INVESTIGATING THE MANAGEMENT OF CONSTRUCTION WASTES IN NAIROBI COUNTY:

BY

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A RESEARCH PROJECT SUBMITTED IN PARTIAL FULFILLMENT FOR THE REQUIREMENTS OF THE AWARD OF THE DEGREE MASTER OF ARTS IN CONSTRUCTION MANAGEMENT IN THE SCHOOL OF THE BUILT ENVIRONMENT, DEPARTMENT OF REAL ESTATE AND CONSTRUCTION MANAGEMENT.

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DECLARATION

DECLARATION BY THE CANDIDATE

This research project is my original work and hasn't been presented for a degree in any other University. No part of this research project may be reproduced without prior permission from the author and/or University of Nairobi.

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DEDICATION

I dedicate this research to my family, more especially my parents for continuously supporting and encouraging me as I was working on this research.

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None of the persons named for their contributions to the completion of this project are responsible for any errors of fact, omission or commission. The author takes full responsibility for the contents of this project.

May the good Lord bless you all.

ABSTRACT

This research project delved into the management of wastes within the construction sites specifically targeting Nairobi County in Kenya. The aim was to investigate sustainable waste management practices in construction sites within Nairobi Count. The objectives of the research project looked into the identification and sustainability of waste management techniques applied and the challenges faced in managing construction wastes within Nairobi. The study is an important drive towards a sustainable construction industry as wastes produced by the sector contributes to the waste stream and affects the environment. This research will eventually answer four research questions which are: What is the average amount of waste produced by construction sites in Nairobi County? What are the waste management techniques adopted by building contractors and stakeholders on these sites? What is the impact of waste management techniques on the environment? And finally, what challenges are experienced by contractors in effecting sustainable waste management techniques?

This research, gives an overview of the various facets of environmental risks caused by construction activities. It narrows down to waste management and details more on the wastes generated by the construction activities, how they are generated and how they are managed. This research goes on to focus on the legal framework put in place to manage waste management and the best practices for waste management, both globally and locally.

The research design applied was a case study research. The target population were NCA 1, NCA 2 and NCA 3 contractors' sites with building projects within Nairobi County. Observation, oral interviews and three-part questionnaires were the instruments of data collection used in the study. A random selection of the registered NCA 1, NCA 2 and NCA 3 building contractors was done and 51 questionnaires were sent out to the contractors' sites.

Data analysis was done using both qualitative and quantitative techniques. Findings indicated that the waste management is practiced in Kenya to a certain extent and is continuously improving. The

Nairobi City Council and environmental organizations such as NEMA have helped a lot in waste management in construction sites. The research findings also indicate that the contractors in Nairobi know the consequences of waste generation on the environment and that the activities they do affect need to be properly management for the purpose of having an environmental friendly environment.

The study recommends employment of proper waste management techniques on construction sites and adoption of best practices from other regions for a sustainable industry.

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ABBREVIATIONS

BREEAM	Building Research Establishment's Environmental Assessment Method
CCD	Convention to Combat Desertification
C&D	Construction and Demolition
CDE	Construction Dust Emission
CED	Construction Excavation and Demolition
EMCA	Environmental Management and Coordination Act
EU	European Union
EWP	Engineered Wood Products
ISWMP	Integrated Solid Waste Management Plan
JICA	Japan International Cooperation Agency
LEED	Leadership in Energy and Environmental Design
NCA	National Construction Authority
NCC	Nairobi City County
NEMA	National Environmental Management Authority
SWM	Solid Waste Management

UN	United Nations
US	United States
USGBC	United States Green Building Council
WMP	Waste Management Plan

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CHAPTER 1: INTRODUCTION

1.0 BACKGROUND OF THE STUDY

The construction industry is one of the consumers and users of natural resources and its activities, in one way or another, have a huge impact on the natural environment. With the ever growing public interest in environmental matters, the industry is being held responsible for the environmental impact of its activities, (Mellissa and Martin). For these reasons, we have regulatory agencies such as the National Environmental Management Authority (NEMA) which ensures that there is the needed environmental management. The Kenyan government is fairly involved and attempts to address most of the challenges facing management of the environment in a modern state. The National Environmental Management Authority (NEMA), along with other agencies like the Water Regulation Management Authority, have the necessary legal and institutional tools they need to protect and conserve the environment of Kenya adequately, ensuring a healthy environment for the people. (Benjamin, 2013).

Kenya has undergone unprecedented infrastructural changes since the introduction of Kenya's vision 2030. Nairobi, in particular, has experienced a boost in the construction sector with the expansion of roads and the construction of high rise buildings being seen everywhere. These construction activities provide some of the most impactful drivers of the environmental change and for this reason provide the backdrop against which to view the said changes in a modern state. In a bid to minimize the risks caused by the construction sites in Kenya, the government, with the help of environmental regulatory bodies harmonized environmental laws under the Environmental Management and Coordination Act (EMCA), Cap 387, to coordinate environmental management efforts in a bid to protect the environment for the current and the future generations. Consequently, every developer is usually obligated to involve an Environmental Impact Assessment (EIA) expert

to ensure that the development is viable and that no major risk is done to the environment. It is for such reasons, among others that NEMA and NCA have been trying to ensure that all the buildings follow the EMCA ACT

For a very long time, environmental regulation in Kenya has often been seen as less concern as compared to other concerns such as economic growth and infrastructure yet poor environmental regulation can lead to significant costs in terms of growth, human health and erosion of the natural resource bases. This has been of major concern seeing as the country is building infrastructure and urbanizing in an attempt to accommodate urban growth. More global environmental regulations, coupled with continuous public awareness regarding protection of the environment and natural resources, has resulted in the need for detailed strategies for environmental risk management, which not only ensure successful project delivery but also protect all stakeholders, (Marsh, 2019).

Out of all the environmental risks brought about by construction activities, waste generation is the one that is caused by a lot, if not all construction projects in Nairobi and that is why the management of this risk is what all the stakeholders have been trying to achieve by setting up all the regulatory bodies we have today such as NEMA, NCC and NCA. A look at the budget for Nairobi City County across the years, it is evident that the budget allocation for waste management has been increasing between 2014 and 2017. *In the financial year 2014/15, the allocation to waste management was KSh.103 million, in 2015/2016 it was KSh700 million while in the following financial year it increased to KSh.1.5 billion* (World Bank Report ,Jan -Mar 07*).*This findings show the intensity that the county is trying to minimize waste generation issues Nationally. Some of the global best practices that have been adopted in managing construction wastes include; prevention, recycling, replacing and reusing. China, for example, has adopted the use of prefabricated materials in their projects which reduces and prevents waste generation by a very

large scale. This practice has been adopted by many nations including Kenya, where some of the latest constructions, use the pre-fabricated materials. In Australia, contractors are required to draft a Waste Management Plan (WMP) defining its policies clearly in order to meet the company's current obligations under the Environmental Protection Act, 1994. By so doing, construction waste is well accounted for. The European Union has set up a commission under the Construction and Demolition Waste Protocol for assessment of constructions before their demolition or renovation which ensures that valuable materials and hazardous substances are identified and separated in advance. This has allowed for appropriate planning and safe and efficient implementation of the renovation or demolition works, and as a result, the waste generated is managed well. Spain implemented a Construction and Demolition (C&D) waste policy with the development of the Second National Plan on C&D waste in 2008 and the Royal Decree 105/2008. In the policy, the contractors in the country are required by law to separate and recover some types of C&D waste if the quantity generated exceeds a certain amount of waste, (Desiree et al, 2014).

1.1 PROBLEM STATEMENT

Construction activities, whether small or large have been known to generate large and diverse quantities of waste. Waste management in construction starts from mobilization all through to the construction process until the project is completed. The emergence of major dumping sites such as the one in Dandora is proof enough that waste is not managed as well as it should in Nairobi County. The EMCA (Waste Management) Regulation of 2006, Part 1 under preliminary provisions gives emphasis or specific definition to various types of waste such as domestic wastes and industrial wastes with little regard to excavation or general construction waste. In part II, Section 4 (1), "*prohibits disposal of waste on a public highway, street, road, recreational area or any*

public place. All waste ought to be disposed of in designated waste". The two ways in which Kenyan contractors are required to manage wastes is through the transportation and disposal of the same wastes. In Nairobi City, the collection of solid waste by the Nairobi County Council is estimated to be as low as 25% of the estimated 1500 tonnes generated daily (JICA, 1998). The Nairobi City Council is also trying to minimize waste generation created by construction sites through transportation by limiting the capacity of materials being carried to the dumping sites on trucks. The Solid Waste Management Act introduced in 2015 has seen the tremendous improvement in the way the counties, more so Nairobi manages its waste. In the policy, waste is classified and this has brought about the order in the collection scheme. It also put penalties in place. It is estimated that 13.30% of the solid wastes being deposited in landfills worldwide comprise C&D waste with a 1:2 ratio of construction to demolition waste. In Holland, for instance, this amounts to around 4.25 thousand million tonnes of construction waste yearly, (Od Wilson). As a developing country aspiring to achieve developed country status by 2030, Kenya is faced with the same challenge of balancing economic growth and preserving the environment (JICA, 1998). With the dominance of foreign nationals such as the Chinese in the country, it is expected that the stakeholders in the country are adopting some of the practices that have helped in environmental management from the foreign nationals. The introduction of prefabricated housing has attracted a lot of developers, especially seeing as its cheap and a faster method of construction. As a method of waste management, it is a very good method of waste prevention seeing as the generated waste from such sites is very minimal.

The County Government of Nairobi has tried to come up with policies, similar to which have been adopted in other nations to best manage the waste generated from construction activities. The National Solid Waste Management Strategy published in 2015, for instance, was put in place as a result of poor state of affairs in the existing waste management facilities within the 47 Counties.

In the strategy, NEMA developed minimum requirement points for the facilities in order to continuously promote compliance with the waste management regulations within the counties.

This research seeks to determine whether the NEMA strategy has helped in waste management more especially seeing as a lot of construction sites continuously generate wastes and give minimal effort to recycling and reusing the materials. Most developers in the country concern themselves with the completion of the project and starting to earn and collect profits from the development and so, the idea of recycling, becomes expensive and a waste of time. This, therefore forms the basis of the problem statement for this study because without proper waste management and the necessary attention by the contractors, the society becomes affected because the wastes become hazardous to the environment. The objective of carrying out this study is to eventually understand the state of construction waste management in Nairobi County and uncover the best global practices that need to be adopted by the contractors within Nairobi to achieve better waste management standards.

1.2 RESEARCH OBJECTIVES

The primary objective of this research is to analyze the various environmental management techniques adopted to reduce waste generation in construction sites in Nairobi County.

Specific objectives of this research project are:

1. To examine the average amount of waste produced by construction sites in Nairobi County.
2. To identify the waste management techniques adopted by building contractors and stakeholders on these sites.
3. To assess the impact of waste management techniques on the environment.
4. To examine challenges experienced in effecting sustainable waste management techniques.

1.3 RESEARCH QUESTIONS

The research seeks to answer some questions in order to realize the objectives of the project.

Specific questions of this research project are:

1. What is the average amount of waste produced by construction sites in Nairobi County?
2. What are the waste management techniques adopted by building contractors and stakeholders on these sites?
3. What is the impact of waste management techniques on the environment?
4. What challenges are experienced by contractors in effecting sustainable waste management techniques?

1.4 RESEARCH HYPOTHESES

This research project aims to find out whether there are some gaps to be filled up by the contractors to achieve best global standards of waste management. Based on the research questions of this project, there are hypotheses formulated which will help in realizing the objectives, both the null and the alternative hypotheses. The null hypothesis of this research project is, *"The improvement of technology in the construction industry and the introduction of new environmental policies have not changed how the contractors manage wastes generated from sites.* "The alternative hypothesis of the research, is, *"Contractors have significantly improved their waste management practices since the introduction of the new environmental policies and the improvement of technology in the construction industry".*

1.5 RESEARCH JUSTIFICATION

There is tremendous growth in the construction industry nationally and this has brought about an increase in the utilization of materials for the construction processes. In an era where talks and conferences about climate change are being discussed, the stakeholders in the construction industry are trying as much as possible to minimize environmental pollution by coming up with the best environmental practices. This research is important as it will inform us of the environmental management techniques being adopted by the construction companies.

Extensive studies on environmental management in Kenya have been carried out but very few have focused on the construction industry. It is for this reason that this study is necessary as it will provide more knowledge on the role of the construction sector in environmental management.

1.6 SIGNIFICANCE OF THE STUDY

Having the set rules, regulations and policies guiding the management of the environment, this study will shed a light on what the construction industry is doing to comply with those set rules. By the end of the study, it will be evident whether the rules and regulations are being followed by the professionals in the field and whether there needs to be more that can be done to properly manage the environment. The study will shed light on the challenges faced by the construction industry when trying to carry out their activities. Most importantly, the study seeks to change the perception created by many that the industry is all negative and a huge environmental pollutant.

1.7 ASSUMPTIONS

The research assumes that the construction projects in Nairobi practice similar environmental techniques as the contractors from other counties. The study also assumes that the contractors between NCA 1 and NCA 3 apply sustainable environmental management techniques while carrying out their work.

1.8 SCOPE OF THE STUDY

With the increase in construction activities in the countries around the globe, concerns have been raised in regards to the depletion and the overuse of natural resources in the process. For this reason, a lot of construction companies have come up with remedies to minimize the consumption of technology and as a result, green building is being practices and the adoption of appropriate technology across the globe has been realized. This research aims to determine whether the contractors in Kenya have adopted the best practices being adopted by other developed nations and also, it seeks to find out what more can be done by the various stakeholders in the field in order to properly manage construction activities and reduce the risks they bring to the environment. This research additionally explores the different environmental risks realized by the construction activities and it analyses the management techniques that have been adopted for them. It also narrows down to the risks that are prone to the contractors in Nairobi County and how the legal framework is helping to manage them.

1.9 ORGANIZATION OF THE STUDY

This research is split into five sections; Chapter One is the introduction of the whole research and it contains the problem statement, the justification of the study, the research objectives, scope of the study and finally the organization of the study.

Chapter Two delves into similar studies that have been done in a similar subject. It composes of the overview of the risks environmental risks, it narrows down waste generation and more specifically the construction and demolition wastes, it also contains the global and local perception of construction wastes, classification of wastes, best practices of construction waste management and finally, the legal framework put in place for waste management.

Chapter Three looks into the guide that the research would follow while conducting the research. It will focus particularly on the data collection, the methods adopted for data collection, data analysis and presentation and the limitations that would be expected while adopting the said data collection methods.

Chapter Four presents the data findings that were collected in the previous chapter and analyses the data with the aim of seeking the problems identified while conducting research. Finally, Chapter Five contains the findings, conclusions and recommendations of the study based on the data collected and analyzed.

CHAPTER 2: LITERATURE REVIEW

2.1 INTRODUCTION

This chapter expounds on various environmental risks that the construction activities are prone to. It will focus on an overview of the possible environmental risks brought about by construction activities, the global and the national perception of waste generation, as evidenced in Nairobi County and its management, various facets of wastes caused by the construction activities and it will narrow down to the most significant wastes generated by the construction sites. This chapter will also highlight the key policies and regulations for waste management in Kenya. This chapter will give a summary of the potential waste generation avenues created by construction activities in Nairobi County and the possible remedies, being adopted by Nairobi's construction sites and regulation authorities.

2.2 ENVIRONMENTAL RISKS CAUSED BY CONSTRUCTION ACTIVITIES

Construction activities have a lot of processes to it and in these processes, the environment is always affected somehow, either positively or negatively. The negative effects of these activities are the risks that the stakeholders in this field are always trying to curb. In the Kenyan Constitution, Article 42 on the Environment provides that- "**—***Every person has the right to a clean and healthy environment, which includes the right to eliminate processes and activities that are likely to endanger the environment and to utilize the environment and natural resources for the benefit of the people of Kenya ''.* The possible environmental risks caused by construction practices are; resource depletion, land degradation, waste management and pollution.

2.2.1 RESOURCE DEPLETION

Natural resources are an essential input in the construction process. This is true for marketed resources (such as metals, minerals, and land) and nonmarket resources (such as clean air, weather, and myriad ecosystem services), (Andrew, 2013). Over the past century, as the global population quadrupled and economic production increased about 20-fold, demand for natural resources rose greatly. The extraction of construction materials grew by a factor of 34, ores and minerals by a factor of 27, (UNEP 2011a). In the past, evidence has shown that a lot of construction practices involved the use of natural resources, both marketed and unmarketed resources such as land, minerals, water and metals without the consideration of the living organisms using the same natural resources. As a result, the effects of such practices brought about climate change, which continues to be a major problem in the country affecting the country's GDP. As a result, the country has been involved in global climate change seminars to mitigate the effects of climate changes. According to new research by construction blogger Bimhow, the construction sector contributes to 23% of air pollution, 50% of the climatic change, 40% of drinking water pollution, and 50% of landfill wastes. In separate research by the U.S. Green Building Council (USGBC), the construction industry accounts for 40% of worldwide energy usage, with estimations that by 2030 emissions from commercial buildings will grow by 1.8%. Some of the practices that result to natural resources depletion include, the use of timber as a raw material in the construction process, land degradation as a result of mineral mining, water shortage due to deforestation and many others.

2.2.2 LAND DEGRADATION

Land degradation is defined as the long-term loss of ecosystem function and productivity caused by disturbances from which the land cannot recover unaided (Bai and others 2008). The UN Convention to Combat Desertification (CCD), of which Kenya is a signatory, recognizes land degradation as a global development and environment issue. Construction activities, such as cutting, grading and filling, greatly reduce the quality of soil quality construction sites. Left unprotected, sites will be further degraded by erosion and begin to adversely affect the surrounding environment. The goal of soil quality management on construction sites is to revegetate for protection against off-site damage and increase soil organic matter levels to remedy the on-site damage caused by site preparation.

Land in Kenya is a key factor of production, making its proper management a requirement for sustainable development (NEMA, 2011). Under Section 9(2) (c) and (d) of EMCA,1999 NEMA, in consultation with lead agencies, is tasked with the function of establishing and reviewing land-use guidelines and examining land use patterns to determine their impact on the quality and quantity of natural resources.

2.2.3 POLLUTION

The construction industry is a major source of pollution, responsible for around 4% of particulate emissions, more water pollution incidents than any other industry, and thousands of noise complaints every year. Although construction activities also pollute the soil, the main areas of concern are air, water and noise pollution. (Jennifer, 2019).

2.2.3.1 Air pollution

Air pollution is one of the biggest polluters within a construction site and comes in many forms, although the three most common pollutants include large amounts of dust, the emission of several gases, and the presence of large amounts of smoke. (Liam, 2019).

All construction sites generate high levels of dust (typically from concrete, cement, wood, stone, silica) and this can carry for large distances over a long period. Construction dust is classified as PM10 - particulate matter less than 10 microns in diameter, invisible to the naked eye. (Jennifer, 2019). Construction Dust Emission (CDE) originates from many types of onsite activities such as excavation, drilling, bulk material transportation, loading and unloading, open-air material storage, concrete and mortar making, cutting and filling, and the movement of equipment. (Jinding Xing 1 et al, 2018). Given the nature of the work undertaken on various construction sites, dust is one of the main causes of air pollution from these sites. Dust is categorized by any particulate matter that is smaller than 10 microns in diameter. (Liam, 2019).

2.2.3.2 Water pollution

Water pollution is another problem from construction sites and is caused by the run-off of debris, dirt, diesel, oil, paints, and other harmful chemicals into the drains (if in an urban site) or into a local waterway (if the construction site is more rural). General wastewater from construction sites can also cause issues with the local water systems. (Liam, 2019). Construction activity can pose a major pollution threat to the environment if discharges from construction sites are not properly handled. Construction site wastewater contains mainly silt, sand and gravel. Indiscriminate

discharge of untreated or partially treated wastewater will have a major impact on the receiving water bodies. In Kenya's construction industries, it is evident that a lot needs to be done in regards to avoiding the water pollution that has not been managed completely. The construction sites close to the water bodies, usually release dirty materials to the water and this has not been a good practice. NEMA has tried to come up with rules and penalties to curb this problem but a lot needs to be done to improve the water pollution caused by the construction industry.

2.2.3.3 Noise pollution

It is a well-known fact that construction activities produce a lot of noise. This noise pollution mainly comes from vehicles, heavy equipment and machinery, but it can also include physical human work such as hammering, as well as grinding and shouting throughout the construction site. Not only is a large amount of noise an issue to any residents in the locale of the construction site, but loud noises can also disturb the natural cycles of animals, which leads to their normal habitats becoming usable (Liam,2019). The preventive measures carried out in Kenya' construction sites include carefully handling materials and through the use of quiet power tools and equipment and carrying out the noisy work at night, to minimize disturbance. The major effects of noise pollution include interference with the communication between the workers, wakefulness, and reduced efficiency.

After the study of the various environmental risks that the construction industry brings about, it is evident that there is a gap in the Waste Management and pollutions caused by the construction activities, this research, will, therefore, seek to study the waste management and pollutions brought about by the construction industry. This study aims to understand what remedies can be done, by

the stakeholders in the industry and the legislative authorities to reduce these risks to the environment.

2.2.4 WASTE GENERATION

Waste generation is one of the largest contributors of environment pollution by the construction activities and as we go deeper into this research, it will be evident that waste management has continued to be a major priority to the construction industry in a means to keep the environment safe for the people living in it.

In Kenya's construction practices, waste generation has been improved tremendously by the adoption of various waste management techniques by the various stakeholders involved in the project. Regarding onsite management activities, adherence to design documents, reduction of the number and extent of design changes and more accurate estimation of materials required in each construction stage have been pointed as practices with great potential to reduce waste generation. Onsite management of construction waste is also considered determinant for its destination. Waste segregation and maximization of onsite materials reuse, for example, are practices that contribute to reducing waste landfilling and material intensiveness in construction, (Larissa and Alessandra, 2017). Waste production on construction sites is often down to inadequate storage and protection, poor or multiple handling, poor site control, over-ordering of materials, bad stock control, lack of training, and damage to materials during delivery, (Udeaja et al, 2013).

Kenya's construction industry is trying to contribute to waste reduction by adopting new policies and practices, which have a more positive impact on the environment. Practices such as land use, green building, reuse and recycling of materials, improving transport networks and the careful

management of construction processes are used to ensure that the waste generated by the construction practices is managed. The Kenyan government, through various organizations such as NEMA and EMCA, is also helping the stakeholders in the construction industry to manage wastes by coming up with policies that have to comply.

2:3 GLOBAL OVERVIEW OF CONSTRUCTION WASTE

Construction waste is defined as the unwanted materials generated by the construction activities, either directly or indirectly. The different types of wastes generated by construction activities include excavation wastes, construction and demolition wastes. Throughout most countries globally, there is a significant increase in the construction of buildings and the boom in this field has seen the various governments come up with measures to control the construction activities. The construction activities involve a lot of processes and in those processes, the environment is somehow affected, either through the emission of gases, dust, noise and construction wastes. The countries, therefore have put up regulations to minimize the production of these wastes to the environment. Globally, the construction industry is coming up with ways of reducing construction wastes by adopting measures such as reusing, recycling, green building and proper management of construction activities. According to Mohamed Osmani (2011), it is estimated that construction waste is as much as 30% of the total weight of building materials delivered to a building site. He found out, in his research that in the EU, more than 450 million tonnes of construction and demolition waste is generated every year, which makes it the largest waste stream in quantitative terms.

Over the years, construction waste has continued to be a problem in many countries. Because of the construction boom in China, one of the piles of construction debris in China became too high unstable and caused a landslide in December 2015, killing 70 people and displacing close to 1000 people from their homes. This landslide could have been avoided had the concerned authorities come up with measure and limits to the quantity of debris in a landfill. In London, the construction waste management is taken seriously as a bid to respond to climate change and as such, there are many policies put in place to help manage the wastes coming from construction sites. Policy 5.18 on Construction, excavation and demolition waste made by the London assembly stipulates that all construction, excavation and demolition (C, E &D) waste management facilities should be encouraged at the existing waste sites by ensuring that construction sites are recycling wastes through planning conditions and removing wastes from sites and bringing them to sites either by water or rail wherever practical. The European Union came up with the Construction 2020 strategy and in it, a protocol called the European Union (EU) Construction and Demolition Waste Protocol was introduced in November 2016 to manage the construction waste produced by the construction sites in the European Countries. In the United States of America, the contractors are encouraged to reduce the disposal of Construction and demolition waste in a bid to manage construction wastes. The materials that have been recycled or reused are included in a Sustainable Materials Management datasheet and from that, the authorities have a way gauging how to guide the contractors on the best management practices. Green building has been adopted by many nations in efforts to minimize waste generation and to adopt sustainable building processes that have less effect on the environment. One of the goals of adopting green building is material conservation and resource efficiency. Once this is achieved, the construction projects have a positive impact on the environment. Appendix IV illustrates the green building certification systems that have been

put in place in different countries to ensure sustainable buildings and pay a keen interest on the materials and waste generation on sites.

2.5 CLASSIFICATION OF CONSTRUCTION WASTES

Construction wastes at the site are clustered into physical waste and non-physical waste. The physical waste is defined as loss of materials, damaged, cannot be repaired, cannot be used or losses during construction activities. However, the non-physical wastes are related to cost overrun and delay in construction projects such as money and time, (S. Nagapan, 2012) cited by Chin Foo et al (2013). This research focuses only on physical wastes. Examples of physical wastes include: Construction and demolition waste, excavation waste and industrial wastes

2.5.1 INDUSTRIAL WASTES

Industrial wastes are any materials rendered useless during the manufacturing process. In the construction industry, industrial wastes include substances such as dust produced during the construction works, masonry blocks cut while shaping the ones being used, fine aggregate, coarse aggregate, scrap metals, among many others. Most of the industrial wastes generated by construction sites are solid wastes.

2.5.1.1 Examples of industrial wastes

Examples of wastes generated by the construction industry through industrial processes are:

I) Dust

Dust is obtained from various building materials such as cement and aggregates, both fine and coarse. Dust is emitted while using these materials and this may have adverse effects on the people handling these materials. The best ways in which dust is managed in Kenya's construction sites is by pouring water over the surfaces to be worked on so as to reduce the amount of dust that would be emitted.

II) Mineral wastes

Most building materials are a product of natural resources. Natural resources. The process of obtaining these minerals harms the environment if not properly handled. The mining of stones in the quarries always leaves landfill in the extracted area and this negatively affects the environment. The dust waste is very aggressive in the atmosphere, in water and soil because of the fine particle and toxic elements. The huge noise from technological processes is also inconvenient for the community.

III) Packaging wastes

Most of the construction materials, especially sanitary ware and fixtures are usually delivered on sites boxed and packaged to prevent them from being damaged while in transit. The material used to package the materials most often is thrown as waste because they cannot be used or recycled. Examples of such wastes are carton boxes and plastics. Plastic is not a preferred material because it is not biodegradable and so when dumped, it creates a menace to the environment. The best way

that some of these wastes, such as plastic bottles and carton boxes are managed is by recycling them for other uses.

The remedy for the industrial wastes in most construction companies is the use of green materials and constructing green buildings which are very friendly to the environment. The availability of agencies such as LEED and BREEAM have given chance to the designers to be creative and minimize the utilization of harmful environmental resources.

2.5.2 EXCAVATION WASTES

Excavation in Kenya's construction sites is normally carried out using tools, machinery and equipment depending on the type of material that is usually excavated. The activity produces a lot of noise and dust which pollutes the environment a lot. Occupational Safety and Health Association, (OSHA) 2015, defines an excavation as *any man-made cut, cavity, trench, or depression in the earth's surface formed by earth removal" covering building to dams and highways*. The extent of excavation in any site is dependent on the depth of the foundation that the building has. With the continuous building of high rise buildings in Nairobi, excavation quantities have gone up leading to the creation of a lot of excavation wastes.

Excavated materials include, but not limited to; soil, gravel, rocks and stones.

2.5.2.1 Classification of excavation wastes

Excavation wastes are classified according to the type of material excavated. They include:

I) Rocks, gravels and excavated stones

In most cases, excavation of rocks is done to pave the way for foundation works. The excavations are carried out using methods such as drilling, blasting and breaking. In Nairobi, for any excavation of rock to be carried out, it is required that the contractor gets approval from the Nairobi City Council.

The activities involved in the excavation of rocks are very noisy and loud and for this reason, the neighbors ought to be notified of the disturbance that comes with such excavation.

As a management practice, the handler of the equipment used in excavations is required to be trained and certified before handling the equipment.

II) Soil and sand excavation

The topsoil and part of the sub-soil gotten from the excavation are what forms the soil and sand during excavation. Before any construction is carried out, soil sampling is usually done and a soil test is done to know the properties of the soil being excavated. During the excavation of soil, a lot of dust is produced and a mitigation measure, water is poured so that to reduce the amount of dust being emitted. Most of the soil and sand excavated is reused, either in the project in backfilling, or elsewhere to fill the landfills.

2.5.3 CONSTRUCTION AND DEMOLITION WASTES

This forms the largest contributor to the construction wastes. As their names suggest, these are the wastes generated throughout the entire construction cycle, right from the design stage right through to the occupation period. C & D waste is defined as *the waste that arises from construction,*

renovation, and demolition activities, (Vivian et al, 2016). The various ways in which these wastes are generated is through errors made during the design stage by the architects, lack of proper procurement by the contractors, poor planning and poor handling of materials during the construction stage, residues of raw materials and changes in building design due to the presence of multiple decision-making stakeholders.

2.5.3.1 Examples of common construction and demolition wastes in Nairobi

These types of wastes are generated right from the time the project begins through to the completion time. They include:

I) Wood

This material is used in different forms in a construction site. It may be chip wood, plywood, shavings, sawdust and also may be used as elements such as doors. The use of wood in the industry negatively affects the environment through deforestation but thanks to the policies put in place the trees cut for construction processes are replaced. Wood becomes a construction waste if it is rendered useless and thrown into the garbage. Timber is known to rot when it comes to contact with water and so, if not properly managed, it becomes a problem to use it for its intended purpose. To maximize the use of wood by the contractors, and reduce wastage variety of wood products are bonded mechanically to produce engineered wood products (EWPs) which are structurally efficient and largely renewable. This type of production makes it possible to reuse and recycle

wood products collected from demolition and use them in another phase of the construction. If properly managed, timber is the most environmentally friendly building product.

II) Masonry wastes

Masonry products are materials that are obtained from natural raw materials such as clay and soil. They include building blocks and concrete. If disposed of, they form a large part of construction Wastes are generated from these materials through demolition and cutting of the large-sized materials while being shaped. The best management practices of these materials are through proper planning such as procuring the materials on-site just before they are used so that they could not be rendered useless while using them. Also, recycling is one of the best ways to reduce these wastes. If carefully handled, they can be used in a different phase.

III) Metal wastes

The use of metals in construction is continually increasing and this is evidence that the generation of metals as waste products is also prevalent. The metals are one of the most preferred building materials because they come in different forms and shapes. In Nairobi, the management of metal waste has been managed well because a large percentage of the metals thrown as wastes are recycled and used to manufacture other materials.

IV) Ceramic wastes.

Ceramic wastes include bricks, tiles, porcelain and sanitary ware. It is estimated that over 30% of debris collected from construction sites is ceramic waste. Ceramic wastes are generated from offcuts and also through breakage because of poor handling of the materials on site while fixing.

In developed nations, the recycling of ceramic wastes is being practiced and this is done by mixing the ceramic wastes with concrete while building. The result is a material with more compressive strength. Locally, recycling of this material waste is not practiced as often.

v) Other wastes.

Construction wastes are a lot and cannot be summed up in one research. The other materials include drywall, plastic, glass, electrical wiring among many others.

Demolition wastes are those wastes that are generated from taking down a construction. Examples of demolition wastes include, but are not limited to: masonry blocks, concrete, timber, metals and aluminum. Construction wastes, on the other hand, are the wastes generated from the construction process. In Nairobi, construction wastes are usually transported to Dandora Dumpsite. This dumpsite is reported to receive over 1500 tons of waste daily which forms less than half the total waste generated from Nairobi in a day. At the dumpsite, there are people employed as separators whose work is to sort the wastes brought in to manage the wastes. Although the construction and demolition wastes are usually classified together, the wastes generated may differ a lot.

2:4 LOCAL PERCEPTION OF CONSTRUCTION WASTE

Waste management in Kenya is something that has been of keen interest of the regulatory authorities, seeing as a lot of measures are being put in pace so as to effectively manage wastes produces and consequently reduce on the plausible environmental risks. The construction industry being a very bus industry, produces a lot of wastes and the wastes and because of this, authorities

such as NEMA and NCA help in managing the construction activities. Devolution has helped in managing such activities from the county levels. Nairobi City County, being the County with the most construction activities is the most suitable for this case study as it would give a better perceptive on the role being played by the regulatory bodies, contractors and the global community in managing the wastes generated contractors. Thus, this project will focus on Nairobi County.

In Kenya, more especially Nairobi County, uncollected debris is always one of the permanent features observed in most construction sites. According to research carried out in 2016 by Jomo Kenyatta University of Agriculture & Technology School of Bio systems & Environmental Engineering, only 25% of construction wastes is collected in Nairobi County. This is a clear indication that the management of this garbage is still a problem that needs much attention. A look at the heap of garbage will also prove that the garbage collected from the sites consists of large quantities of waste building materials and demolition materials. A large of wastes generated from construction sites are usually solid wastes. According to Integrated Solid Waste Management Plan, ISWMP (2010), between 250-300 tons of waste is recovered either through recycling or reusing per day and they account for only between 8-10% of the wastes generated in a day. This can be attributed to the economic growth experienced in the country and the boom in the construction industry. According to research done on Integrated Solid Waste Management Plan for Nairobi City County, between 2010 and 2020, Nairobi County has no avenues of safe disposal, and only 400 to 600 tons of its waste gets to the Dandora dumpsite every day and consequently, a large chunk of waste generated cannot be accounted for. The environmental agencies such as NEMA, therefore, came up with levies and policies to supervise and coordinate such activities as waste disposal and management. To sort out poor solid waste management being experienced, NEMA came up with minimum requirements for implementation by the Counties as a baseline. These requirements include designation, securing and manning of the disposal sites, promotion of

efficient collection and transportation of generated waste. The implementation of these mechanisms is what needs to be followed by all contractors in the city to realize proper waste management. Some regulations, however, have been complying by the contractors. An example is the transportation of wastes from sites with the trucks with a certain limit.

The Kenyan construction industry is learning from the best practices all over the world and most designers are trying to design and build green buildings. This technology started being adopted in the twenty-first century in a bid to fight climate change. Notable buildings which have adopted green building in Nairobi include the Coca-Cola headquarters in Upperhill, Standard Chartered's new building in Westlands and Strathmore Business School. In the year 2014, Nairobi Business Park and Garden City Mall got the LEED Gold pre-certification, making the buildings the first commercial structures in East Africa registered officially as green buildings under international standards of the world's leading green code. These buildings were built and designed to meet the Leadership in Energy and Environmental Design (LEED) certification standard.

2.6 BEST PRACTICES FOR CONSTRUCTION WASTE MANAGEMENT

Due to continuous increase in the quantity of waste being generated by Nairobi's construction industries, there is increased concerns by the regulatory authorities to manage the waste and make the environment friendlier (Jhankar, 2015). Figure 1 shows the management hierarchy explaining the best ways to manage generated wastes by the construction activities.

Figure 2: Waste Management hierarchy.

Source; (Demirbas, 2011)

From the trends in Nairobi's construction sites, both the construction and demolition wastes are rampant and need more sensitization and attention paid so as to improve the environment and better manage the construction industry in the County.

2.7 LEGAL FRAMEWORK SURROUNDING CONSTRUCTION AND DEMOLITION WASTE

The Kenyan government has come up with extensive rules and regulations to be followed by its citizens and more specifically the stakeholders working in the construction sector. The rules are

either an act of parliament, existing laws, and the building codes. The policies are summarized below.

2.7.1 ACTS OF PARLIAMENT

2.7.1.1 The National Sustainable Waste Management Act, 2017

This is an act of the parliament that was passed as a bill 2018 with the objective of enhancing sustainable waste management by improving waste management through the promotion of material recovery and generation of energy, and promoting activities aimed at reusing or composting waste materials into useful products and plausible sources of energy, with the hopes of reducing the amount of waste destined for secure final disposition. Part IV, section 11(1) of the act states that T*he National government, through the national organs and agencies responsible for implementing this Act, are obligated to put in place uniform measures that seek to minimize waste that is generated and, where waste is generated, to ensure that waste is reused, recycled and recovered in an environmentally sound manner.*

2.7.1.2 Environmental Management and Co-ordination Act (EMCA) No .8 of 1999

This is an Act that was implemented to improve Environmental management and conservation. Section 87(4) of EMCA states that "*every person whose activities generate waste shall employ measures essential to minimize waste through treatment reclamation and recycling*."

Contravening this section attracts "*Imprisonment for a term of not more than two years or a fine of not more than one million shillings or both imprisonment and fine*." Section 9 of EMCA, 1999 further states that, *the objective for which the Authority was put in place is to exercise general supervision and coordination over all the environment matters and to be the principal instrument of Government in the implementation of all policies relating to the environment.* For this reason, the Act acts as a guiding principle to the citizens on the minimum requirements required by NEMA for the conservation of the environment. Some of the regulations under this act include:

I) Waste Segregation and Reduction at Production and Consumption Levels

This act establishes a framework for environmental management on the handling and disposal of waste such as excavation waste at a source level. It encourages the reduction of waste generation by monitoring the production of the materials.

II) Primary Storage, Collection, Transportation and Transfer Stations

Due to the transportation of the construction wastes from one place to another, EMCA came up with rules to guide this process. Section 87(2), paragraphs (a) and (b) of EMCA states that, "*no person shall transport any waste other than- in accordance with a valid license to transport waste issued by the Authority; and to a waste disposal site established in accordance with a license issued by the Authority*".

III) Treatment and landfills

Section 87(5) of the Environmental Management and Co-ordination Act (EMCA) puts emphasis on the need to treat any waste from whatever source by employing measures to minimize waste. Section 86(2) stipulates that "*The Standards and Enforcement Review Committee established under section 70 shall, in consultation with the relevant lead agencies, recommend to the Authority measures necessary to: prescribe standards for waste, their classification and analysis, and formulate and advice on standards of disposal methods and means for such wastes*". However, these standards are not being followed and there are no strict consequences for not following these standards. A look at the Dandora dumpsite will prove that a lot needs to be done to adhere to these standards.

2.7.3 THE CONSTITUTION OF KENYA

The Kenyan constitution, in chapter 5 talks about land and environment. Part 2 of section 69(1) (a) of the constitution on environment and natural resources states that the state shall (a) ensure sustainable exploitation, utilization, management and conservation of the environment and natural resources, and ensure the equitable sharing of the accruing benefits; (f) establish systems of environmental impact assessment, environmental audit and monitoring of the environment; and (g) eliminate processes and activities that are likely to endanger the environment. Furthermore, the Constitution under schedule 4, has devolved the function of waste management to County Governments, and enforcement authorities have been provided for under the Public Health Act Cap 242 and other legal statutes.

2.7.4. NAIROBI CITY COUNTY BYLAWS

The country has come up with various laws to improve waste management. These laws are enforceable by the city dwellers and include:

2.7.4.1 Solid waste management

The Nairobi City Council is mandated to manage and regulate wastes within the city. The county requires that trade premises users and owners shall separate wastes that ought to be recycled and dispose them in a separate container provided or approved by the council. This is not followed by most contractors and city dwellers because all the wastes generated are usually dumped together and when they get to the dumpsites is when they are segregated. Case in point the Dandora dumpsite where separators are hired to carry out this activity.

2.7.4.2 Resource recovery and Construction and Demolition Wastes

The county has come up with laws to recover the wastes generated from the construction sites. According to section 9(8) of the County by-laws, the council shall, "*make provision for small-scale resource recovery activities to be undertaken by organized groups at designated sites before disposal.*" The city council does not make provisions for such activities nor does it charge any persons as it is considered a less formal activity meant to help the council reduce waste disposal.

2.8 SIMILAR CASE STUDIES

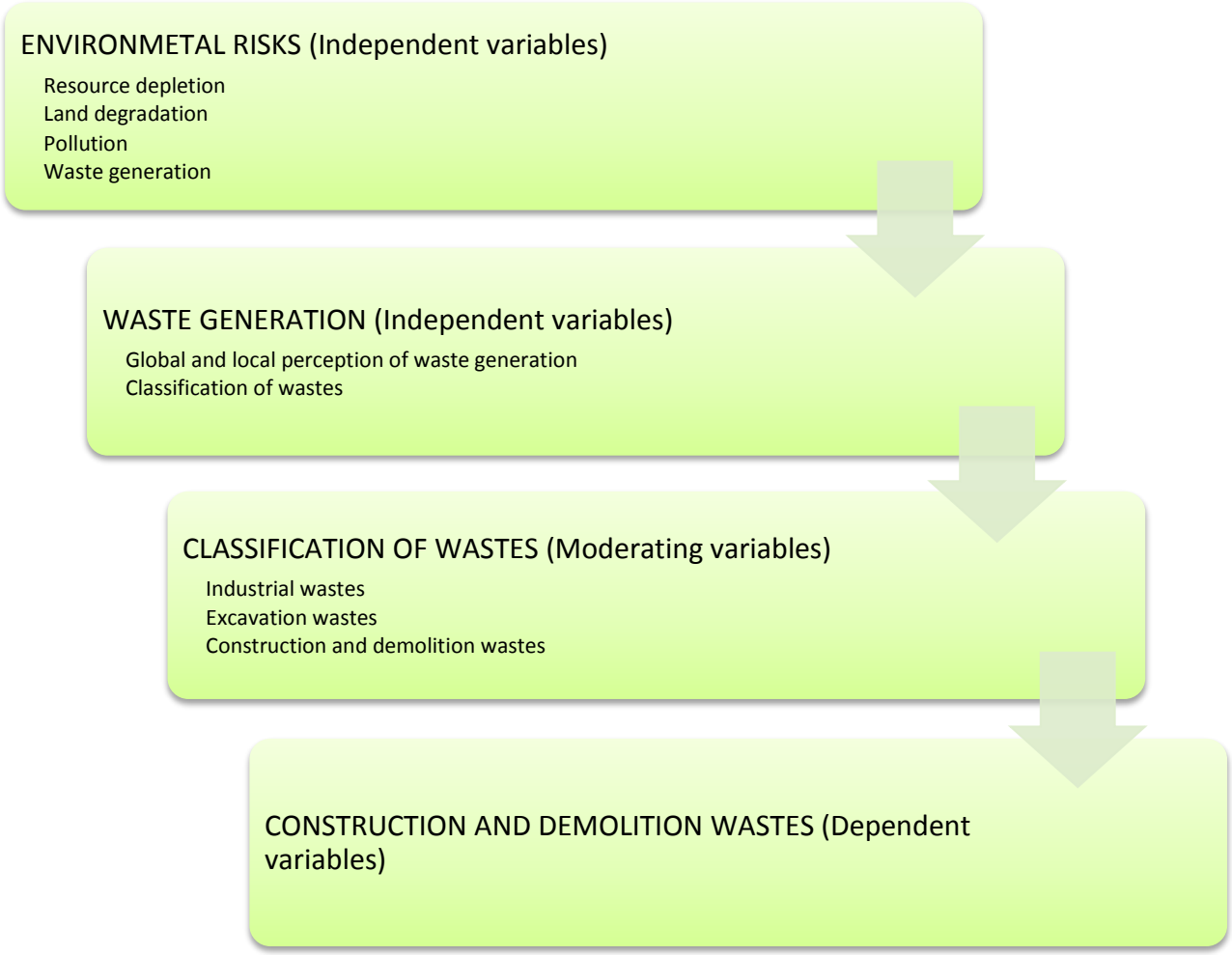
There has been extensive studies undertaken by different researchers in Kenya on Environmental management that are similar to this research topic. Wanjohi, Ndoria C (University of Nairobi, 2015), conducted a research on "*Solid waste disposal and its effect on the socio-economic environment in residential estates".* The research focused solely on the waste disposal and did not study the possible remedies of reducing the solid waste from construction sites. Kibowen, Kathy C (University of Nairobi, 2018), researched on *"Sustainable excavation waste Management on construction sites; case of Nairobi county, Kenya*". Her research delved into the excavation wastes in construction sites. It however, did not shed light on how the other facts of wastes can be minimized research aims to dwell on the construction and demolition wastes which have not been researched extensively in Kenya's construction market.

2.9 CONCEPTUAL FRAMEWORK

This research's conceptual framework is guided by environmental risk management, more specifically, construction waste management measures employed in order to ensure that prevention, recycling, reusing and proper disposal are practiced by construction firms in Nairobi. The main emphasis is on the construction and demolition wastes in Nairobi County by big construction firms in the country. The key areas to be discussed include; types of construction and demolition wastes, the best practices of their management, both globally and locally and the legal framework governing the management of C &D wastes. This research will be guided by the conceptual framework model shown in

Figure **3**

Figure 3: Conceptual model



Source; (Author, 2019)

2.10 SUMMARY OF LITERATURE REVIEW

All risks, are harmful to the environment but they are not treated with equal measures in the country. The involvement of international construction firms in the country has brought about some positive incentives into the proper management of these risks. For instance, the introduction of precast concrete has minimized to a large extent the risks, such as noise pollution, air pollution and waste generation that would have been brought about by the conventional method of in-situ preparation. A lot of studies have been done on construction and demolition wastes in other countries but locally, the studies carried out have generalized the environmental risks with very few of them focusing on the construction and demolition wastes. This research will be guided by the conceptual framework, illustrated earlier in this chapter. Having narrowed down the potential environmental risks brought about by the construction activities and realized that there is a gap in the wastes, the research will aim to find possible waste management measures employed to ensure that prevention, recycling, reusing and proper disposal are practiced by construction firms in Nairobi. The key areas to be discussed include; types of C&D wastes, the best practices of their management, both globally and locally and the legal framework governing the management of these wastes.

CHAPTER 3: RESEARCH DESIGN AND METHODOLOGY

3.1 INTRODUCTION

Chapter three delves into the research design and the methodology adopted while carrying out the research. It will explain the various data collection methods and the target audience of the research. It justifies the research methodology used in order to realize the objectives of the study. The chapter contains: research design, population, sample size and sampling procedures, research instruments and data analysis.

3.2 RESEARCH DESIGN

This research is a case study that will be carried out based on trends adopted by most contractors in Nairobi County. A case study is "*An empirical inquiry that investigates a contemporary phenomenon within its real-life context whereby only a very small geographical area or number of subjects of interest are examined in detail"*, (Yin, 2003). The sole aim of this research study, therefore is to get information from a certain group of contractors within Nairobi County on how they manage the wastes generated from their sites so as to understand the extent of waste management by construction sites. The study will focus on NCA 1, NCA 2 and NCA 3 contractors because these are the contractors who have been approved and licensed to carry out big projects with so much activity and taking a longer span of time. Because of the size of the projects these contractors carry out, they are mandated to follow all the waste management regulations put in place and to adhere to all the environmental risks that their construction sites could pose to the

neighboring community. The local authority is also keen on checking their waste management techniques because they could arguably produce more wastes as compared to the other class of contractors. By limiting the research to NCA1, NCA 2 and NCA 3 contractors only, the research will provide deep analysis into the concept of waste management in Nairobi's construction sector.

According to Lijphart (1971), there are six types of case studies: atheoretical, interpretive, hypothesis-generating, theoretical confirming, theoretical-informing, and deviant. Atheoretical and interpretive case studies are hypothesis-generating case studies, in that, they establish a new theory from a case study, they focus on the single case rather than generalizing a theory based on the study. Theory-confirming and theory-infirming case studies employ an analysis within an already established theory. A deviant case study, shows a deviant case from conventional generalization, (Moses and Knutsen, 2012). From the three categories of case study above, this thesis can be characterized as a theoretical-confirming case study because it seeks to confirm or to dispute the theory that waste management is being practiced by contractors in Nairobi County. This study will concentrate on a community level, which in this case is Nairobi County.

3.3 SOURCE AND NATURE OF DATA

3.3.1 Area of study

This research was carried out in Nairobi County in Kenya. This is because a large number of NCA 1, NCA 2 and NCA 3 contractors are located in this County and also, this is the county with the most construction activities. Additionally, this region has been chosen to facilitate easy accessibility.

3.3.2 Target population

The research targeted 1661 NCA 1, NCA 2 and NCA 3 contractors in Nairobi County who have been registered by the National Construction Authority to carry out building works, road works and water works in the year of the case study, 2019. The sites studied were those which have been actively conducting operations for over a year. The persons targeted to answer the questionnaires at the construction sites for analysis included the site managers in charge of the operations of the sites.

3.4 SAMPLING

3.4.1 Sampling frame

The sampling frame included the 1661 NCA 1, NCA 2 and NCA 3 contractors registered by The National Construction Authority in the year of the study 2019 and had construction sites within Nairobi in the year 2019.

3.4.2 Sampling technique and size

The respondents to be considered in the study were sampled using a simple random sampling method. Since the population of the sample is not known, Nassiuma's formula (2000) was adopted to determine the appropriate sample size needed using an acceptable coefficient of 30% and

relative standard error of 5% on the 1661 registered NCA 1, NCA 2 and NCA 3 construction companies.

Since the population of the sample is not known, the sample size was arrived at using Nassiuma's formula (2000) shown below;

$n = NC2 \div C2 + (N-1)\ e2$

Whereby;

n= sample size to be determined

N=Total population of the contractors

C=Coefficient of variation which is usually $\leq 30\%$

e=margin of error which is fixed between 2-5%)

The study sample was calculated at 30% coefficient of variation to ensure that the sample frame is wide enough to justify the results were being generalized for Nairobi County. A margin error of 5% was used for this research since the research is a theoretical- confirming kind of case study and therefore the variables could not be manipulated hence necessitating relatively higher margin of error.

The sample size for the study was hence calculated as seen Table 1 as shown;

Table 1: Sample size

Sample frame (NCA 1 – NCA 3 contractors)	**Sample size**	**Sent Questionnaires**	**Responses**
1661	35	51	39

$$n = \frac{(1661 \times (30/100))^2}{(30/100)^2 + (1061-1) \times 5^2/100} = \frac{149.49}{(0.09+1660)x0.002} = \frac{149.49}{4.24}$$

n= 35.25 =35

Source; (Author, 2019)

After determining the targeted sample size of 35, the sample was drawn from the sample frame using a universal random sampling table (see appendix III)). The digits of the total population within the sample frame, which is total number of the registered contractors, was considered. Four number digits were required; 001-1661 with numbers exceeding 1661 not usable and passed over while those less than 1661 but repeating themselves were considered only once. Considering the first four digits of the table appended, selection begun at line 365 and random numbers, starting with 0554, were picked by reading across the columns, left to right, on each successive line. The obtained numbers were then marked on the sample frame to identify the specific firms to be interviewed that is 35 in total. The survey was kept open for the selected firms as some firms had more than one construction site running between 2011- 2016. 51 questionnaires were thus sent out to the site supervisors to increase the chances of meeting the targeting sample size.

3.5 DATA COLLECTION

This section outlines the data instruments and the methodology adopted in order to get the research data. The instruments used to collect data was questionnaires, observation and occasional guided oral interviews were carried out to some of the target population working in selected construction sites.

3.5.1 Data processing

Oral interviews, observation and questionnaires carry out the research. Questionnaires were sent out to selected respondents. The questionnaires contained both structured and unstructured questions, all of which were helpful in answering the research objectives. The structured questions limited the respondents to a selected answer so as to get a predetermined nature of responses for the study. The unstructured questions are open-ended and the allow help in getting an overview of the respondents so as to capture the entirety of the target population. The instruments designed for the study had 5 parts questionnaire that assisted in the collection of the data from the respondents (see appendix II). This data collection instrument allowed for both subjective and objective views of respondents to be assessed. Parts two to part five contained questions with 5 Likert scale that allowed the respondents to choose from an option that aligns with their views by asking the extent to which they concur with particular statements. The questions in the questionnaire were derived from the research objectives and were derived from the review of literature that has been researched and reviewed.

3.5.1 Data analysis and presentation

Data analysis was done using both qualitative and quantitative techniques. Tables, charts, percentages and textual write-ups of the data collected were adopted in the case of the quantitative technique, while descriptions were used in the qualitative analysis.

The data collected was first sorted to eliminate errors made during data collection and then entered into the computer for analysis.

3.6 LIMITATION OF DATA COLLECTION

The data was obtained from contractors practicing within the Nairobi County. As a result, the applicability of the findings to other parts of the country is uncertain and requires to be investigated.

CHAPTER FOUR: DATA PRESENTATION AND ANALYSIS

4.1 INTRODUCTION

This chapter covers the step by step analysis of the information that was collected in the previous chapter. It elaborates the findings of the study that was carried out on the management of construction and demolition wastes by construction firms in Nairobi County. The objectives of this research were fourfold and included: To examine the average amount of waste produced by construction sites in Nairobi County; to identify the waste management techniques adopted by the building contractors and stakeholders on these sites; to assess the impact of waste management techniques on the environment and to examine the challenges experienced in effecting sustainable waste management techniques. Questionnaires were sent out to the respondents and the data obtained was analyzed, and interpreted with the purpose of realizing the research objectives. The chapter concludes with a summary of the findings that were presented.

4.2 RESPONSE RATE

The survey targeted 51 respondents, and out of this, 39 responded positively by answering the questionnaire as requested. Table 2 illustrates the rate of response amongst targeted contractors in Nairobi County.

Table 2: Response rate

Category of respondents	**Sample population**	**Response**	**Percentage (%)**
Site supervisory staff	51	39	76.47

Source; (Author, 2019)

As depicted in Table 2, the response rate was slightly above 76%. This response rate was considered reasonable enough for data analysis. The respondents targeted were the most suitable to give the best data because they are the ones mostly involved with the day to day activities on construction sites.

4.3 DEMOGRAPHIC INFORMATION OF THE RESPONDENTS

Out of the 39 respondents, the demographic information was summarized to get an overview of the diversity of the collected data. The respondents were limited to only the site staff who were in supervisory positions such as the construction managers and the site agents because they are most suited to give the correct data that would help with the research. They demographic information of interest to the study was: the kind of projects and the nature of work that they involved; the NCA registration category of the construction firms; the experience they had working in the construction sector. These aspects are presented in Table 3, Table 4, Table 5, Table 6 and Figure 4.

Table 3: Type of project carried out

	Frequency	**Percentage (%)**	**Cumulative**
Residential	19	48.7	48.7
Commercial	16	41	89.7
Health facility	4	10.3	100
TOTAL	39	100	

Source; (Author, 2019)

From Table 3, most of the respondents work in residential projects and commercial projects. This shows that there is more demand for people to live within Nairobi and to carry out their businesses within the city. Commercial and residential projects usually have a lot of activities in them, therefore, it is expected that the data collected will depict the accurate situation of sites within Nairobi County.

Table 4: NCA category of the construction firms

	Frequency	**Percentage (%)**	**Cumulative**
NCA 1	30	76.9	76.9
NCA 2	7	18	94.9
NCA 3	2	5.1	100
TOTAL	39	100	

Source; (Author, 2019)

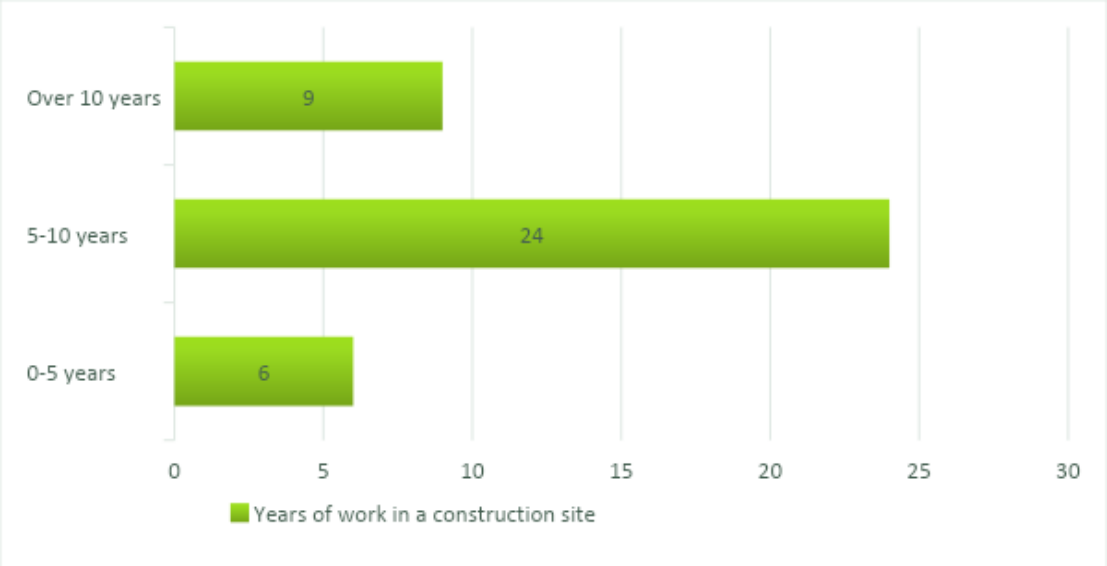
From Table 4, the data gathered is a representation of the contractors who carry out the big projects in the city. Most of the respondents were from NCA 1 category of contractors, hence understanding of the waste management techniques employed by such firms will be useful. The research limited the respondents to contractors registered between NCA 1 and NCA 3 because the magnitude of the projects that they undertake is big enough to get credible information.

Table 5: Nature of work in the construction site

	Frequency	**Percentage (%)**	**Cumulative**
Civil works	17	43.6	43.6
Building works	21	53.8	97.4
Renovation works	1	2.6	100
TOTAL	39	100	

Source; (Author, 2019)

Figure 4: Years of work in the construction industry



Source; (Author, 2019)

Table 6: Years of work in a construction site

	Frequency	**Percentage (%)**	**Cumulative**
0-5 years	6	15.4	15.4
5-10 years	24	61.5	76.9
Over 10 years	9	23.1	100
TOTAL	39	100	

Source; (Author, 2019)

The information from Table 5, Table 6 and Figure 4 shows that the respondents have been in practice for satisfactory number of years, hence have a clear grasp of the construction and can offer valid information concerning the management of wastes in the construction field within Nairobi County.

4.4 AVERAGE AMOUNT OF WASTE GENERATED IN A CONSTRUCTION SITE

This section analyses the average quantity of waste that is generated from the sites within Nairobi County. From the study findings, the major environmental risks that result from construction activities include: land degradation, pollution and waste generation with waste generation being the most risk posed to the environment indicated by 74.3% of the respondents mentioning waste generation, 68.9% of them mentioning noise pollution and 43.1% of the respondents mentioning land degradation. Out of the six risks mentioned in the literature review, it was realized that the waste generation is the risk that is observed with all respondents, (100%) strongly agreeing with the statement that waste is generated in large quantities in their sites. Noise pollution came second as another risk being generated by construction activities with 84% of the respondents agreeing with the fact that noise pollution is observed in their sites a lot. 76.9% of the respondents disagreed with the statement that resource depletion is common in their sites while 14.1% agreed with the statement.9% of the respondents were neutral. This is an indication that resource depletion is not as huge of a risk as pollution and waste generation are. 73.8% of the respondents disagreed with the statement that land degradation is a risk mostly observed in their construction sites, confirming that land degradation is not a problem that is observed by the stakeholders in the construction

industry while carrying out projects. Consequently, from the data collected, it is apparent that waste generation and pollution, specifically noise pollution are the risks that construction sites within Nairobi County need to fight and put more effort to curb.

The respondents were asked to describe the materials that are mostly generated from their sites. Concrete was observed to be the waste generated most with 23% compared to the other materials. Ceramics were observed to be the least amount of material being generated on sites, at 4%. These materials are classified under the construction and demolition wastes and from the findings, it is clear that a lot of effort ought to be put by the stakeholders in the construction industry so as to reduce the generation of these materials. Table 7 illustrates the results as responded in the questionnaire.

Table 7: Waste materials mostly generated from site

	Percentage (%)	**Cumulative**
Plastics	7	7
Metals	9	16
Concrete	23	39
Stones	19	58
Aluminum	9	67

Timber	15	82
Tiles	14	96
Ceramics	4	100
TOTAL	100	

Source; (Author, 2019)

The generation of hazardous wastes was also researched and the respondents were asked to describe the materials that were generated from a selected list. Table 8 shows the response that was observed.

Table 8: Hazardous wastes mostly generated from site

	Percentage (%)	**Cumulative**
Asbestos	5	5
Solvents	66	71
Mineral fibers	13	84
Lead	0	84
Fiberglass	16	100
Silica	0	
TOTAL	100	

Source; (Author, 2019)

None of the respondents reported that both lead and silica is generated from their sites. Solvents wastes were reported to be produced the most with 66%. Fiberglass was close to solvents with 16% being generated from sites.5% of the respondents reported that asbestos was being generated from their sites. The use of asbestos was banned in the country, therefore, the 5% response was reported by the respondents who carried out demolition works in the sites that had asbestos initially. Most of the respondents reported that the amount of hazardous materials generated from sites was not as significant as the construction and demolition wastes that were generated. This is an indication that the production of hazardous materials is being avoided by a lot of the contractors.

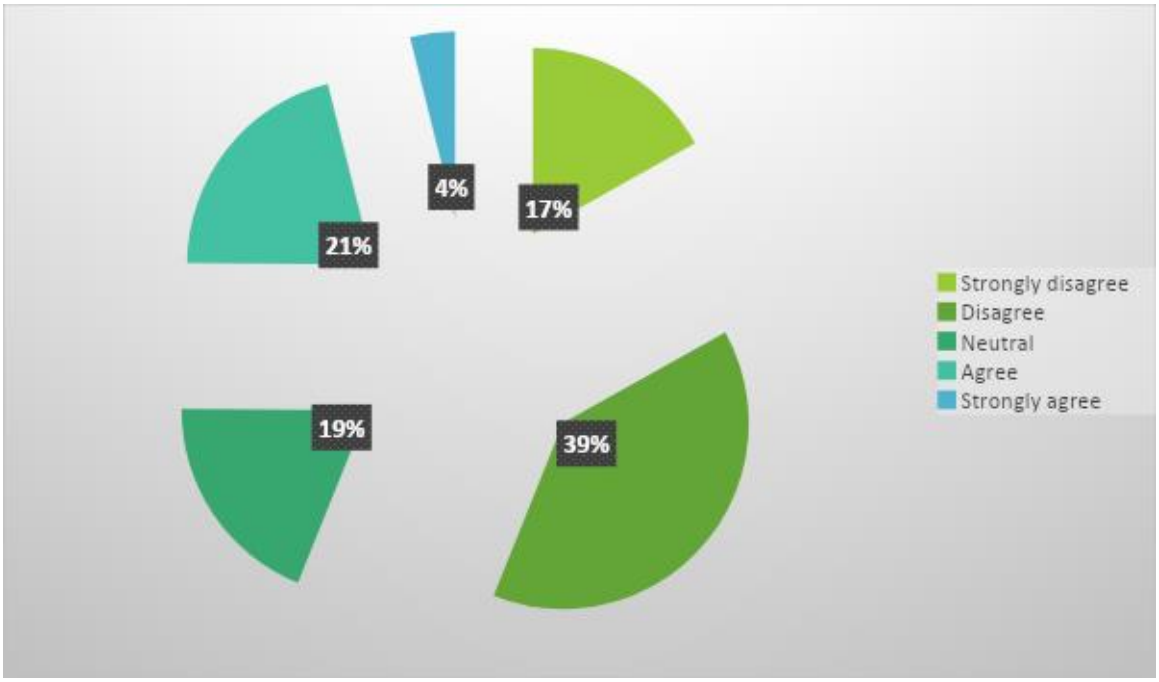
The amount of waste generated from sites can be concluded to be of different forms and from the data collected from questionnaires, it is apparent that the generation of wastes is observed in most sites within Nairobi, and the management of these wastes is important, right from the generation all through to disposal of the wastes.

4.5 CONSTRUCTION WASTE MANAGEMENT TECHNIQUES

4.5.1 Waste management techniques

According to the research: segregation of waste before dumping is not common practice among the contractors in Nairobi; most construction sites have a sizable waste pits and the waste created is usually disposed of from site frequently as indicated in **Figure 5**,**Figure 6** and **Figure 7**:

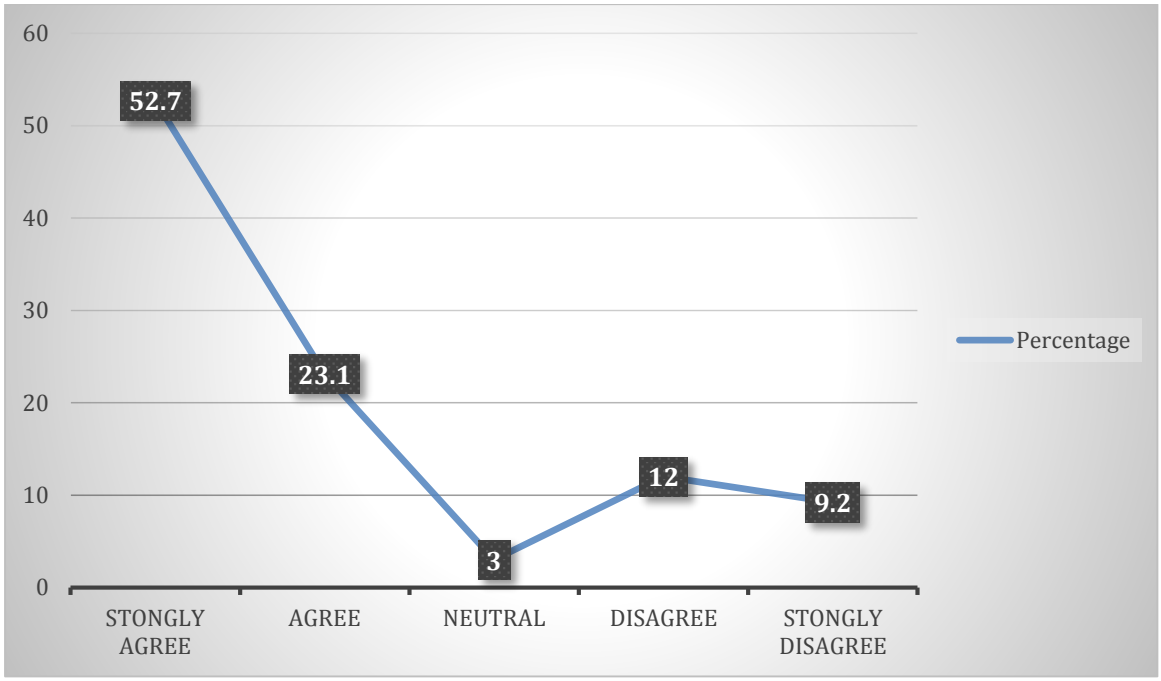
Figure 5: Construction waste segregation before dumping



Source; (Author, 2019)

From figure 4.2, it is evident that the contractors need to be encouraged to segregate the wastes generated seeing as this can help in reusing and recycling the materials elsewhere.39% of the respondents reported that they did not practice segregation while only 4% of the respondents reported to be practicing segregation in their sites. The difference in percentages is explained by most of the respondents saying that segregation of the materials meant deploying people for that activity and it was considered a waste of time and cost which did not directly have an impact on the completion of the project.

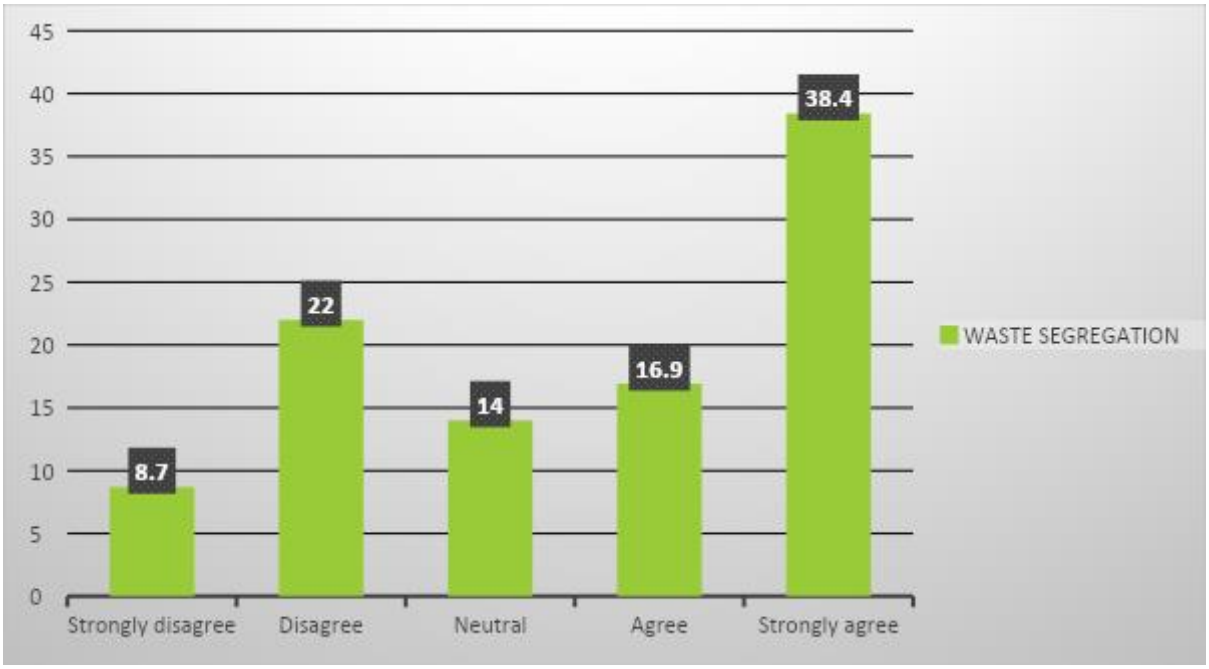
Figure 6: Presence of sizable waste pits on site



Source; (Author, 2019)

From Figure 6, 52.7% of the respondents strongly agreed to have sizable waste pits on site while 9.2% of the respondents strongly disagreed to having sizable waste pits. The response shows that a lot of sites pay attention to the wastes generated on sites and for this reason, they have allocated a section in their sites for proper disposal of the wastes. This can be attributed to policies stipulated by NCC and NEMA that every site should have a waste pit on their sites.

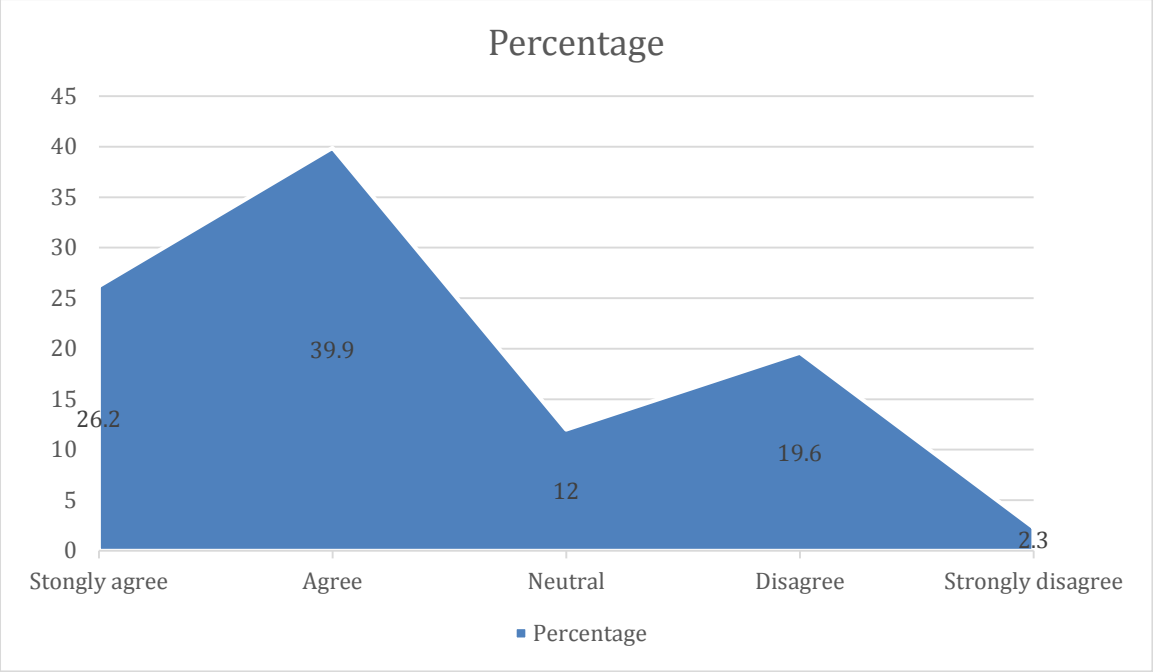
Figure 7: Disposal of wastes from site frequently



Source; (Author, 2019)

From Figure 7, majority of the respondents (38.4%) of the respondents strongly agreed that they frequently disposed wastes from their sites, while 8.7% of the respondents strongly disagreed to frequently disposing materials from sites. The respondents who did not dispose materials frequently cited the location of their sites from the dumping sites as a factor limiting them from frequently disposing the materials and the position of the sites as another limiting factor. Some construction sites, especially those within the city plan to dispose their wastes during the weekends when there is less activity on the adjacent properties and the sites too. Other sites, however, produce a lot of waste and therefore, they could not wait until the weekends to dispose their wastes from sites.

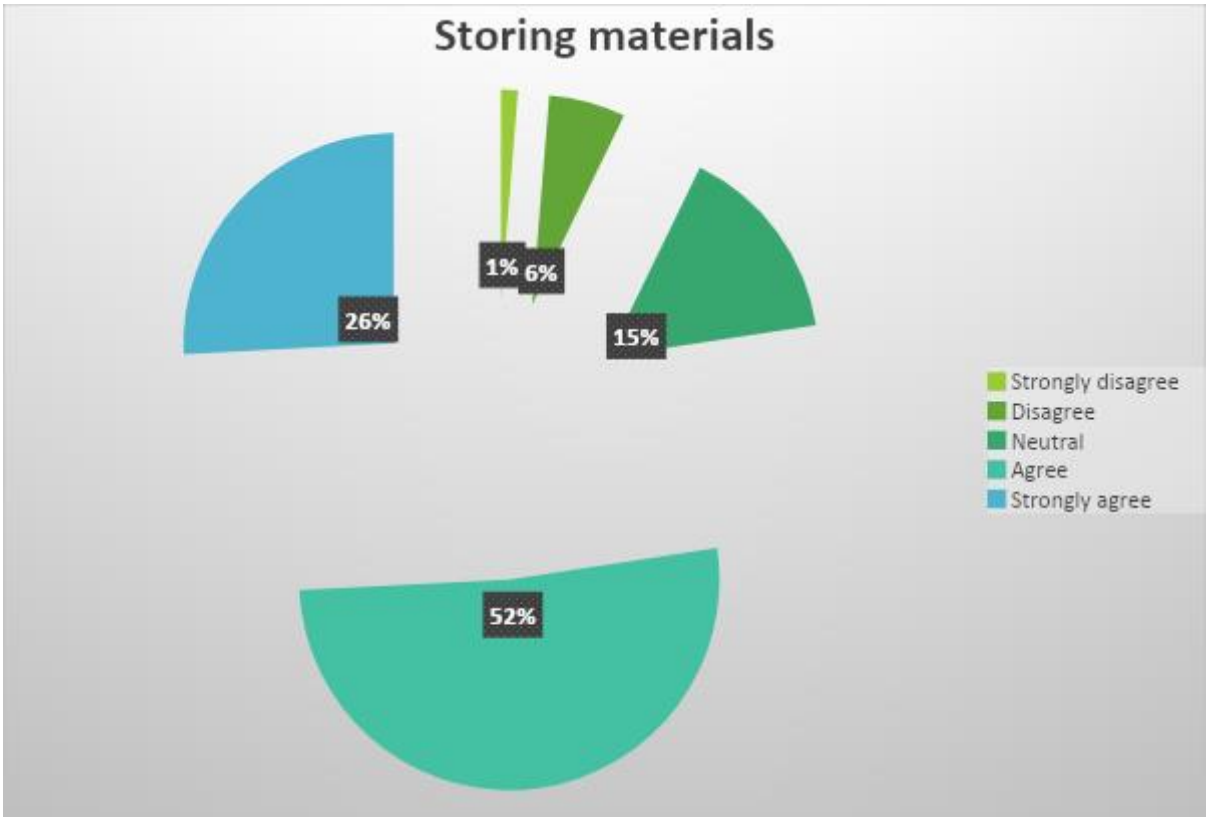
Figure 8: Salvaging materials that are fit for use



Source; (Author, 2019)

From the data collected in **Figure 8**, not all the waste that is generated is thrown away but some of them are salvaged to be used for a different task. Very few contractors throw the salvageable materials.26.2% of the respondents strongly agreed that they salvaged materials that would otherwise have been thrown as waste while only 2.3% of the respondents did not salvage useful materials from wastes. The difference in the response shows that a lot of the contractors care about what they throw away as waste which is a good practice in waste management.

Figure 9: Storing excess materials for future use



Source; (Author, 2019)

In determining whether the excess materials on the site are stored for use in another project, the respondents noted that only 1% did not store the materials while 52% used the excess materials for other projects rather than throwing the materials away. From the findings, the contractors care about the cost of materials and in situations where they can save the excess materials for use in another project, they usually take that option. Some contractors have a deal with their suppliers to return the materials back to them once they are done with the project. This is good practice because it eliminates the possibility of having excess materials on site that would otherwise be waste. This data is illustrated in **Figure 9**;

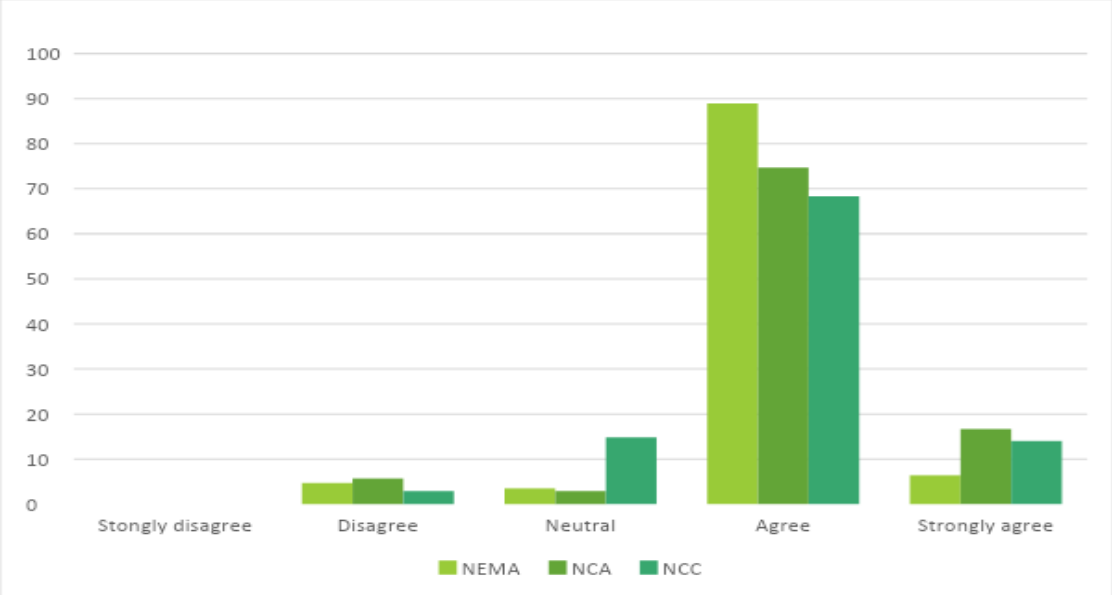
Most contractors consider segregation of the waste a waste of time and manual labor, therefore they dump all their materials without segregating them. Most construction sites were reported to

have a sizable waste pit, which was indicated by 53% of the respondents confirming the statement. 38 percent of the respondents reported that they dispose their wastes frequently. By disposing the wastes frequently, it means that they did not wait to fill their waste pits so as to get the wastes dumped from site. Most of the respondents confirmed that they had waste removed from site as often as multiple times a day during to reduce littering on sites. Consequently, from the data collected on the basic waste management techniques, it is observed that most sites within Nairobi County have put some effort in managing the wastes produced from sites and a little more effort can be put by the few contractors who have not yet been accustomed to practicing waste management techniques.

4.5.2 Compliance with the rules and regulations.

The respondents were asked whether they comply with the rules and regulations put in place compliance and regulatory authorities such as NEMA, NCA and NCC and their results are illustrated in **Figure 10**:

Figure 10: Compliance with the authorities



Source; (Author, 2019)

From the chart shown, most contractors comply with the rules and regulations put in place by NEMA, NCC and NCA in relation to waste management. This can be attributed to the fact that failure to comply with these rules and regulations leads to repercussions such as penalties and closure of site, which contractors avoid at all costs. Contractors work towards the completion of the projects within the stipulated time frame and without incurring extra charges. So, non-compliance with the regulatory authorities will lead to extra charges that had not been planned for. Consequently, the contractors opt to comply with the policies put in place in order to be in a safe place.

Table 9: Training of personnel on waste management

	Percentage (%)	Cumulative
Strongly disagree	6	6
Disagree	8.7	14.7
Neutral	13	27.7
Agree	66	93.7
Strongly agree	6.3	100
TOTAL	100	

Source; (Author, 2019)

When asked whether the respondents have a team of employees trained periodically on environmental management, 66% of the respondents agreed with the statement. Small percentage of contractors don't have employees who are trained periodically on waste management. It is a requirement for every construction site to have trained and certified Health & Safety officer who oversees the health and safety matters of their projects. It is for this reason, therefore, that the most construction sites have a team on site who are trained on health and safety matters on sites. From the data collected in Table 9, it shows that the waste management on sites is being treated with the concern that it should and that's why there is a large percentage of sites (66%) with a team of workers to monitor the waste management on sites.

Table 10: Soliciting opinions from environmental organizations

	Percentage (%)	**Cumulative**
Strongly disagree	5.1	5.1
Disagree	59.6	64.7
Neutral	13.2	77.9
Agree	13	90.9
Strongly agree	9.1	100
TOTAL	100	

Source; (Author, 2019)

In determining whether the construction companies within Nairobi solicit opinions from environmental organizations such as NEMA on waste management practices, 59.6% of the respondents disagreed with the statement that they solicit opinions. 13% of the respondents agreed that they solicited opinions on waste management in their projects. The data showed depicted a gap in the involvement of the regulatory authorities in the project life cycle. The authorities are involved only while getting the approvals and during the inspection. Majority of the respondents confirmed that they sought opinions mostly from the design team and the client but they would not seek the opinion of the regulatory bodies. This data is summarized in Table 10.

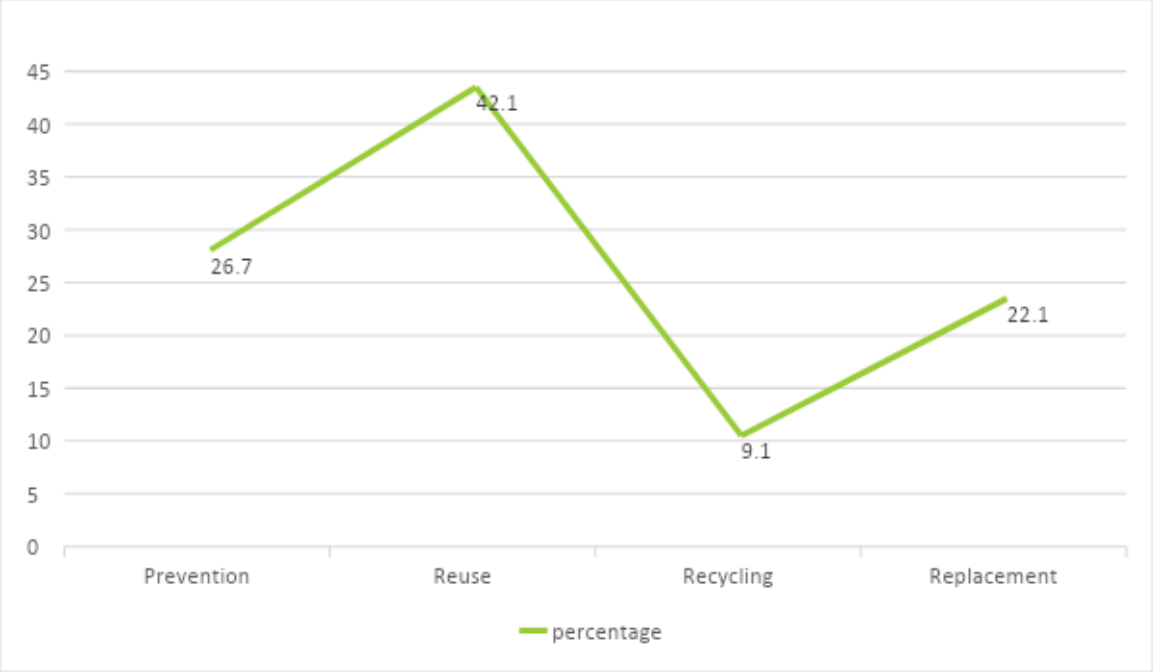
Table 11: Presence of waste management policies on site

	Percentage (%)	**Cumulative**
Strongly disagree	11	11
Disagree	36	47
Neutral	18	65
Agree	26	91
Strongly agree	9	100
TOTAL	100	

Source; (Author, 2019)

The respondents were asked whether there were waste management policies put in place specifically to manage the wastes generated on site.11% strongly agreed that they had such policies while 9% strongly disagreed. The ratio of those who had waste management policies on their site was almost similar to those didn't have waste management policies on their sites. The waste management policy that was reported by most respondents was the reusing of materials that had not been damaged too much. The use of excavated soil in backfilling is a good example of how these contractors practiced waste management. A summary of this data is shown in Table 11.

Figure: 11 Waste management techniques employed



Source; (Author, 2019)

The respondents were asked which waste management techniques is practiced most in their sites between prevention, reuse, recycling and replacement.26.7% of the respondents said that they practiced prevention as their waste management practices, 42.1% said that they reused their wastes, 9.1% said that their recycled the wastes generated on sites and 22.1% said they replaced materials as a way of managing wastes on site. This can be shown in

Figure: 11. The data collected showed that the practice of reusing and prevention as a measure of waste management has been well embraced by the contractors in Nairobi County. This can be explained by the fact that the contractors are keen on saving some money while undertaking the projects. However, there are some efforts that need to be put on recycling and replacement as it is being done by other contractors in the developed countries.

4.6 IMPACTS OF WASTE MANAGEMENT TECHNIQUES ON THE ENVIRONMENT

The respondents were asked whether they were able to reuse materials after properly handling the materials. Most of the respondents confirmed that they were able to reuse the materials. However, the ability to reuse the materials is dependent on the site agents monitoring how the construction workers handled the materials. This requires maximum supervision. The sites with multiple foremen supervising the construction workers end up taking care of their materials better than the sites with one supervisor overseeing all the construction activities on site. Table 12 describes the data that was collected on this question.

Table 12: Ability to reuse materials after being handled carefully

	Percentage (%)	**Cumulative**
Strongly disagree	3	3
Disagree	7	10
Neutral	4	14
Agree	59.6	73.6
Strongly agree	26.4	100
TOTAL	100	

Source; (Author, 2019)

In determining whether the management policies put in place by regulatory authorities such as NEMA, NCC and NCA have positively affected the environment, 64.9% of the respondents strongly agreed while 6.3% strongly disagreed. These findings can be attributed to the fact that the regulatory authorities come up with the policies with the intention of solving a problem that has already been identified and needs to be addressed, hence, by complying with the set rules and regulations, the impact on the environment is positive. The data is summarized in Table 13

Table 13: Positive impact of waste management policies on the environment

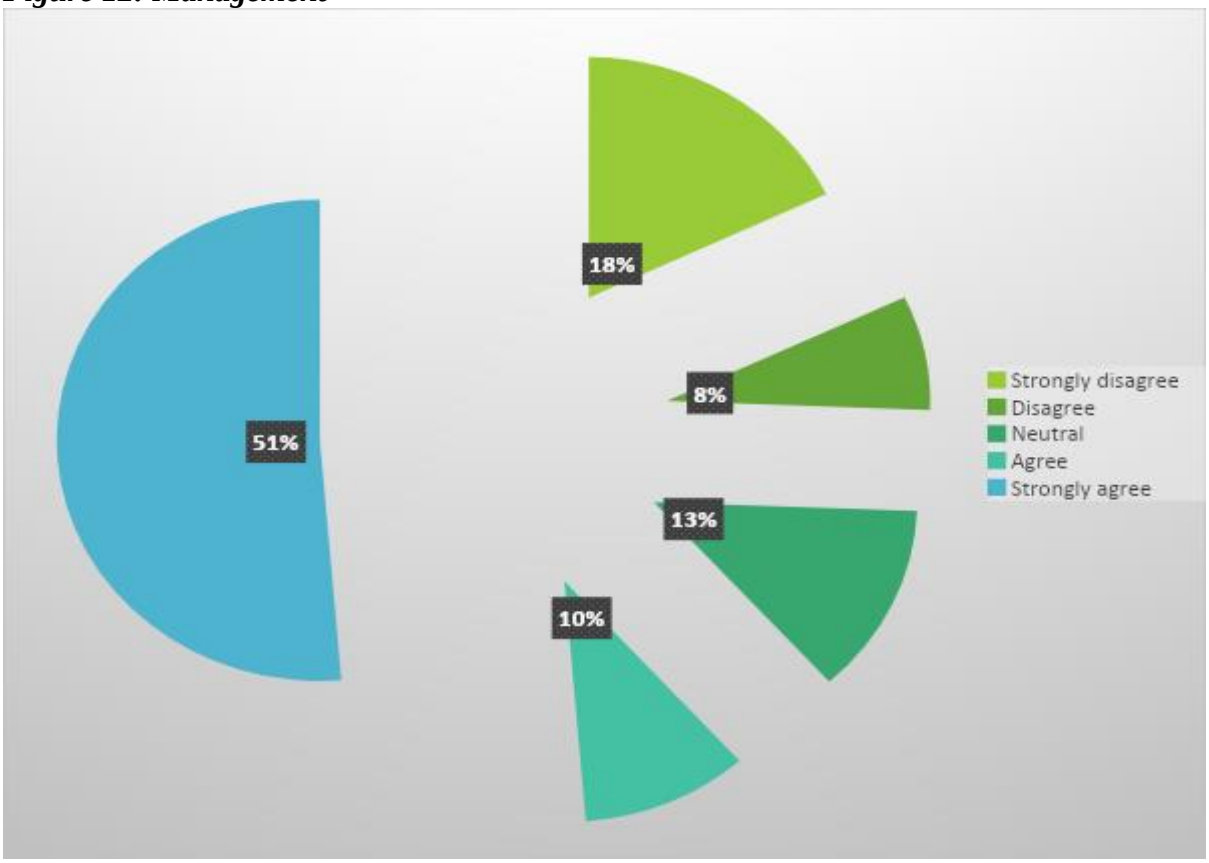
	Percentage (%)	**Cumulative**
Strongly disagree	6.3	6.3
Disagree	2	8.3
Neutral	6.7	15
Agree	20.1	35.1
Strongly agree	64.9	100
TOTAL	100	

Source; (Author, 2019)

4.7 CHALLENGES EXPERIENCED RELATING TO WASTE MANAGEMENT

In an effort to find out the challenges experienced by the construction companies within Nairobi County, the respondents were asked whether they agreed that some selected factors limited effective waste management on site Figure 12 to Figure 18 illustrate the perception of the respondents.

Figure 12: Management

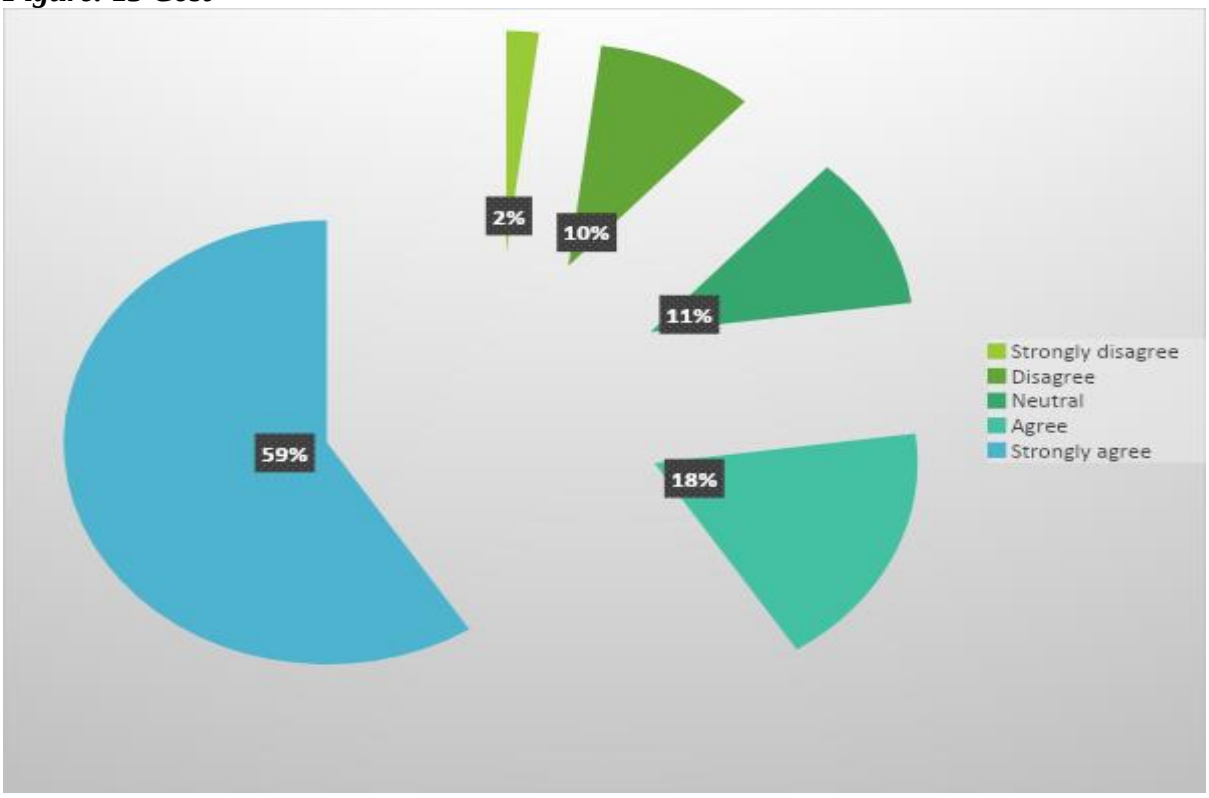


Source; (Author, 2019)

From **Figure 12**, majority of the respondents (51%) said that management had a lot to do with the waste management not being practiced to its full capacity. This is because the management made decisions based on completion of the projects and didn't concentrate much on the handling of the materials. The management of the construction companies spent less time on site and for this

reason, they would not be involved in the proper implementation of policies that would ensure proper waste management on sites. Some respondents however said that the management helped a lot on them manage materials on the site, hence minimizing wastes.

Figure: 13 Cost

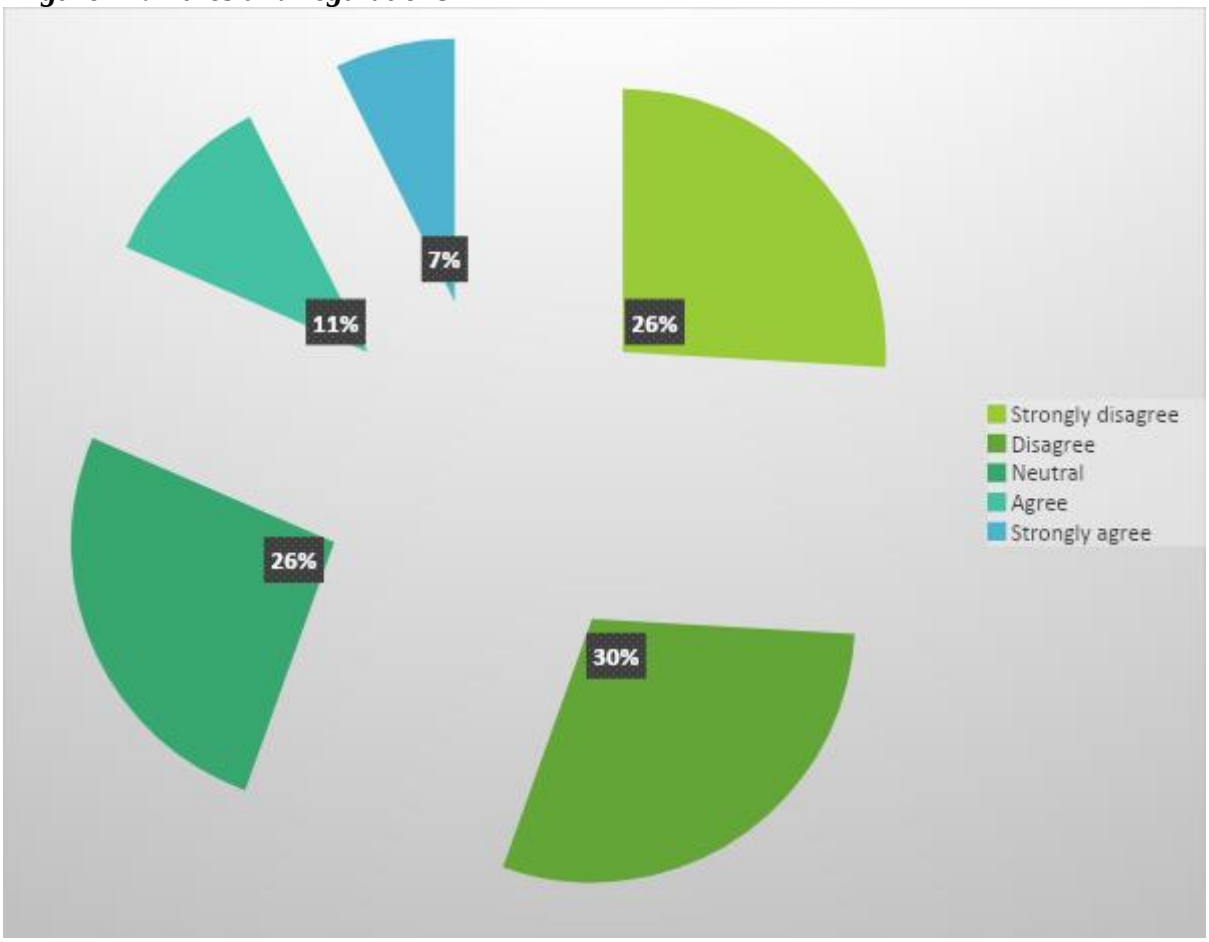


Source; (Author, 2019)

As illustrated in **Figure: 13**, cost is the factor that affects waste generation the most as compared with the other limiting factors. 59% of the respondents strongly agreed that cost is a limiting factor in waste management while 2% of the respondents strongly disagreed. This is solely because most companies work with the aim of achieving profits at the completion of the projects. The use of materials with less effect on the environment and less chances of generating wastes costs more as compared to using materials with adverse effects on the environment. An example is the use of

prefabricated panels in place of concrete. The panels cost more, therefore, contractors would opt to use the less expensive option at all times in order to make money.

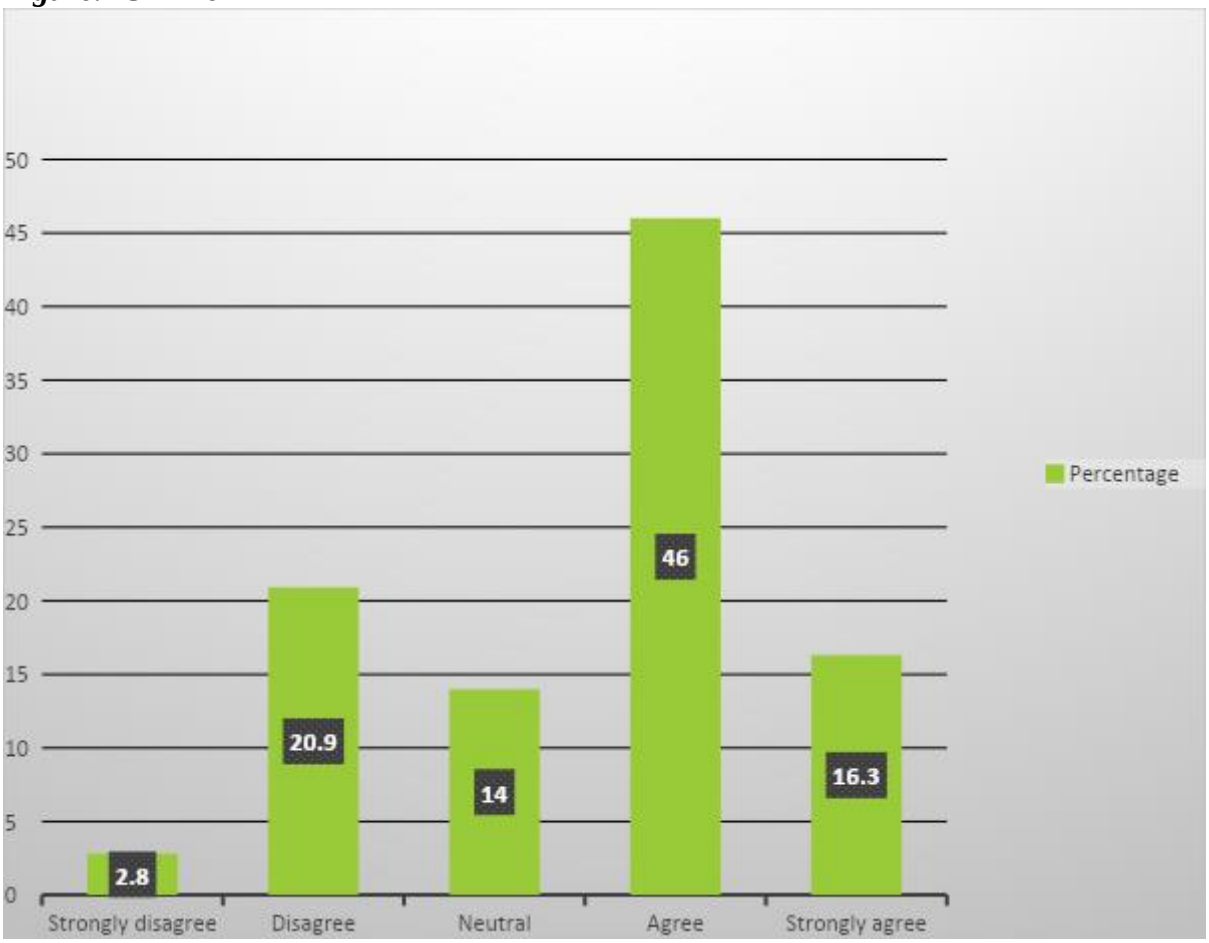
Figure 14: Rules and regulations



Source; (Author, 2019)

In determining whether rules and regulations were a limiting factor in waste management, it was found out that most construction companies don't consider the rules to be limiting, but instead a factor that helps the contractors manage the wastes generated in site better. This has been well illustrated in **Figure 14**.

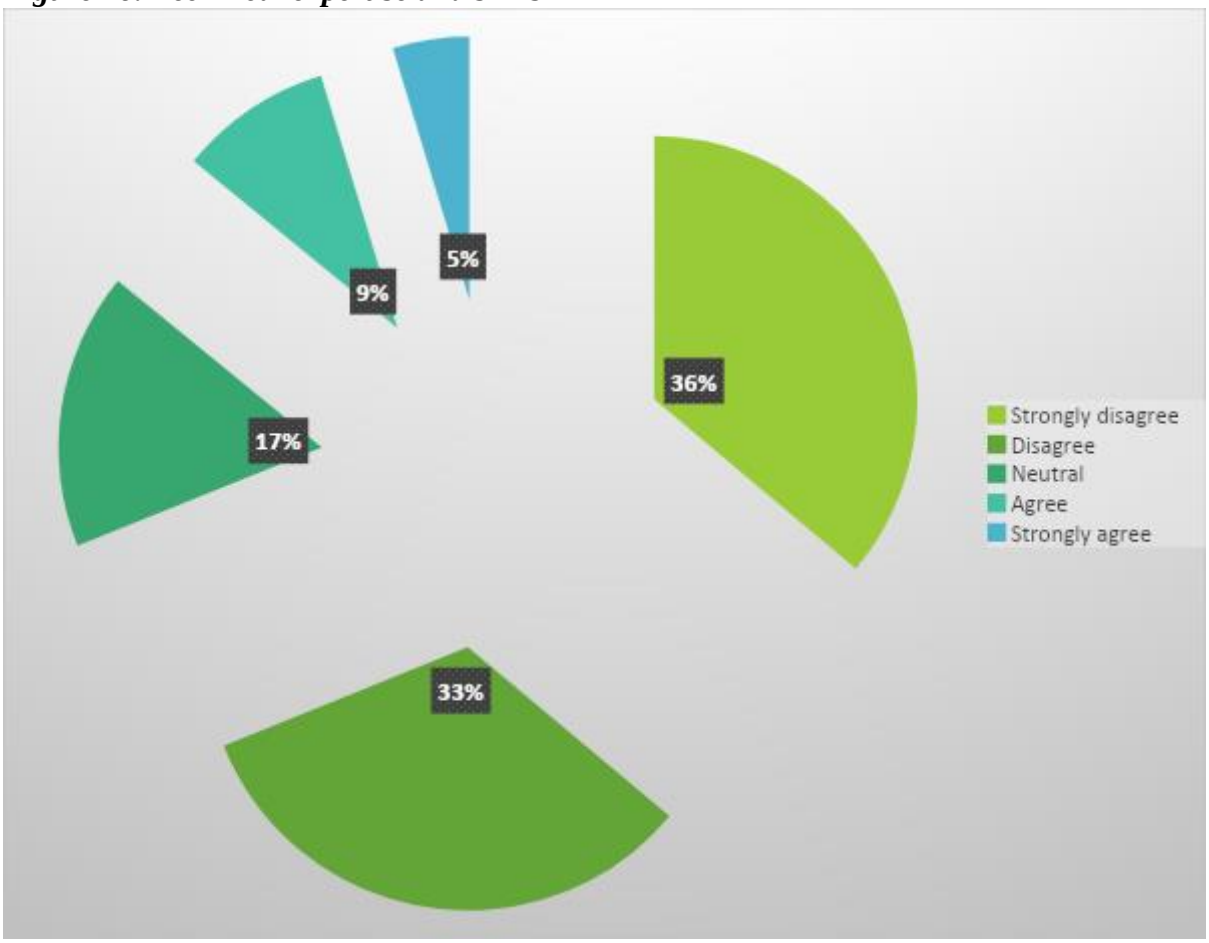
Figure: 15 Time



Source; (Author, 2019)

Most respondents agreed that time was a limiting factor in trying to manage wastes in construction sites, with 16% strongly agreeing and 46% agreeing with the asked question while only 3% strongly disagreed that time affected the management of wastes generated on sites. This is an indication that the time that is considered is the completion of the actual project rather than spending some time to manage wastes.

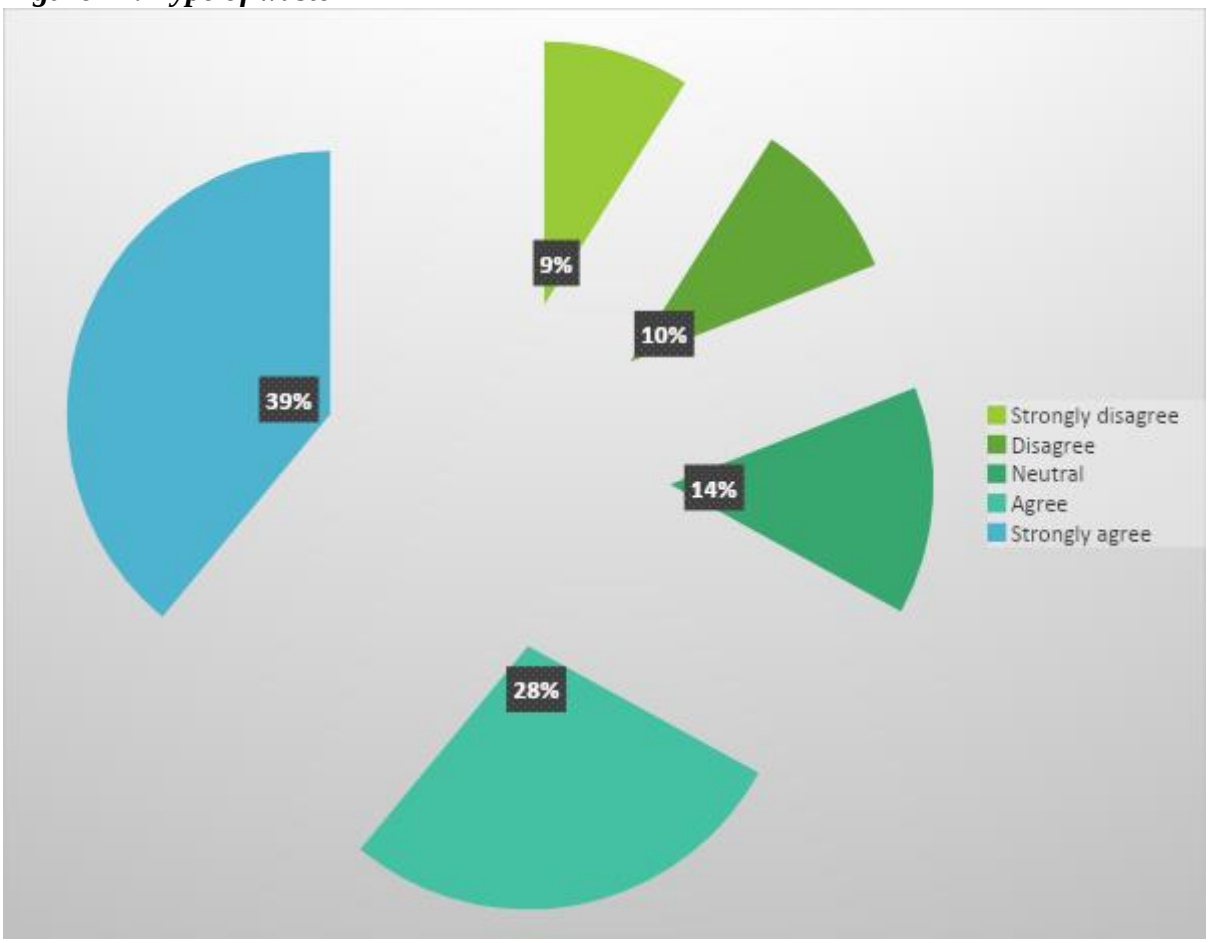
Figure 16: Technical expertise and skills



Source; (Author, 2019)

In a bid to understand whether the presence of technical expertise helps to manage wastes, the respondents were asked to share their opinions. As shown in **Figure 16**, 36% strongly disagreed that the presence of technical expertise posed a challenge in managing wastes on site. 33% of the respondents disagreed that the presence of technical expertise was a limiting factor in the management of construction wastes.

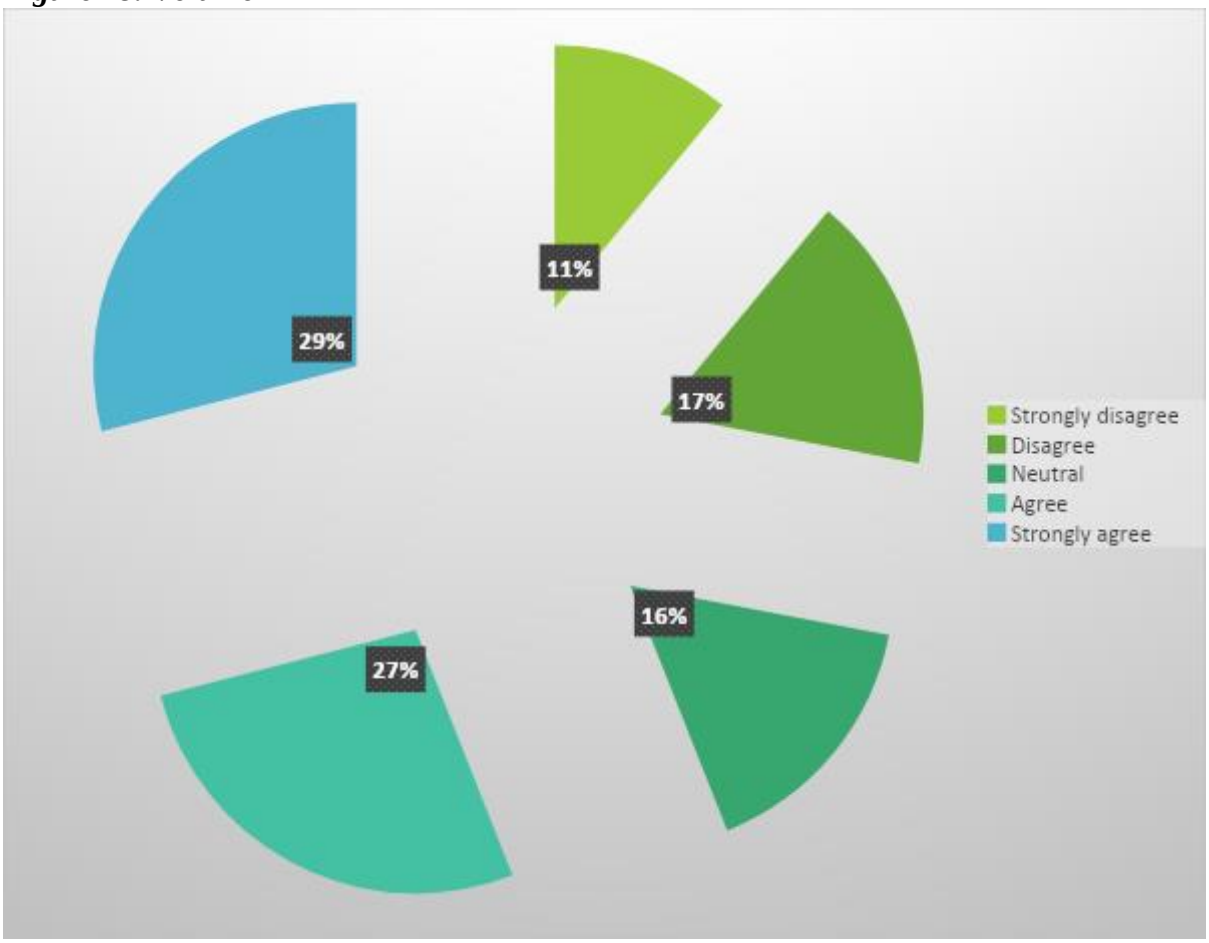
Figure 17: Type of waste



Source; (Author, 2019)

In determining whether the type of waste generated had an effect on the way management was carried out in sites, 39% of the respondents concurred, while 9% of the respondents strongly disagree. This is an indication that the management of wastes in the construction sites is dependent on the type of wastes that are generated. Some wastes are well managed either by recycling or reusing but other wastes are expensive to either reuse or recycle and are disposed out of site.

Figure 18: Volume



Source; (Author, 2019)

Volume was another factor that was asked to the respondents whether it is a limiting factor in managing construction wastes.29% of the respondents strongly agreed and 27% of them agreed that the volume of waste played a huge role in waste management. 11% of the respondents, however, said that the volume of wastes generated did not have an effect on its management. Most contractors manage the wastes very well when the quantity of wastes generated is less because the time they would dedicate to managing the wastes is very insignificant, therefore, it would be a doable task to carry out as compared to when the volume of wastes is huge.

4.8 SOLUTIONS ADOPTED TO MINIMIZE CHALLENGES EXPERIENCED ON SITES

The respondents were asked whether they had solutions for minimizing the challenges that barred them from managing wastes on sites and there were a few solutions that were shared. Some respondents said that they recycled the materials they got from demolition in their subsequent projects. Other respondents said that they replaced the materials that would generate more wastes with more appropriate materials. An example given by one of the respondents is a situation where they use steel structures on sites in place of concrete while erecting beams and columns. The adoption of green building practices is another way in which the contractors have tried to minimize the generation of wastes on sites.

The compliance with the rules stipulated by the regulation authorities is another way in which the construction companies have helped minimize the generation of wastes in Nairobi County. An example is by having waste pits on sites. The presence of waste pits allows the contractors to monitor the wastes generated and consequently reduce the amount of waste dumped on sites.

When asked whether there are measures that the respondents could take to improve waste management on their sites, they gave different opinions. The generation of construction and demolition wastes was observed to be in large quantities as explained by the respondents and the solution most of them suggested was practicing more of recycling. From the questionnaire that was administered to the respondents, it was evident that most of the wastes generated was taken directly to the dumping sites because the contractors did not pay much attention to the recycling and reusing of materials because most of them saw this as a waste of valuable time and monetary resources.

4.9 SUMMARY OF THE PRESENTATION AND ANALYSIS

Based on the information from in this chapter's data, it is evident that the management of wastes is something that is of importance in Nairobi's construction sites and that is of concern to the regulatory authorities too. The fact that a lot of construction sites practice recycling and prevention as said by most respondents is an indication that there is improvement in the management of wastes by the construction industries. The policies put in place by the regulation bodies has been of great importance also as the contractor work towards complying the set rules and regulations.

However, there are some practices that need to be adopted in our country that have proven to help tremendously in minimizing the generation of wastes in the country. Some of these practices include the adoption of green building which has started being embraced by a few stakeholders in the field.

CHAPTER FIVE: CONCLUSION AND RECOMMENDATION

5.1 INTRODUCTION

The study had four objectives which were used to formulate and administer research question which were administered, and the responses presented, analyzed and interpreted in order to get to a conclusion.

This chapter, therefore, presents the recommendations based on the findings of the research and the conclusions that the researcher arrived at.

5.2 CONCLUSION OF RESEARCH FINDINGS

5.2.1 Average amount of waste produced by construction sites in Nairobi County.

The quantity of waste generated in Nairobi by the contractors is of significant amount that cannot be ignored. For this reason the stakeholders in the industry have tried to come up with measures to reduce the quantity of waste generation by adopting measures such as the appropriate technology and green building. Rules such as the limit on wastes being disposed from site and seeking approval before disposing of materials has helped to a great extent in reducing wastes being disposed because the contractors are aware that they have to incur some charges while trying to dispose the wastes from sites to the dumping sites.

5.2.2 Waste management techniques adopted by building contractors and stakeholders

The management of waste generated from construction has been taken seriously by the stakeholders in the industry and there is continuous improvement as to how waste management is being practices in the construction sites. The presence of governing bodies such as NEMA which help in sensitizing the stakeholders in the construction sector have been useful in the adoption of key management practices that would not have otherwise been adopted. Construction sites are required to have sizable waste pits throughout the project cycle and by having such, the wastes can be properly managed.

5.2.3 The impact of waste management techniques on the environment

Policies employed by organizations such as NEMA and NCC have seen tremendous improvement in the management of wastes by the construction companies more especially because there are fines and levies imposed on the contractors for not following the stipulated rules for environmental management. The involvement of the local authorities and the government in the construction process has also been of significant help in the proper management of the wastes and as a result, the minimization of the environmental risks caused by construction has been managed.

5.2.4 Challenges experiences in effecting sustainable waste management

Nairobi County has a very large population and a result, there is need for more buildings, either commercial or residential to feed the growing population. With the increase of the population, there is an increase in the production and generation of wastes. This has been a problem that the county government has been facing seeing as there is need to reduce the wastes generated, which is hard to happen, especially when there is a boom in the market and a slow growth in the waste management techniques. A lot of sensitization has been done on the management of wastes from the site level and the building team generally. The fact that in Nairobi County we have only one dumping site, the Dandora Dumpsite used for dumping all sorts of wastes from the county is an indication that there needs to be more effort by the County of Nairobi authorities in improving the waste management in the county.

5.3 SUMMARY AND RECOMMENDATIONS OF RESEARCH FINDINGS

5.3.1 Average amount of waste produced by construction sites in Nairobi County.

After carrying out the research, it was realized that most construction sites in Nairobi produce a lot of construction and demolition wastes, most of which includes the materials used in constructions such as concrete, stones timber, tiles, metals and ceramics. Large percentage of the wastes generated from these sites could be managed well by way of prevention, replacing, reusing or recycling. There are a lot of ways or recycling materials that are being practiced in other nations that can be adopted here in Kenya for the purpose of reducing the production of wastes in large

quantities. A good example is the use of precast concrete which is being embraced slowly by the contractors. The precast concrete can be used in place of in-situ concrete and it can save on a large quantity of waste generated in site. The presence of foreign firms in our country such as the Chinese has helped a lot in the introduction of appropriate technology, hence, the construction industry is realizing and improvement in the management of wastes. The recommendation for reducing the amount of wastes being generated from sites is by encouraging the contractors in the waste management techniques that are available and to also learn from the best practices globally and to adopt whatever works best for them.

5.3.2 Waste management techniques adopted by building contractors and stakeholders

The construction firms in Nairobi, through the help of the environmental organization bodies have tried to come up with the remedial measures of managing wastes generated from the construction sites. The techniques adopted include: reusing of the materials that could have otherwise been wastes. An example is the use of tiles cut while fixing in landscaping, using stones excess stones in backfilling and using concrete in the external works such as walkways. However, there is a need to improve on the waste management techniques by the construction firms within the country. The adoption of green building is an area that can still be adopted. My recommendation for realizing that more and better waste management techniques are adopted is by involving regulatory bodies such as NEMA,NCC and NEMA on a frequent basis in order to monitor how the construction sites are managing the wastes generated by them.

5.3.3 The impact of waste management techniques on the environment

Wastes generated by contractors can be municipal waste, excavation wastes, and construction and demolition wastes. These wastes have a negative impact on the environment when not properly management. Wastes when disposed of in the wrong places may lead to pollution such as water pollution. For this reason, waste management is encouraged. The only recommendation that I would give for achieving a better impact on the environment is by reducing the waste generated on the construction sites. The governing bodies such as NEMA and NCC have been of great importance in the management of these wastes. Proper management leads to a friendly and conducive environment for people to live in.

5.3.4 Challenges experiences in effecting sustainable waste management

The challenges observed by the construction companies are not adverse and can be well addressed by the stakeholders in the construction companies and the organization bodies. Non-compliance to the regulatory bodies was one of the limiting factors in realizing proper management of the wastes. In the previous months, the county has seen the demolition of sites in riparian zones. This is an indication that some developers do not comply with the rules stipulated by the regulatory bodies. From the responses given in the questionnaire, it is apparent that the limiting factors in realizing proper waste management have been well identified and a good percentage of the respondents have realized where the gap is and they are trying to manage the wastes in every possible way. The recommendation for addressing the challenges experienced in effecting sustainable waste management is by recording the wastes generated on sites and taking note of what is generated most, hence it can be easier for a contractor to know what measures to employ best so as to achieve a good construction environment.

5.4 CONCLUSION

Waste management is critical area that needs more attention than what is getting currently. The boom in the construction industry has realized an increase in the production of wastes from the construction sites, and in Nairobi County, the production of Construction and Demolition wastes is more than the other wastes generated. For this reason, a lot of focus needs to be drawn to waste generation as an environmental risk and more policies need to be made in order to realize good and conducive environments. The construction sites in Nairobi County have realized the importance of waste management and that is why we have the sites taking the measures required of them in order to realize better and conducive construction environments. Various studies have been undertaken on the management of environmental risks caused by the construction sites but very few of them have focused on waste generation. This research, consequently, sheds light on the status of waste generation and focuses on the construction and demolition wastes management by the construction firms. The research concluded that significant waste management techniques have been employed by the contractors in Nairobi County but there is still need to improve on the management so as to achieve best global practice levels.

5.5 AREAS OF FURTHER RESEARCH

Further research can be done on the role of waste management on the health and safety performance of construction firms in Kenya. Another area of further study could be the role and the influence of the regulatory authorities in effective implementation of waste management during the construction process.

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APPENDICES

Appendix I: Introduction Letter

Sharon Jepkemboi,

University of Nairobi,

Dept. of Real Estate and Construction Management

P. O. Box 67174-00200,

Nairobi, Kenya.

Date: ……

Dear Sir/Madam,

R E: INTRODUCTION

I am a student at the University of Nairobi undertaking a Master of Arts degree in Construction Management. I am currently undertaking a research study entitled **'INVESTIGATING THE MANAGEMENT OF ENVIRONMENTAL RISKS IN KENYA'S CONSTRUCTION PROJECTS: CASE STUDY NAIROBI COUNTY'.**

The study is expected to provide useful information that will be beneficial for practitioners in the construction industry in relation to the care of the environment.

You have been identified as one of the respondents to provide information for the study. This is therefore to request you to complete the questionnaire attached as honestly as possible. All information that you provide will be treated with utmost confidence and will be used for the purpose of this study only.

Thank you for your co-operation.

Yours faithfully,

Sharon Jepkemboi,

M.A. Candidate in Construction Management, University of Nairobi.

Appendix II: Questionnaire

Dear Respondent,

This questionnaire has been made to assist in "**INVESTIGATING THE MANAGEMENT OF ENVIRONMENTAL RISKS (MORE SPECIFICALLY, WASTE GENERATION) IN CONSTRUCTION PROJECTS WITHIN NAIROBI COUNTY".** As a person working as and for a construction company, you have been chosen to contribute to this study. I hereby request you to kindly complete this questionnaire. The data collected by this questionnaire will be treated as confidential and will only be used for academic purposes. Thank you in advance for your cooperation and involvement in this exercise.

Section A: General Information

Please state the appropriate response that describe your background information.

1. What is your position/rank in your Organization? ……..
2. What kind of projects are you involved in?

   Residential ( ) Commercial ( ) Health facility ( )
3. Between NCA 1-3, which NCA category is your Construction Company? …….....
4. Nature of Construction work involved majorly?

   Civil Construction Works ( ) Building Construction Works ( ) Renovation Works ( )
5. How long have you worked in the construction Industry? …….

0-5 Years ( ) 5-10years ( ) Over 10 Years.

6. How many years have you worked in a construction site?

0-5 Years ( ) 5-10years ( ) Over 10 Years.

Section B: Average amount of waste generated in a construction site

7. Which of the following environmental risks is your site highly prone to? (Please tick (√) or Mark (X) in the adjacent box)

Resource depletion	
Land degradation	
Air pollution	
Noise pollution	
Water pollution	
Waste generation	

8. Please indicate the extent to which you agree with the following statements by using a scale of 1 to 5 where **1= strongly disagree, 2= Disagree, 3=Neutral, 4=Agree and 5 = strongly agree.**

In our construction site, the following wastes are generated in large quantities					
Resource depletion					
Land degradation					
Air pollution					
Noise pollution					
Water pollution					
Waste generation					

3. Please tick (√) or (X) which best describes the materials that are mostly generated on your site.

Plastics	
Metals	
Concrete	
Stones	
Aluminum	
Timber	
Tiles	
Ceramics	

4. Please tick (√) or (X) which best describes the hazardous materials that mostly generated on your site.

Asbestos	
Solvents	
Mineral fibers	
Lead	
Fiber glass	
Silica	

5. Please indicate the extent to which you agree with the following statements by using a scale of 1 to 5 where **1= strongly disagree, 2= Disagree, 3=Neutral, 4=Agree and 5 = strongly agree.**

Please tick (√) or (X) which best describes your opinion of the statement.

During the construction process, the following is normally done;	1	2	3	4	5
Material wastes are usually segregated into various types before dumping					
Our construction site sets aside space for a sizable waste pit					
The waste generated on site is disposed of from site very frequently					

Section C: Waste management techniques employed by the team on sites

6. Please indicate the extent to which you agree with the following statements by using a scale of 1 to 5 where **1= strongly disagree, 2= Disagree, 3=Neutral, 4=Agree and 5 = strongly agree.**

Please tick (√) or (X) which best describes your opinion of the statement.

In relation to the waste management techniques available, our site usually;	1	2	3	4	5
Complies to all of NEMA'S rules and regulations on waste handling					
Complies to all of NCA's rules and regulations on waste handling					
Complies to all of NCC's rules and regulations on waste handling					
Has a team of employees periodically trained on environmental management					
Tries every day to minimize waste management by recycling and reusing the wastes whenever possible					
Has a waste management policy just to combat waste management in the site					

7. Please tick (√) or (X) which best describes the measures taken to minimize waste generation on your site.

Prevention	
Reuse	
Recycling	
Replace	

8. Please indicate the extent to which you agree with the following statements by using a scale of 1 to 5 where **1= strongly disagree, 2= Disagree, 3=Neutral, 4=Agree and 5 = strongly agree.** Please tick (√) or (X) which best describes your opinion of the statement.

When waste is generated on site;	1	2	3	4	5
We segregate our wastes on site with reference to the type of waste generated					
We often salvage the materials that are not damaged badly					
We always keep excess material left after usage for the next project					
We always solicit opinions from environmental organizations on how to properly manage them					

Section D: Impact of waste management techniques on the environment

9. Please indicate the extent to which you agree with the following statements by using a scale of 1 to 5 where **1= strongly disagree, 2= Disagree, 3=Neutral, 4=Agree and 5 = strongly agree.**

Please tick (√) which best describes your opinion of the statement.	1	2	3	4	5
Most of the waste generated in our sites is reused after they are carefully handled					
The waste management policies employed by NEMA and NCC have positively affected the environment					

Section E: Challenges experienced relating to waste minimization.

10. Please indicate the extent to which you agree with the following statements by using a scale of 1 to 5 where **1= strongly disagree, 2= Disagree, 3=Neutral, 4=Agree and 5 = strongly agree.**

These are the main challenges limiting the effective waste management in our site?	1	2	3	4	5
Management					
Cost					
Laws and regulations					
Time					
Technical expertise and skills					
Type of waste					
Volume					

11. What solutions has your site adopted to minimize these challenges?

_____

12. Are there any techniques that could be used to properly managed wastes in our site?

_____

Appendix III: Random sampling table

Table of Random Numbers

36518 36777 89116 05542 29705 83775 21564 81639 27973 62413 85652 62817 57881
46132 81380 75635 19428 88048 08747 20092 12615 35046 67753 69630 10883 13683
31841 77367 40791 97402 27569 90184 02338 39318 54936 34641 95525 86316 87384
84180 93793 64953 51472 65358 23701 75230 47200 78176 85248 90589 74567 22633
78435 37586 07015 98729 76703 16224 97661 79907 06611 26501 93389 92725 68158
41859 94198 37182 61345 88857 53204 86721 59613 67494 17292 94457 89520 77771
13019 07274 51068 93129 40386 51731 44254 66685 72835 01270 42523 45323 63481
82448 72430 29041 59208 95266 33978 70958 60017 39723 00606 17956 19024 15819
25432 96593 83112 96997 55340 80312 78839 09815 16887 22228 06206 54272 83516
69226 38655 03811 08342 47863 02743 11547 38250 58140 98470 24364 99797 73498
25837 68821 66426 20496 84843 18360 91252 99134 48931 99538 21160 09411 44659
38914 82707 24769 72026 56813 49336 71767 04474 32909 74162 50404 68562 14088
04070 60681 64290 26905 65617 76039 91657 71362 32246 49595 50663 47459 57072
01674 14751 28637 86980 11951 10479 41454 48527 53868 37846 85912 15156 00865
70294 35450 39982 79503 34382 43186 69890 63222 30110 56004 04879 05138 57476
73903 98066 52136 89925 50000 96334 30773 80571 31178 52799 41050 76298 43995
87789 56408 77107 88452 80975 03406 36114 64549 79244 82044 00202 45727 35709
92320 95929 58545 70699 07679 23296 03002 63885 54677 55745 52540 62154 33314
46391 60276 92061 43591 42118 73094 53608 58949 42927 90993 46795 05947 01934
67090 45063 84584 66022 48268 74971 94861 61749 61085 81758 89640 39437 90044
11666 99916 35165 29420 73213 15275 62532 47319 39842 62273 94980 23415 64668
40910 59068 04594 94576 51187 54796 17411 56123 66545 82163 61868 22752 40101
41169 37965 47578 92180 05257 19143 77486 02457 00985 31960 39033 44374 28352
76418

Appendix IV: Green building rating and certification systems.

BUILDING RATING OR CERTIFICATION SYSTEM	SINGLE- OR MULTI-ATTRIBUTE	TYPE OF STANDARD OR CERTIFICATION	MANAGING ORGANIZATION	ISSUES / AREAS OF FOCUS
1.Leadership in Energy and Environmental Design (LEED)	Multi-Attribute	Green building rating and certification system through independent third-party verification for: New Construction (NC) Existing Buildings, Operations &	U.S. Green Building Council	Performance in: Sustainable Sites Water Efficiency Energy & Atmosphere **Materials & Resources** Indoor Environmental Quality Locations & Linkages Awareness & Education Innovation in Design Regional Priority through a set of prerequisites and credits

		Maintenance (EB O&M) Commercial Interiors (CI) Core & Shell (CS) Schools (SCH) Retail Healthcare (HC) Homes Neighborhood Development (ND)		
2.Building Research Establishment Environmental Assessment Method (BREEAM)	Multi-Attribute	Green building rating and certification system through on-site independent third-party verification for: New Construction In-Use	BRE Global	Performance in: Energy Health & Well-being Transport Water **Materials** **Waste** Land Use & Ecology Management **Pollution**

		Refurbishment & Fit Out Communities Infrastructure		No prerequisites for In-Use
3.Green Globes	Multi-Attribute	Green building guidance and assessment program for: Existing buildings New construction	Green Building Initiative in the U.S. BOMA Canada	Environmental assessment areas to earn credits in: Energy Indoor Environment Site Water **Resources** Emissions **Project/Environmental Management**

				No prerequisites
4.Living Building Challenge	Multi-Attribute	Performance-based standard, and certification program for: Landscape and infrastructure projects Partial renovations and complete building renewals New building construction Neighborhood, campus and community design	International Living Future Institute	Performance areas include: Site Water Energy **Materials** Health Equity Beauty All areas are requirements.

5.Beam (Hong Kong)	Multi-Attribute	Comprehensive standard and supporting process covering all building types, including mixed use complexes, both new and existing to assess, improve, certify, and label the environmental performance of buildings	Business Environment Council	Performance and assessment in: Site aspects **Material aspects** Water use Energy use Indoor environmental quality Innovations and additions
6.CASBEE (Japan)	Multi-Attribute	Building assessment tools for Pre-design New Construction	JSBC (Japan Sustainable Building Consortium) and its affiliated sub-committees	Assessment areas include: Energy efficiency **Resource efficiency** Local environment, and Indoor environment

		Existing Building and Renovation		
7.EDGE	Multi-Attribute	A universal standard and a certification system for residential and commercial structures.	International Finance Corporation (IFC), a member of the World Bank Group	Assessment areas include: Energy Water **Materials**
8.Green Star SA (South Africa)	Multi-Attribute	Green building rating system for: Office Retail Multi-unit residential	Green Building Council of South Africa administers program Independent assessors to assess and score projects	Categories assessed in: Management Indoor Environmental Quality Energy Transport Water **Materials** Land Use & Ecology Emissions

				Innovation
9.Pearl Rating System for Estidama (UAE)	Multi-Attribute	Green building rating system for: Community Buildings Villas Temporary Villas and Buildings	Abu Dhabi Urban Planning Council	Assessment of performance in: Integrated Development Process Natural Systems Livable Communities Precious Water Resourceful Energy **Stewarding Materials** Innovating Practice

Source; (USGBS, 2016)