage where variations in design are minimized, design errors are eradicated and communication on design specifications are properly handled when

effective and efficient design approaches are adopted ensuring construction waste is sustainably managed.

5.3.2 Education and Training Programs

The study established that number of workers with technical recycling skills has influence on the sustainable management of residential construction solid waste and that the number of trainings on construction waste reduction has influence on sustainable management of residential construction solid waste. These results are in agreement with Oyenuga and Bhamidiarri (2015) who found evidence on the effective implementation of industry targeted programs that positively influenced the sustainable management of construction projects solid waste in the United Kingdom (U.K). Specifically, they observed that both the use of awareness campaigns which had improved information levels on the Life Cycle Assessment Model (LCAM) that advocates on the need to reduce, reuse and recycle construction solid waste and the introduction of economic incentives in the form of job creation in the recycling industry resulted to a more sustainable way of managing construction solid waste on project sites

The study further found that the number of trainings on construction waste reuse does not influence on sustainable management of residential construction solid waste and that the number of number of workers with professional construction skills influence the sustainable management of residential construction solid waste. This concurs with Nagapan, Abdul Rahman and Asmi (2012) established that lack of industry targeted programs in the form of both charge schemes and awareness campaigns negatively influenced the sustainable management of construction project solid waste in Malaysia. Further, they note that this has continually created negative attitudes among construction consultants and their clients on the need to adopt sustainable practices such as; reuse and recycling of construction solid waste.

5.3.3 Industry Targeted Programs

It was clear that the number of charge schemes has influence on the sustainable management of residential construction solid waste and that the number of recycling incentives has influence on sustainable management of residential construction solid waste and that the number of number of awareness campaigns does not influence the sustainable

management of residential construction solid waste. These findings corelate with Muleya and Kamalondo (2017) who found evidence on the adverse influence of the ineffective implementation of industry targeted programs on the sustainable management of construction projects solid waste in Zambia. In particular, they argued the non-existence of awareness creation campaigns and failure to provide economic incentives that would encourage the adoption of a SWMP resulted to low degrees of; reduce, reuse and recycling of construction sites solid waste.

5.3.4 Low Waste Technology and Recycling Equipment

The study revealed that the number of buildings using prefabricated technologies has influence on the sustainable management of residential construction solid waste and that the existence of buildings using large panel steel formwork does not influence on sustainable management of residential construction solid waste. Ortiz, Pasqualino, and Castells (2010) who observed that the availability of recycling equipment positively influenced the sustainable management of construction projects solid waste in Spain. Further, they note the availability of concrete debris crushers, wood waste grinders and shredders and plastic granulators led to reduced production of construction solid waste in residential sites that were in most cases recycled or reused.

The study found that the number of concrete debris crushers on site does not influence the sustainable management of residential construction solid waste and that existence of plastic shredders and granulators on site has influence on the sustainable management of residential construction solid waste. These findings conform to Zhang, Wu and Shen, (2012) who found evidence indicating that access to recycling equipment and the utilization of low-waste technology on site positively influenced the sustainable management of construction projects solid waste in Hong Kong. They note that the use of prefabricated products and materials, large panel steel formwork and access to recycling equipment such as; concrete debris crushers and plastic granulators had a positive significant influence on the sustainable management of construction projects solid waste.

5.4 Conclusions

In Imenti North, sustainable management of construction projects solid waste is positively and significantly influenced by design approaches and management. It was clear that sustainable management of residential construction solid waste is not influenced by poor site coordination arising from poor communication but influenced by the number of rework incidents. Further it was established that number of design variations and design enquiries influence the sustainable management of residential construction solid waste.

Education and training programs were found to positively and significantly influenced the sustainable management of construction projects solid waste in Imenti North. This was attributed number of trainings on construction waste reduction that dictates the number of workers with technical recycling skills. Also, the number of number of workers with professional construction skills influence the sustainable management of residential construction solid waste.

The study also concluded that industry targeted programs have a positive influence sustainable management of construction projects solid waste in Imenti North. It was clear that the number of charge schemes and recycling incentives has influence on sustainable management of residential construction solid waste. Moreover, the it was clear that number of awareness campaigns does not influence the sustainable management of residential construction solid waste.

Low waste technology and recycling equipment was further concluded to positively and significantly influence sustainable management of construction projects solid waste in Imenti North. It was clear that number of buildings using prefabricated technologies and that the existence of buildings using large panel steel formwork influence on sustainable management of residential construction solid waste. Further it was revealed that the number of concrete debris crushers on site does not influence the sustainable management of residential construction solid waste and that existence of plastic shredders and granulators on site has influence on the sustainable management of residential construction solid waste.

5.5 Recommendations

The study recommends that awareness of the benefits of solid waste management should be created and the general population mobilized. The county government should be the initiator of community participation. The several methods studied would be effective in changing mindset of the population. The TV media, public Barraza's, posters and person to person should be utilized depending on the budgets available.

The project managers in Meru County should diversify the form of waste disposal used. This will enable them to address the different nature of waste produced in the county. Different types of waste that are generated in a county require different methods to address the problem of waste disposal the more options the county has in methods of disposal the more they are able to address different types of wastes generated.

The county government can formulate programs and education/training packages to empower the construction workers and contractors on management of building design and the sustainable management and disposal of construction solid waste. This will aid towards achieving the zero-waste principle. This informed by the positive attitude by public hospital management to be involved and trained in solid waste management. The study also recommends that public hospitals management should organize educational activities such as the organisation of conferences, seminars and workshops, publication of training manuals, case studies and best practices, and provision of technical and financial assistance should also be conducted.

The government should design better approaches on waste management and help create markets for waste materials through policy making, economic incentives, regulations, enforcement of regulations, and campaigns/promotions. By recognizing and giving awards to best practices in waste management, the government would help increase the public's awareness of initiatives and encourage others to adopt similar approaches. The county government could help establish the residential solid waste committees. This will create a forum of communication, engagement and working together between the households and the department in solid waste service provision. This is supported by the citizen participation theory.

Government should allocate enough budget for provision of low waste technology and recycling equipment within Meru county which should be reviewed periodically to ascertain if the monies are put to correct use and to ensure efficient effective Solid Waste Management. The government should encourage the development of better waste management through waste reduction, reuse, recycling and composting. As the facilitator for waste management program development (using concepts such as the polluter pays principle and cleaner production), the government should support businesses and communities through pilot projects, funding, training, technical assistance, information exchange, follow-up support and monitoring.

The government should encourage better waste management practices and help create markets for waste materials through policy making, economic incentives, regulations, enforcement of regulations, and campaigns/promotions. By recognizing and giving awards to best practices in waste management, the government would help increase the public's awareness of initiatives such as the SWM program and encourage others to adopt similar approaches.

5.6 Suggestions for Further Studies

This study only focused on determinants of sustainable solid waste management in construction projects in Imenti North, Meru County. The study recommends the same study to be done in other sub counties in Meru county. Further a similar study can be done in other counties in Kenya.

A study should also be carried out on the influence of Government policies on effectiveness of effective Solid Waste Management and to establish the influence of other stakeholders like NGOs and NEMA on effective Solid Waste Management.

Moreover, the study suggests that study should be conducted to establish the influence of public's awareness of initiatives on sustainable Solid Waste Management. Since this study was also limited to construction projects, a similar study needs to be done focusing on other projects like Road projects.

REFERENCES

Abarca Guerrero, L. Maas, G.J., and Lambert, A.J.D. (2012). Construction waste generation due to design phase. *Gerontechnology, Volume11 Issue, 2*,pp.137-138.DOI: 10.4017/gt.2012.11.02.173.00.

Abdelhamid, M.S. (2014). Assessment of different construction and demolition waste management approaches. *Housing and Building National Research Center Journal, Volume,10,* pp.317-326.

Agyekum, K., Ayarkwa, J., and Adinyira, E. (2012). Consultants' Perspectives on Materials Waste Reduction in Ghana. *Engineering Management Research Volume.1, No.1;*, pp.138-150.

Agyekum, K. Ayarkwa, J., and Adjei--Kumi, T. (2013). Minimizing Materials Wastage in Construction- A Lean Construction Approach. *Journal of Engineering and Applied Science Volume, 5 Issue, No.1*, pp.125-146.

Ajayi, S. (2017). Design, procurement and construction strategies for minimizing waste in construction projects. *Unpublished PHD Dissertation, University of the West of England.*, Retrived from:http://eprints.uwe.ac.uk/30123.

Ajayi, S.ed, Oyedele, L., Kadiri, K., Akinade, O., Bilal, M., Owolabi, H., and Alaka, H. (2016). Competency-based measures for designing out construction waste: Task and contextual attributes. *Engineering,Construction and Architectural Management, Volume 23 Issue No.4*, pp.464-490.

Al Zarouni, T. (2015). Impact of Using Recycled Materials in the Construction Industry of the United Arab Emirates. *Unpublished Doctoral dissertation, The British University in Dubai (BUiD)*, pp.3-87.

Al-Hajj, A., and Hamani, K. (2011). Material Waste in the UAE Construction Industry: Main Causes and Minimization Practices. *Architectural Engineering and Design Management, Volume 7, Issue, 4,* pp.221-235:DOI:10.1080/17452007.2011.594576.

Al-Hajj, A. and Iskandarani, T. (2012). Reducing Waste Generation on the UAE Construction Sites. *Paper presented at 7th International Conference on Innovation in Architecture, Engineering & Construction,* (pp. pp.1-13). São Paulo, Brazil: Heriot-Watt University.

Al-Rifai, J., and Amoudi, O. (2016). Understanding the Key Factors of Construction Waste in Jordan. *Jordan Journal of Civil Engineering, Volume 10, Issue, No.2,*.

Altuncu, D., and Kasapseçkin, M.A. (2011). Management and recycling of constructional solid waste in Turkey. *Procedia Engineering 21*, pp.1072-1077.

Atombo, C., Dzantor, J.C.K., and Agbo, A.A .(2015). Integration of Sustainable Construction in Project Management: A Case Study in Ghana. *International Journal of Construction Engineering and Management, Volume, 4 Issue,1*,pp.13-25.

Ayarkwa, J., Agyekum, K., and Adiniyira, E. (2011). Exploring Waste Minimization Measures in the Ghanaian Construction Industry. *Built Environment Journal, volume, 8 Issue No.2,* pp.22-30.

Bekr, G. A. (2014). Study of the Causes and Magnitude of Wastage of Materials on Construction Sites in Jordan. *Journal of Construction Engineering Volume 2014*,pp.2-6.

Bell, J. (2010). *Doing your research project: A guide for first-time researchers in education,health and social science (5th ed.).*Maidenhead, England; Open University Press.

BIO Intelligence Service, (2011). *Study on the management of construction and demolition waste in the EU: Final report for the European Commission.* Retrieved From:http://www.eu-smr.eu/cdw/docs/BIO_Construction%20and%20Demolition%20Waste_Final%20report_09022011.pdf.

Bohne, R.A., and Wærner, E.R. (2014). Barriers for deconstruction and reuse/recycling of construction materials in Norway. In a. R. Nakajima S, *Barriers for deconstruction*

and reuse/recycling of construction materials. (pp.89–107).CIB Publication 397.Working Commission W115.Construction Materials Stewardship.

Calvo, N., Varela-Candamio, L., and Novo-Corti, I. (2014). A Dynamic Model for Construction and Demolition (C&D) Waste Management in Spain: Driving Policies Based on Economic Incentives and Tax Penalties. *Sustainability 2014, 6*,pp.416-435.

Cha, H.S., Kim,J., and Han, J.Y. (2009). Identifying and assessing influence factors on improving waste management performance for building construction projects. *Journal of construction engineering and management, Volume 135, Issue 7*, pp.647-656.

Chikezirim, O., and Mwanaumo, E. (2013). Evaluation of Waste Management Strategies Adopted In Tshwane Building Industry.*Journal of Construction Project Management and Innovation Volume,3 Issue No.1*, pp.498-510.

Chinda, T. (2016). Investigation of factors affecting a construction waste recycling decision.*Civil Engineering and Environmental Systems Volume 33 Issue 3*, pp.214-226.

Couto, J.P., and Couto, A. (2009). Strategies to improve waste management in Portuguese construction industry: the deconstruction process. *International Journal of Environment and Waste Management, Volume, 3(1-2),*pp.164-176.

Dania, A.A., Kehinde, J.O. and Bala, K. (2007)). A study of construction material waste management practices by construction firms in Nigeria. *Proceedings of the 3rd Scottish Conference for Postgraduate Researchers of the Built and Natural Environment.* Glasgow: Glasgow Caledonian University.

De Vos A.S., Strydom, H., Fouché, G.B., and Delport, C.S.L. (2011). *Research at the grass roots for the social sciences and human service professions. 4th ed.*Pretoria:JL Van Schaik Publishers.

Djokoto, S.D., Dadzie, J., and Ohameng-Ababio, E. (2014). Barriers to sustainable construction in the Ghanaian construction industry: consultants

perspectives.*Journal of Sustainable Development,Volume 7, Issue, No.1*, pp.134-143.

Drost, E.A. (2011). Validity and Reliability in Social Science Research. *Education Research and Perspectives, Vol.38, No.1*,pp.105-123.

Emmel, N. (2013). *Sampling and choosing cases in qualitative research: A realist approach.* London: SAGE.

Eze, E.C., Seghosime, R., Eyong, O.P., and Loya, O.S. (2017). Assessment of materials waste in the construction industry: A view of Construction Operatives, Tradesmen and Artisans in Nigeria. *The International Journal of Engineering and Science (IJES) Volume, 6 Issue, 4*,pp.32-47.

Ferek, B., Harasymiuk, J., and Tyburski, J. (2016). Recycling and reuse of chosen kinds of waste materials in a building industry. *In IOP Conference Series: Materials Science and Engineering (Vol. 145, No. 3,)* (p. 032002). Bristol, U.K:IOP Publishing.

Fombe, L. F., and Ntani, M. D. (2012). Building and Endangering Urban Landscapes: the Case of Construction Wastes in Bamenda Cameroon. *Journal of Sustainable Development,* Volume, *5 Issue,* 10, pp.60-67.

Gangolells, M., Casals, M., Forcada, N., and Macarulla, M. (2014). Analysis of the implementation of effective waste management practices in construction projects and sites. *Resources, Conservation and Recycling, Volume,93* ,pp.99-111.

Garba, A., Olaleye, Y.O., and Jibrin, N.S. (2016). Material Resources Optimization for Sustainable Construction in Nigeria. *Journal of Engineering and Architecture Volume. 4, Issue No.1*, pp.33-47.DOI: 10.15640/jea.v4n1a3.

Giwa, T., and Peng, C. (2013). Environmental Profiling As an Approach for Quantifying the Environmental Sustainability of Residential Buildings in Nigeria.*International Conference on Sustainable Design, Engineering, and Construction:Developing the Frontier of Sustainable Design, Engineering, and Construction,* (pp.431-440).Virginia: American Society of Civil Engineers.

Hashemi, A., Noguchi, M., and Atlan, M. (2015). Feasibility of Application of Modern Methods of Construction in Iran,. *ZEMCH 2015 International Conference*,(pp.1-14). Lecce, Italy.

Kabir, S., Al.-Ismaeel, A.A., Bu Aeshah, A.Y., and Al-Sadun, F.S. (2015). Sustainable Management Program for Construction Waste. *College of Engineering, King Faisal University,Al Ahsa, Kingdom of Saudi Arabia*, pp.1-12.

Kothari, C.R. (2012). *Research Methodology: An introduction. In Research Methodology: Methods and Techniques.*New Delhi: New Age International.

Kozlovská, M., and Spišáková, M. (2013). Contruction waste generation across construction project life-cycle. *Organizat ion, technology and management in construction.An International Journal Volume 5 Issue 1*, pp 687-695.

Laquatra, J. and Pierce, M. (2011). *Waste Management at the Construction Site, Integrated Waste Management - Volume I, Mr. Sunil Kumar (Ed.), ISBN: 978-953-307-469-6,*. Rijeka, Croatia: InTech:Retrieved From:http://www.intechopen.com/books/integrated-waste-management-volume-i/waste-management-at-the-construction-site.

Leedy, P.D., and Ormrod, J.E. (2010). *Practical Research: Planning and Design, Ninth Edition,*. New York: Macmillan Publishing Company.

Li, Y., and Zhang, X. (2012). Comparison and analysis of international construction waste management policies. *Construction Research Congress 2012:Construction Challenges in a Flat World* (pp. pp.1672-1681). Virginia :American Society of Civil Engineers.

Lu, W., and Yuan, H. (2010). Exploring critical success factors for waste management in construction projects of China.*Resources,conservation and recycling, Volume 55 Issues,2*, pp.201-208.

Macfarlane, B. (2009). *Researching with integrity: The ethics of academic enquiry.*New York, N.Y:Routledge.

Madinah, N., Boerhannoeddin, A., and Ariffin, R. N. B. R. (2014) Sustainable Management of KCCA Mpererwe Landfill: History, present, future possibilities and solutions. A qualitative study. *Journal of Environmental Science, Toxicology and Food Technology*, *Volume 8, Issue 1*, pp.87-95.

Manewa, R.M.A.S., Rameezdeen, R., Amaratunga, R.D.G., and Ginige, K. (2007). Towards The sustainable construction through minimising site waste in Sri Lanka. *7th International Postgraduate Conference in the Built and Human Environment* (pp.319-326). Manchester: University of Salford.

Manowong, E. (2012). Investigating factors influencing construction waste management efforts in developed countries: An experience from Thailand. *Waste Manage. Res.30*,pp.56–71.

Mendis, D., Hewage, K.N., and Wrzesniewski, J. (2015). Contractual obligations analysis for construction waste management in Canada. *Journal of Civil Engineering and Management, Volume 21 Issue,7*, pp.866-880.

Merid, M., Abera, N., and Belachew, T., (2010). The Role of Construction Management Professional in minimizing wastage of material in building construction; The Case of Addis Ababa. *Unpublished Thesis, Addis Ababa University,* pp.1-76:http://hdl.handle.net/123456789/4059.

Mohamed, F.A.R., and Mohamed, A.S.H. (2016). A Glance on Construction Solid Waste Management in Khartoum. *International Journal of Science, Engineering and Technology Research (IJSETR) Volume 5, Issue 1*,, pp.101-106.

Monyoncho, G.O. (2013). Solid Waste Management in Urban Areas Kenya: A case study of Lamu Town. Unpublished Research Project, Post-Graduate Diploma, Department of Real Estate and Construction Management, University of Nairobi.

Motowidlo, S.J., Borman, W.C., and Schmit, M.J. (1997). A theory of individual differences in task and contextual performance.*Human Performance, Volume, 10 Issue No.2* , pp.71-83.

Muhwezi, L., Chamuriho, L.M., and Lema,N.M. (2012). An investigation into Materials Wastes on Building Construction Projects in Kampala-Uganda. *Scholarly Journal of Engineering Research Volume.1(1),* pp.11-18.

Mulders, L. (2013). High quality recycling of construction and demolition waste in the Netherlands. *Unpublished Master Degree Thesis,Utrecht University*, pp.1-55.

Muleya, F. and Muyoba, R. (2010,August 15). Minimising Construction Material Waste through Design. *National Council for Construction, Construction News Magazine,Zambia, Issue No 003.*, pp. pp.10-21.

Muleya, F. and Kamalondo, H. (2017). An Investigation of Waste Management Practices in the Zambian Construction Industry. *Journal of Building Construction and Planning Research Volume 5*, pp.1-13.DOI: 10.4236/jbcpr.2017.51001.

Nagapan, S., Abdul Rahman, I. and Asmi, A. (2012). Construction Waste Management: Malaysian Perspective.*The International Conference on Civil and Environmental Engineering Sustainability* (pp.229-309). Johor Bahru, Malaysia:Universiti Tun Hussein Onn Malaysia.

Najafy, M. (2014). The Evaluation of Construction Waste Management in Northern Cyprus. *Unpublished MSC, Institute of Graduate Studies and Research, Eastern Mediterranean University*, pp.1-96.

Ndihokubwayo, R. and Haupt, T.C. (2010). Waste reduction through lean and agile thinking: case of variation orders.*Faculty of Engineering*,pp.1-11.Retrieved from: http://hdl.handle.net/11189/1091.

Neuman, W.L. (2011). *Social research methods:Quantitative and qualitative methods (7thed.).*Boston, MA:Allyn & Bacon.

Nikmehr, B., Hosseini, M.R., Oraee, M., and Chilesehe, N. (2015). Major Factors Affecting Waste Generation on Construction Sites in Iran. *Proceedings of the 6th nternational Conference on Engineering, Project, and Production Management* (pp. pp.528-536). Brisbane: Griffith School of Engineering,Griffith University.

Ntshwene, K., Essah, E.A., and Dixon, T.J., (2014). Investigating The Level Of Awareness of Building Assessment Tools In The Construction Industry of Botswana. *30th Annaul Association of Reasearchers in Construction Management Conference* (pp. 23-32). Association of Researchers in Construction Management.

O'Brien, D. and Scott, P.S. (2012). "Correlation and Regression",.. In In H. Chen, *in Approaches to Quantitative Research –A Guide for Dissertation Students* (pp. 1-16). Taylorville: Oak Tree Press.

Orodho, J.A. (2009). *Elements of Education and Social Science Research Methods, Second Edition.*Maseno:Kanezja.

Ortiz, O., Pasqualino, J.C., and Castells, F. (2010). Environmental performance of construction waste: Comparing three scenarios form a case study in Catalonia,Spain.*Waste management, Volume 30, Issue No.4*, pp.646–654.

Owolabi, J. D., Amusan, L.M., Udoh, V., Tunji-Olayeni, P.F., Peter, N.J., Omuh, I.O., and Joshua,O. (2014). Recycling of some selected building materials in the construction industry: Prospect and challenges.*Science Research, Volume 2 Issue 2* , pp.21-26.

Oyedele, L.O., and Ajayi, S. (2014). Use of recycled products in UK construction industry: An empirical investigation into critical impediments and strategies for improvement. *Resources, Conservation and Recycling Volume 93* , pp.23-31.

Oyenuga, A.A., and Bhamidiarri, R. (2015). Sustainable Approach to Managing Construction and Demolition Waste: An Opportunity or a New Challenge? *International Journal of Innovative Research in Science, Engineering and Technology Volume. 4, Issue11,*pp.10368-10378.

Park, J. and Tucker, R. (2016). Overcoming barriers to the reuse of construction waste material in Australia: a review of the literature. *International Journal of Construction Management,Volume 17,Issue 3* , pp.228-237.

Polit, D. and Beck, C.T. (2012). *Essentials of nursing research: Appraising evidence for nursing practice.* .Philadelphia, PA: Wolters Kluwer Health/Lippincott Williams & Wilkins.

Powmya, A. and Abidin, N.Z. (2014). The challenges of green construction in Oman. *International Journal of Sustainable Construction Engineering and Technology, Volume 5 Issue,1* , pp.33-41.

Priyadarshi, H. S., and Sameersinh, V.A. (2013). Construction Waste: Source Identification, Quantification And Its Management In Housing Projects. *International Conference on Sustainable Built Environment* (pp.1-12). Kandy,Sri Lanka:University of Moratuwa:Retrieved from http://dl.lib.mrt.ac.lk/handle/123/8956.

Qiu, B.X.(2010). Six areas for China's building energy saving and my prospects. *The 6th International Conference of Green Buildings and Energy-Efficiency*, (pp. 29-31).Beijing.

Reid, J. M., Hassan, K.E.GE., and Al-Kuwari, M.B.S.(2015). Improving the management of construction waste in Qatar. . *In Proceedings of the Institution of Civil Engineers-Waste and Resource Management (Vol. 169, No. 1,).* (pp.21-29).Doha:Thomas Telford Ltd.

Ritter, N.L. (2010). *Understanding a Widely Misunderstood Statistic: Cronbach's α. Southwest Educational Research Association (pp. 2-16).*New Orleans:Texas A&M University.

Rogers, S. (2011). Battling construction waste and winning: lessons from UAE. *Proceedings of the Institution of ivil Engineers-Civil Engineering Vol. 164, No. 1,* (pp.41-48). London:Thomas Telford Ltd.

Saadi, N., Ismail, Z., and Alias, Z. (2016). A Review of Construction Waste Management and Initiatives In Malaysia. *Journal of Sustainability Science and Management Volume 11 Number 2*,,pp.101-114.

Sabai, M.M. (2013). Construction and demolition waste recycling into innovative building materials for sustainable construction in Tanzania. *Unpublished, Ph.D. Thesis, Eindhoven University of Technology,*, pp.1-198:DOI:10.6100/IR757934.

Sabai, S.M.M., Lichtenberg, J.J.N., Cox, M.G.D.M., Mato, R.R., and Egmond, E.L.C. (2014). Sustainable Approach for Recycling Construction and Demolition Waste into Building Material in Tanzania. *The Journal of Building and Land Development*, pp. 88-105.

Sabai, S.M.M. (2015). Cradle-to-Cradle Production: Concrete Waste Recycling for Sustainable Construction in Tanzania. *American Scientific Research Journal for Engineering, Technology, and Sciences (ASRJETS) Volume 14, Issue No.3*, pp.119-129.

Saghafi, M.D., and Teshnizi, Z.A.H. (2011). Building deconstruction and material recovery in Iran:an analysis of major determinants. *Procedia Engineering, 21*,pp.853-863.

Salaria, N. (2012). Meaning of the term descriptive survey research method.*International journal of transformations in business management, Volume, 1 Issue, No.6*, pp.161-175.

Saris, W.E., and Gallhofer, I.N. (2014). *Design, Evaluation, and Analysis of Questionnaires for Survey Research.* John Wiley & Sons Inc: New York.

Steven, G.H., Brady, T.W., and Patricia, A.B. (2010). *Applied Survey Data Analysis* .New York, N.Y: Taylor and Francis Group, LLC.

Steven, K. Thompson. (2012). *Sampling, 3rd Edition.* Hoboken,New Jersey: John Wiley and Sons Inc: DOI: 10.1002/9781118162934.

Tam, V.W.Y., and Lu, W. (2016). Construction waste management profiles, practices, and performance: a cross-jurisdictional analysis in four countries.*Sustainability, Vome 8 (2), 190*, pp.1-16.

Thomas, J., and Wilson, P.M. (2013). Construction waste management in India. *American Journal of Engineering Research Volume,2* ,pp.6-9.

United States Enviornmental Protection Agency (2009). *Construction and Demolition Waste;*. New York, N.Y: United States Enviornmental Protection Agency.

Urio, A.F., and Brent, A.C. (2006). Solid waste management strategy in Botswana: The reduction of construction waste. *Journal of the South African Institution of Civil Engineering, Volume, 48 Issue, 2*, pp.18-22.

van Wyk, L. (2014).Towards Net-Zero Construction and Demolition Waste. The Green Building Handbook: South Africa Volume 5., Cape Town, South Africa: Green Building Media.

Vaz, L.E.S., Pontual, L.V., Mainier, F.B., and da Motta, A.L.T.S. (2016). Construction and Demolition Waste Management Scenario in Republic of Cape Verde—The Case Study of City of Praia. *Journal of Environmental Protection Volume, 7*, pp.2009-2017.

Villoria Sáez, P., del, Rio Merino, M., and Porras-Amores, C. (2012). Estimation of construction and demolition waste volume generation in new residential buildings in Spain. *Waste Management & Research, Volume 30, Issue 2* , pp.137-146.

Vogt, W.P., Gradner, D.C., and Haeffele, L.M. (2012). *When to use what research design.* New York, NY: The Guildford Press.

Wahab, A.B., and Lawal, A.F. (2011). An evaluation of waste control measures in construction industry in Nigeria. *African Journal of Environmental Science and Technology Volume.5(3),*pp.246-254.

Wang, J., Yuan, H., Kang, X., and Lu, W. (2010). Critical success factors for on-site sorting of construction waste: A china study. *Resources, Conservation and Recycling Volume, 54 Issue, 11*, pp.931-936.

Wee, S.T., Shan, Ng.L., Wai, T.L., and Chen, G.K. (2015). Theoretical Framework for Sustainable Construction Waste Management in Penang,Malaysia. *Australian Journal of Basic and Applied Sciences, Volume 9 Issue No.33*, pp.427-435.

Wokekoro, E. (2007). Solid Waste Management In The Construction Industry (A Case Study of Port Harcourt Metropolis). *Unpublished Thesis, Faculty of Environmental Sciences, Rivers State University of Science and Technlogy* , pp.1-12.

Wong, E.O.W., and Yip, R.C.P. (2002). Balance theory for recycling of construction and demolition wastes: *Advances to Building Technology, Volume 2*, pp.1431-1438.

Ya'cob, A.S., Zawawi, W.N.A., Isa, M.H., and Othman, I. (2013). Factors that affect sustainable construction waste management efforts at site. *The Sustainable City VIII, Vol. 2*,pp.1169-1176.

Yean Yng Ling, F., and Song Anh Nguyen, D. (2013). Strategies for construction waste management in Ho Chi Minh City, Vietnam. *Built Environment Project and Asset Management, Volume, 3 Issue No.1* ,pp.141-156.

Yuan, H., Shen, L., and Wang, J. (2011). "Major obstacles to improving the performance of waste management in China's construction industry",. *Facilities Volume, 29 Issue:5/6*, pp.224-242: https://doi.org/10.1108/02632771111120538.

Zhang, X., Wu, Y., and Shen, L. (2012). Application of low waste technologies for design and construction: a case study in Hong Kong. *Renewable and Sustainable Energy Reviews, Volume,16 Issue,5*, pp.2973-2979.

APPENDICES

Appendix I: Letter of Transmittal

Felix Otieno Omondi

P.O Box 6464-40100

Kisumu, Kenya.

Dear Respondent,

DETERMINANTS OF SUSTAINABLE MANAGEMENT OF SOLID WASTE MANAGEMENT: A CASE STUDY OF CONSTRUCTION PROJECTS IN IMENTI NORTH, MERU COUNTY.

I am a student at the University of Nairobi and currently pursuing a course of study for the Master of Arts Degree in Project Planning and Management. Pursuant to the pre-requisite course work, I am currently carrying out a study on factors influencing sustainable management of construction solid waste in Kenya. The focus of my research will be construction projects' sites in Imenti North, Meru County and this will involve use of questionnaires administered to Consultants, Clients and Staff at department of water, environment and sanitation of County Industry of Meru. Respondents are not restricted to a certain set of answers. Statements in the research questionnaire are just guides through which you are requested to provide your opinions on the topic under study. Kindly note the data you provide will be used for research purpose only and your identity will be held confidential.

Thank you for your time.

Yours Faithfully,

Felix Otieno Omondi
L50/83825/2016

Appendix II: Respondents Questionnaire

This questionnaire is to collect data for purely academic purposes. You are kindly requested to answer the questions as sincerely as possible. The information you will give will only be used for research purposes and your identity will be treated with confidentiality.

Fill the questionnaire by putting a tick √ in the appropriate box or by writing your response in the provided spaces.

PART A: PERSONAL INFORMATION

1. Please indicate your age?

   20-29 ☐ 30-39 ☐ 40-49 ☐ 50 and above ☐

2. Indicate your Gender.

   Male ☐ Female ☐

3. What is your level of education?

   Certificate ☐ Diploma ☐ Degree ☐ Masters and Above ☐

   Any other please specify

   _____

4. How long have you worked as consultant in the construction industry in Meru County? Please write down in the space provided?

   _____

PART B: Design Approaches and Management and Sustainable Management of Construction Solid Waste

5. To what extent do you agree with the following statements? Using as scale of 1-5 where 1=strongly disagree, 2=disagree 3= neutral 4= agree 5= strongly agree

Statement	**1**	**2**	**3**	**4**	**5**
The number of design variations has influence on the sustainable management of residential construction solid waste.					
The number of design enquiries does not influence the sustainable management of residential construction solid waste.					
The number of rework incidents influences sustainable management of residential construction solid waste.					
Poor site coordination arising from poor communication on design does not influence sustainable management of residential construction solid waste.					

6. Suggest practical design management strategies that construction consultants and their clients can employ to successively implement sustainable construction solid waste management on site in residential buildings.

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PART C: Education and Training Programs and Sustainable Management of Construction Solid Waste

7. To what extent do you agree with the following statements? Using as scale of 1-5 where 1=strongly disagree, 2=disagree 3= neutral 4= agree 5= strongly agree

Statement	**1**	**2**	**3**	**4**	**5**
The number of workers with technical recycling skills has influence on the sustainable management of residential construction solid waste.					
The number of number of workers with professional construction skills does not influence the sustainable management of residential construction solid waste.					
The number of trainings on construction waste reduction has influence on sustainable management of residential construction solid waste.					
The number of trainings on construction waste reuse does not influence on sustainable management of residential construction solid waste.					

8. Suggest policy strategies that can be adopted by governments to ensure that consultants and their clients adopt training programs on sustainable construction solid waste management practices.

PART D: Industry Targeted programs and Sustainable Management of Construction Solid Waste

9. To what extent do you agree with the following statements? Using as scale of 1-5 where 1=strongly disagree, 2=disagree 3= neutral 4= agree 5= strongly agree

Statement	**1**	**2**	**3**	**4**	**5**
The number of charge schemes has influence on the sustainable management of residential construction solid waste.					
The number of number of awareness campaigns does not influence the sustainable management of residential construction solid waste.					
The number of recycling incentives has influence on sustainable management of residential construction solid waste.					

10. Suggest policy measures that can be adopted by governments to ensure that consultants and their clients implement sustainable construction solid waste management practices.

_____

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PART E: Low Waste Technology and Recycling Equipment and Sustainable Management of Construction Solid Waste

11. To what extent do you agree with the following statements? Using as scale of 1-5 where 1=strongly disagree, 2=disagree 3= neutral 4= agree 5= strongly agree

Statement	**1**	**2**	**3**	**4**	**5**
Existence of plastic shredders and granulators on site has influence on the sustainable management of residential construction solid waste.					
The number of concrete debris crushers on site does not influence the sustainable management of residential construction solid waste.					
The number of buildings using prefabricated technologies has influence on the sustainable management of residential construction solid waste.					
Existence of buildings using large panel steel formwork does not influence on sustainable management of residential construction solid waste.					

12. Suggest policy measures that can be adopted by governments to encourage the use of low waste technologies and access to recycling equipment for implementation of sustainable construction solid waste management practices.

PART E: Sustainable Management of Residential Construction Solid Waste

13. To what extent do the following measures of sustainable management of residential construction solid waste in Meru County? Use a scale of 1-5 where 1= very great extent, 2= great extent, 3= moderate extent, 4= little extent and 5 = not at all

Statement	**1**	**2**	**3**	**4**	**5**
Markets for recycled construction materials.					
Number of landfills with construction solid waste materials.					
Subsidized Recycling Equipment.					
Reuse of construction materials and materials' packaging.					
Recycling of construction solid materials.					